water and sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments

STATUS QUO AND DELINEATION OF INTEGRATED UNITS OF ANALYSIS AND RESOURCE UNIT REPORT

FINAL
May 2022

FC/02771.cdr
Last updated: 2022/05/26

Department of Water and Sanitation

Chief Directorate: Water Ecosystem Management

PROJECT NUMBER**:** WP 11387

Status Quo and Delineation of Integrated Units of Analysis and Resource Unit Report

CLASSIFICATION OF SIGNIFICANT WATER RESOURCES AND DETERMINATION OF RESOURCE QUALITY OBJECTIVES FOR WATER RESOURCES IN THE USUTU TO MHLATHUZE CATCHMENTS

MAY 2022

REFERENCE

This report is to be referred to in bibliographies as:

Department of Water and Sanitation, South Africa, May 2022. Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: Status Quo and Delineation of Integrated Units of Analysis and Resource Unit Report. Prepared by: WRP Consulting Engineers (Pty) Ltd. DWS Report: WEM/WMA3/4/00/CON/CLA/0222.

REPORT SCHEDULE

Report Index Number	DWS Report Number	Report Title
1	WEM/WMA3/4/00/CON/CLA/0122	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Inception Report including Gap Analysis chapter**
2	**WEM/WMA3/4/00/CON/CLA/0222**	**Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: Status Quo and Delineation of Integrated Units of Analysis and Resource Unit Report**
3	WEM/WMA3/4/00/CON/CLA/0322	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Resource Units Delineation and Prioritisation Report**
4	WEM/WMA3/4/00/CON/CLA/0422	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Hydrology Systems Analysis Report**
5	WEM/WMA3/4/00/CON/CLA/0522	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **River EWR estimates for Desktop Biophysical Nodes Report**
6	WEM/WMA3/4/00/CON/CLA/0622	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **River Survey Report**
7	WEM/WMA3/4/00/CON/CLA/0722	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Basic Human Needs Report**
8	WEM/WMA3/4/00/CON/CLA/0822	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Groundwater Report**
9	WEM/WMA3/4/00/CON/CLA/0922	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **River specialist meeting Report**
10	WEM/WMA3/4/00/CON/CLA/1022	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Estuary Survey Report**
11	WEM/WMA3/4/00/CON/CLA/1122	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Wetland Report**
12	WEM/WMA3/4/00/CON/CLA/1222	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Ecological Water Requirements Report**
13	WEM/WMA3/4/00/CON/CLA/1322	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Scenario Description Report**
14	WEM/WMA3/4/00/CON/CLA/0123, Volume 1	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Ecological Consequences Report, Volume 1: Rivers**
	WEM/WMA3/4/00/CON/CLA/0123, Volume 2	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Ecological Consequences Report,**

Report Index Number	DWS Report Number	Report Title
		Volume 2: Estuaries
15	WEM/WMA3/4/00/CON/CLA/0323	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Ecosystem Services Consequences Report**
16	WEM/WMA3/4/00/CON/CLA/0423	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Economic & User water quality Consequences Report**
17	WEM/WMA3/4/00/CON/CLA/0523	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Water Resource Classes Report**
	WEM/WMA3/4/00/CON/CLA/0623, Volume 1	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Resource Quality Objectives Report, Volume 1: Rivers**
18	WEM/WMA3/4/00/CON/CLA/0623, Volume 2	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Resource Quality Objectives Report, Volume 2: Estuaries**
	WEM/WMA3/4/00/CON/CLA/0623, Volume 3	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Resource Quality Objectives Report, Volume 3: Wetlands and Groundwater**
19	WEM/WMA3/4/00/CON/CLA/0723	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Monitoring and Implementation Report**
20	WEM/WMA3/4/00/CON/CLA/0124	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Main Report**
21	WEM/WMA3/4/00/CON/CLA/0224	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Issues and Responses Report**
22	WEM/WMA3/4/00/CON/CLA/0324	Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Close out Report**

Shaded Grey refers to this report.

APPROVAL

Project Name:	*Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments*
Report Title:	***Status Quo and Delineation of Integrated Units of Analysis and Resource Unit Report***
Author(s):	*Louw, D., Cloete, R., Huggins, G., Mackenzie, J., Sami, K., Scherman, P., Seago, C.J. and Van Niekerk, L.*
Editor:	*S Koekemoer*
Client Report No.:	*WEM/WMA3/4/00/CON/CLA/0222*
Contract Number:	*WP11387*
Lead Consultant:	*WRP Consulting Engineers, supported by Scherman Environmental*
Status of Report:	*FINAL*
First Issue:	*April 2022*
Final Issue:	*May 2022*

Approved for the PSP by:

.....

CJ Seago

Study Leader

Approved for the Department of Water and Sanitation by:

07/06/2022

.....

Mr Mkhevu Mnisi

Project Manager

4/7/2022

.....

Ms Lebogang Matlala

Director: Water Resource Classification of

CD: Water Ecosystem Management

ACKNOWLEDGEMENTS

The following persons are acknowledged for their contribution to this report:

Project Management Team:

Matlala, L	DWS: Water Resource Classification
Mnisi, M	DWS: Water Resource Classification
Makanda, C	DWS: Water Resource Classification
Khoza, P	DWS: Reserve Determination (Ground Water)
Pillay, R	DWS: Regional Office, Water Quality Planning
Sawunyama, T	IUCMA: Inkomati-Usuthu Catchment Management Agency

AUTHORS

The following persons contributed to this report:

Author	Company
Louw, Delana	Rivers for Africa
Cloete, Riekie	Conningarth Economists
Huggins, Greg	Nomad Consulting
Koekemoer, Shael	Koekemoer Aquatic Services
Mackenzie, James	MacKenzie Ecological & Development Services
Sami, Karim	WSM Leshika
Scherman, Patsy	Scherman Environmental
Seago, Caryn	WRP Consulting Engineers
Van Niekerk, Lara	Council for Scientific and Industrial Research (CSIR)

EXECUTIVE SUMMARY

BACKGROUND

Chapter 3 of the National Water Act, 1998 (NWA) (Act 36 of 1998), deals with the protection of water resources. Section 12 of the NWA requires the Minister to develop a system to classify water resources. In response to this, the Water Resource Classification System (WRCS) was gazetted on 17 September 2010 and published in the Government Gazette no. 33541 as of Regulation 810. The WRCS is a step-wise process, whereby water resources are categorised according to specific classes that represent a management vision of a particular catchment. This vision takes into account, the current state of the water resource, the ecological, social, and economic aspects that are dependent on the resource. Once significant water resources have been classified through the WRCS, Resource Quality Objectives (RQOs) have to be determined to give effect to the class.

The Chief Directorate: Water Ecosystems Management (CD: WEM) of the Department of Water and Sanitation (DWS), initiated a study to determine the Water Resource Classes and RQOs for all significant water resources in the Usutu to Mhlathuze Catchment. The Usutu to Mhlathuze Catchments are amongst many water-stressed catchments in South Africa. These catchment areas are important for conservation, and contain a number of protected areas such as natural heritage sites, cultural and historic sites, as well as other conservation areas that need protection.

STUDY AREA

The study area is the Usutu to Mhlathuze Catchment, which has been divided into six drainage areas, as well as secondary catchment areas:

- W1 catchment (main river: Mhlathuze).
- W2 catchment (main river: Umfolozi).
- W3 catchment (main river: Mkuze).
- W4 catchment (main river: Pongola) - part of this catchment area falls within Eswatini.
- W5 catchment (main river: Usutu) - much of this catchment falls within Eswatini.
- W7 catchment (Kosi Bay and Lake Sibaya).

PURPOSE OF THIS REPORT

The Purpose of this report is to describe the status quo of the water resources in the Usutu to Mhlathuze Catchment in terms of the water resource system. The report is to documents the results of Task 1: Delineate Integrated Units of Analysis (IUAs) and Resource Units (RU) and describe the status quo of the Usutu to Mhlathuze Catchment. The objective of this task is to define IUAs, and to provide a status quo description of each IUA.

STATUS QUO: SURFACE WATER RESOURCES

The Study Area includes six secondary catchments, for which the status quo has been outlined as part of this report. The significant surface water resources of the catchments and the main users are summarised in **Table 1**.

Table 1 Significant surface water resources of the catchments and the main users

Secondary catchment	Area (km^2)	MAR (million m^3/a)	Dam capacity (million m^3)	Main impoundments	Domestic & Industrial use (million m^3/annum)	Afforestation area (ha)	Irrigation use (million m^3/annum)	Transfers in	Transfers out
W1	5 661	816	314	Goedertrouw Dam, Lake Nsezi, Lake Mzingazi, Lake Nhlabane, Lake Cubhu	107	64 072	140	From Thukela From Umfolozi (Thukela: current capacity: 38 million m^3/a, future to be doubled, Umfolozi: 8 million m^3/a)	-
W2	10 008	825	35	Vuna Dam, Vokwena Dam, Klipfontein Dam	30	57 846	53	-	To Mhlathuze (8 million m^3/a)
W3	9 545	578	48	Hluhluwe Dam	4	38 042	85	From Pongola (20 million m^3/a)	-
W4	11 714	1104	2571	Pongolapoort Dam	26	75 610	275	-	To Mkuze (20 million m^3/a)
W5*	7 627	949	695	Westoe Dam, Jericho Dam, Morgenstond Dam, Heyshope Dam,	11	226 510	12	-	To Vaal & Olifants (from Jericho: 74 million m^3/annum, from Heyshope, 135 million m^3/annum.
W7	2 589	143	0	Lake St Lucia	3	24 591	0	-	-

*Note: All figures include RSA portion only.

STATUS QUO: GROUNDWATER

Groundwater recharge is 2998 Mm^3/a, of which 1836 Mm^3/a is aquifer recharge. Baseflow is 2319 Mm^3/a. Groundwater use is less than 20 Mm^3/a.

Groundwater is of Class 0 (<70 mS/m) over most of the study area. Poor quality groundwater is associated with the upper Karoo Letaba and Jozini Formations, and in the Cretaceous sediments. Elevated nitrates are found in isolated localities. This can be attributed to the removal of vegetation and possibly sanitation practices. Elevated fluoride is found in the upper Karoo volcanics, and in some the some intrusive and extrusive granitoids, volcanics and metamorphics.

W1 Catchment: Recharge declines from over 200 mm/a on the Northern Zululand Coastal Plain to 50 - 60 mm/a inland. Aquifer recharge is 100 - 150 mm/a on the coastal plain and only 20 - 40 mm/a inland. Groundwater is minimally used and the stress index is below 0.05. Baseflow generation decreases inland from 135 mm/a to 40 mm/a. On the middleveld and lowveld, 30-40%

of baseflow is from groundwater. The percentage declines towards the coast and in the more rugged Kwazulu-Natal Coastal Foreland.

W2 Catchment: Recharge declines from over 200 mm/a on the Northern Zululand Coastal Plain to 30 - 40 mm/a inland on the Lowveld and Middleveld. Aquifer recharge is over 150 mm/a on the coastal plain. It declines rapidly to less than 40 mm/a inland and is only 10 - 20 mm/a over the Middleveld and Lowveld. Groundwater is minimally used and the stress index is below 0.2. Baseflow generation decreases inland from 80 mm/a to 10 mm/a. Groundwater baseflow increases proportionally from 20% to over 40% of baseflow towards the coast.

W3 Catchment: Recharge declines from 150 - 200 mm/a on the Northern Zululand Coastal Plain to 20 - 30 mm/a inland on the Lowveld and Middleveld. Aquifer recharge is 100 - 190 mm/a on the sandy coastal plain where interflow is minor and decreases from 40 mm/a to 10 mm/a inland. Groundwater is minimally used and the stress index is below 0.05.
Baseflow generation decreases inland from 60 mm/a to 6 mm/a. With the broadening of the flat coastal plain northwards, interflow becomes less significant and over 60% of baseflow is from groundwater in the Lowveld and coastal plain. In the Middleveld it is less than 30%.

W4 Catchment: Recharge is only 10 - 20 mm/a on the drier Lowveld west of the Lebombo range. The highest recharge is on the escarpment of the North-western Highveld, where it reaches 100 - 150 mm/a. Aquifer recharge is over 40 mm/a on the Northern Zululand Coastal Plain, but only 10 - 15 mm/a in the Lowveld. It is 15 - 30 mm/a in the North-eastern and North-western Middlevelds. Groundwater is minimally used and the stress index is below 0.05. Baseflow generation decreases to the east from 125 mm/a on the escarpment to 6 mm/a in the Lowveld. The proportion of groundwater baseflow increases from 10% to 70% towards the east.

W5 Catchment: Recharge in the South African portion of the catchment ranges from 50 - 100 mm/a increasing eastward. Aquifer recharge is only 15 - 30 mm/a. Due to hilly nature of the catchment, much of the recharge is lost as interflow. Groundwater is minimally used and the stress index is below 0.2. Baseflow generation increases to the east from 20 mm/a on the Highveld to 100 mm/a at the border in the Middleveld escarpment to 6 mm/a in the Lowveld. Groundwater baseflow is 10 - 30% of total baseflow.

W7 Catchment: Recharge to Q70A is 133 mm/a. Aquifer recharge is 132 mm/a. Due to the flat sandy nature of the catchment, interflow does not occur and all recharge percolates to the regional aquifer as aquifer recharge. Groundwater is minimally used and the stress index is below 0.05. Baseflow in the catchment is 25 mm/a. The majority of baseflow is not to rivers, but as through flow to coastal lakes where they cut into the Uloa Formation. 97% of baseflow is from groundwater baseflow.

STATUS QUO: ECONOMICS

The economic analysis consists of the status quo of the current economic activities that is directly and indirectly water dependant. The water users in the primary sector that is directly dependant involves irrigation agriculture and commercial forestry. They are divided into the main crops and tree species that are produced in the Usutu to Mhlathuze Catchment. Sugar cane irrigation and gum trees are the prominent water users that initiate secondary and tertiary sector economic activities. These water users produce different products that keep the sugar and sawmills operational. Several ecotourism facilities are also operating in the Study Area. They are not

necessary water large water users, but if water sources in the catchment are reduced, it can affect production.

The description of the economic activities is provided below according to secondary catchment:

- **W1 Catchment:** It is a busy economic catchment. Land use comprises of irrigated sugar cane, citrus, vegetables and commercial forests. Industries include a paper mill, sugar mill, shipping and port activities in Richards Bay and Empangeni.
- **W2 Catchment:** This sub-catchment consists of various economic activities. Cultivation of irrigated maize, vegetables and sugar cane occurs in the area. Thirty percent of the total commercial forestry takes place here as well as saw- and sugar mill activities at Mtubatuba. Ecotourism is at St Lucia Lake and the iMfolozi and Hluhluwe Game Reserves. In December 1999, the iSimangaliso Wetland Park was declared a UNESCO World Heritage Site. The park covers areas in both W2 and W3 secondary catchments.
- **W3 Catchment:** Cultivation in this sub-catchment consists of Queen pineapples, winter vegetables, sugar cane and commercial forestry. Ecotourism features the uMkuze Game Reserve.
- **W4 Catchment:** Consists of the largest sugar cane irrigation land use in the total catchments and includes a sugar mill situated at Pongola town.
- **W5 Catchment:** Mostly irrigated maize and winter vegetables are produced in the catchment. Close to 40% of commercial forestry of the total catchment is produced in W5. Production of paper products takes place at a paper mill in Piet Retief.
- **W7 Catchment:** Economic activities are limited to a small share of commercial forestry production compared to the rest of the catchment. The area is rather renowned for its ecotourism activities with the main attractions at the Kosi Estuary and Lake Sibaya.

STATUS QUO: WATER QUALITY

The study catchments are still largely rural, with the impacts of coal mining (present and past) and mine decant still present in certain areas. Water quality issues appear to be localised due to problems such as non-compliant Waste Water Treatment Works (WWTW), failing sewage infrastructure and industrial complexes, although non-point sources of pollution such as increasing salinity levels are widespread and difficult to manage.

The drivers of water quality state in aquatic systems in the study area are largely the following:

- Coal mining operations and associated consequences, particularly in the northern and north-western region and particularly where the mines have been closed (DWS, 2020). The Richards Bay Coal Terminal is the centre of operations for SA's aluminium industry, making SA the second-largest exporter of steam coal in the world (source: https://municipalities.co.za/provinces/view/4/kwazulu-natal).
- The growth of the Richards Bay urban/industrial complex; both in terms of water demand and waste discharge (DWS, 2020).
- Irrigation return-flows and rising salinity levels. The sugarcane plantations along the coastal belt are critical to the Gross Domestic Product (GDP) of the area, together with the sub-tropical fruit grown in the area. Farmers inland concentrate on vegetable, dairy and stock farming (source: https://municipalities.co.za/provinces/view/4/kwazulu-natal).
- Areas of poor land management have resulted in high sedimentation levels in river systems.
- Extensive forestry in the areas around Vryheid, Eshowe, Richmond, Harding and Ngome (source: https://municipalities.co.za/provinces/view/4/kwazulu-natal).

- Cholera and other diseases have been reported in some rural areas due to poor sanitation and using run-of-river for domestic use (DWS, 2020).
- Most of the municipal WWTW are only partially functional and therefore contribute to some form of pollution within the river catchments. Some of the challenges observed include, but are not limited to, the following (K Naidoo, DWS KZN, *pers. comm*.):
  - Burst pipes/manhole overflows.
  - Pump station failure.
  - Non-functional components of the WWTW.
  - Inadequate disinfection leading to discharge of poor-quality effluent.
  - Nutrient enrichment downstream of WWTW discharges and irrigation schemes. Toxic algal blooms and game fatalities have been reported in the upper reaches of Pongolapoort Dam. Filamentous algal growth has been seen in the Assegaai River downstream of Piet Retief, and algal blooms in the Klipfontein Dam near Vryheid on the upper Umfolozi River (DWS, 2020).

The identification of water quality priority areas (shown as tables per secondary catchment) are based on a water quality impact rating (0 - 5) assigned to priority areas, i.e. from 3 (Large) to Critical (5). Estuaries with a High or Very High Pollution Pressure status have been included in water quality priority tables.

STATUS QUO: ECOSYSTEM SERVICES

The Usutu-Mhlathuze Water Management Area, because of the nature of the communities that it intersects, plays an important role in maintaining important Ecological Goods, Services and Attributes (EGSA) on-site as well as other users. An EGSA is a product that emerges from processes or features within largely natural environments, which enhances human wellbeing and is directly used by people. 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 primary tools. These were:

- Geographic Information System (GIS) overlays of quaternary catchments
- Cross check of GIS data with available mapping to determine livelihood profiles.

In terms of EGSA the most critical aspects per Catchment are the following:

- The Mhlathuze Catchment includes a diverse set of settlement types as well as land and economic uses. In terms of provisioning aspects of the ecosystem services the rivers and their associated goods are potentially most important to the hinterland areas given over to Ingonyama Trust.
- As with the Mhlathuze, the Mfolozi Catchment includes a diverse set of settlement types as well as land and economic uses. The Hluhluwe iMfolozi Game Park is of considerable importance as a nature reserve. The river and its integrity are crucial to the functioning of the Park. In terms of provisioning aspects of the ecosystem services the rivers and their associated goods are potentially most important to the hinterland areas given over to Ingonyama Trust. The Ulundi areas are of interest in this regard, The area is associated with the central Zulu Kingdom and the ritual and historical aspects are also of importance.
- The Mkuze area is made up of subsistence farming (Ingonyama Trust) commercial farming, extensive game and nature reserves including state or private concerns. Again, in terms of provisioning aspects of the ecosystem services the rivers and their associated goods are potentially most important to the hinterland areas given over to Ingonyama Trust. The

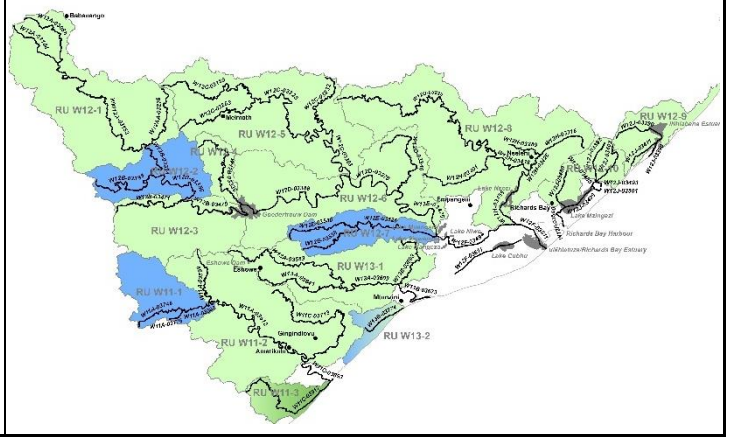
DukuDuku area is prominent with respect to the importance of provisioning services. The northern Zulu Kingdom historical aspects are of importance.

- The Pongola Catchment includes a mixture of land use and types of economic activity. Downstream of Jozini Dam the area is given over to Tribal Trust land that includes the Makhathini Flats. People in this area are closely reliant on provisioning services provided by the river and its floodplains.
- The Usutu area includes a series of catchments west of eSwatini. The Assegai River and tributaries upstream of Driefontein are mostly given over to commercial farming. The Usutu as it exits Swaziland is mostly Ngonyama Trust and the Ndumo Game Reserve and this is important in terms of EGSA considerations.
- The W7 catchment (Kosi Bay and Sibaya Lake) includes systems that feed into Kosi Bay as well as Lake Sibaya. The water bodies function as key providers of provisioning services for subsistence communities.

ECOLOGICAL RIVER STATE

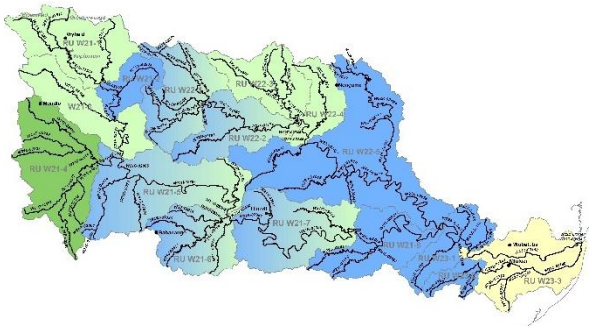
Determination of the Present Ecological State (PES), which represents the ecological status quo of the rivers, is undertaken as part of the EcoClassification process. Data from a countrywide desktop assessment, referred to as the PES/EI/ES or PESEIS project, was used as the baseline for the status quo assessment. The status quo assessment consists of a table and short summary for each tertiary catchment. The PES is provided as an integrated state, the EcoStatus. Different processes are followed for each component to assign an Ecological Category (EC) from A to F (where A is natural, and F is critically modified). Colours in the figures are as follows: A (light blue), B (dark blue), C (light green), D (dark green), E (yellow), F (red). Half categories indicate shades of the relevant category for example; B/C EC would be dark blue and light green.

Table 2 Ecological status quo of rivers

Status Quo Description	RU PES ECs
W1 Catchment (Main River: Mhlathuze)	
▪ W11: Mostly non-flow related activities – extensive agriculture, vegetation clearing, alien vegetation. Mostly in a C (moderately modified) condition. ▪ W12: Upstream of Goedertrouw Dam – roads, extensive overgrazing, sand mining, alien vegetation, forestry, small dams. – mostly in C condition. ▪ W12: Downstream of Goedertrouw Dam. Mostly in C EC. Tributaries dominated by rural settlements, forestry, dry land cultivation, dams and towns. The Mhlathuze River has changed in character (alluvial to a rapid pool system) and is canalised and highly modified in lower sections. ▪ W13: Mlalazi River – parts associated with Umlalazi Nature Reserve and in a B/C EC.	

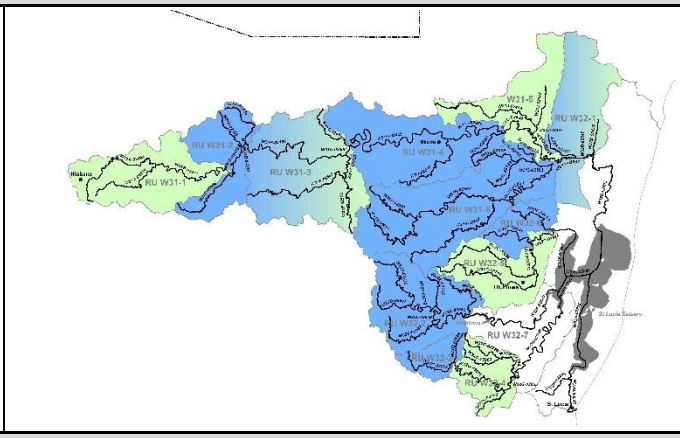
W2 Catchment (Main River Umfolozi)

- W21 & 22 White & Black Umfolozi and tributaries outside the Hluhluwe iMfolozi Game Reserve - forestry, dams, irrigation, erosion, sedimentation, coal mining around Vryheid. Mostly in a C EC.
- W21 & 22 White & Black Umfolozi and tributaries bordering or in Hluhluwe iMfolozi Game Reserve mostly in a B EC.
- W23 Umfolozi in and downstream of the Hluhluwe iMfolozi Game Reserve in a B EC. Further downstream it falls to an E EC due to extensive forestry, irrigated sugar cane and canalisation.



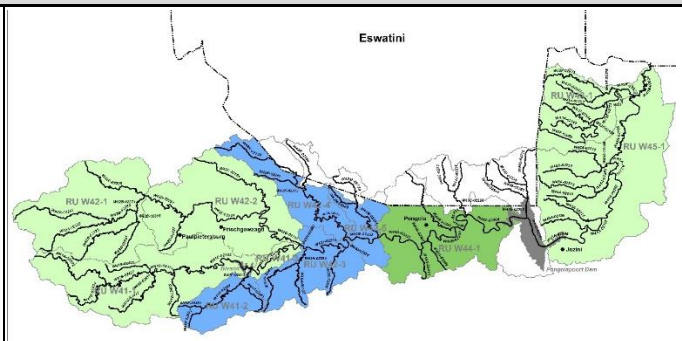
W3 Catchment (Main River Mkuze)

- W31 (Mkuze River) varies from C to B. Impacts are forestry, coal mining, dams, rural areas, irrigated crops, alien vegetation, instream dams, erosion and sedimentation. B section in or bordering uMkuze Game Reserve.
- W32 (Hluhluwe River) B in or bordering Hluhluwe iMfolozi Game Reserve. Tributaries in a C EC (overgrazing, sand mining, subsistence farming, erosion, sugarcane, urban, dams and levees).



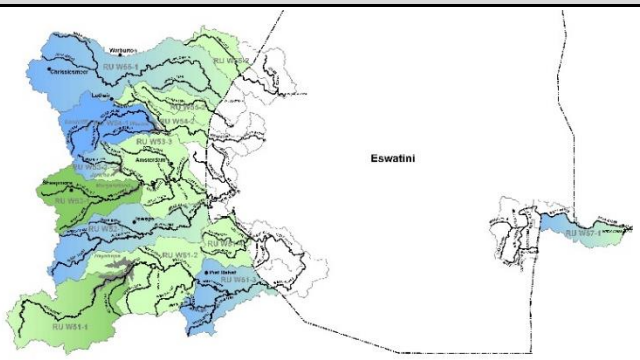
W4 Catchment (Main River Pongola)

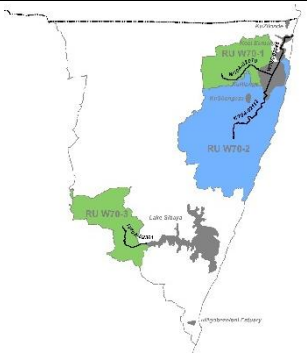
- W41 (Bivane River) in a C EC. Upstream from Bivane Dam – forestry, agriculture.
- W42 (Pongola River and tributaries) varies from a C and B (Ithala Game Reserve) EC. Impacts are extensive forestry, agriculture, dams, urban areas, alien vegetation, overgrazing, erosion, sand mining.
- W44 (Pongola River) D EC. Impala Irrigation Board canal system, Grootdraai Weir, extensive flow changes, sugar cane farming.
- W45 (Pongola River, Floodplain and Tributaries downstream of Pongola Dam) C EC. Significant changes in flow regime.
- W43 (Ngavuma River) in C EC – subsistence farming, overgrazing, forestry, sedimentation, alteration of drainage lines.



W5 Catchment (Main River Usutu)

- W51 (Assegaai River). Upstream of Heyshope Dam in C/D EC – forestry, irrigation. Downstream of dam in largely in C EC due to flow changes.
- W52 (Hlelo River) B/C EC. Forestry, dams, mining, overgrazing.
- W53 (Ngwempisi River) largely D and C EC. Instream dams, extensive forestry, alien vegetation, wetland draining, flow changes.
- W54 (Usutu River). B EC upstream of Westoe Dam, C EC downstream of dam (flow regime changes, forestry, urban areas).
- W55 (Mpuluzi & Lusushwana Rivers). Forestry, dams, sedimentation, erosion.
- W57 (lower Usutu River) B/C EC. Borders Ndumo Game Reserve.



W7 Catchment (Kosi and Sibaya Lakes)	
▪ River feeding into Sibaya is in a D EC (water quality issues from townships). ▪ Rivers feeding into Kos in a B EC (within iSimangaliso Wetland Park) and a C EC (urban areas, forestry, WWTW).	

STATUS QUO: WETLANDS

According to the latest national wetland map (National biodiversity assessment; van Deventer *et al.*, 2018) there are almost 371 603 Ha of wetlands (excluding estuaries) in the study. This includes five RAMSAR sites, the St Lucia System, Lake Sibaya, Kosi Bay, Ndumo Game Reserve and the Turtle Beaches / Coral Reefs of Tongaland. A detailed breakdown of wetland distribution and extent within each of the secondary catchments is shown in the table below. The Pongola (W4) secondary catchment is the highest representing 30% of wetland hectarage, and the Mhlatuze (W1) and Mkuzu (W3) the lowest. The study area is also diverse in terms of wetland types and while riverine wetlands dominate with 104038 Ha (excluding estuaries), all other HGMs are well represented.

Table 3 HGM wetland area (Ha) within each secondary catchment excluding estuaries (analysis from NWM5, 2018 data)

Secondary Catchment	Main River	Channeled Valley Bottom	Unchanneled Valley Bottom	Depression	Floodplain	Riverine	Seep	Total (Ha)	Total (%) of Wetlands in the Study Area
W1	Mhlathuze	851	3078	949	6705	3882	4490	19953	5
W2	Umfolozi	1399	1764	672	3897	32299	26072	66103	18
W3	Mkuze	706	2722	9484	11844	3501	4689	32947	9
W4	Pongola	20759	3842	433	17660	61752	8626	113072	30
W5	Usutu	33081	3404	11266	12934	2605	16814	80104	22
W7	Sibaya and Kosi	184	2878	33191	21991		1181	59425	16
Total		**56980**	**17688**	**55995**	**75030**	**104038**	**61873**	**371603**	**100**

An estimation of wetland condition and the ecological condition of inland wetlands modelled from ancillary data (using mainly land use within variously defined buffer zones around wetlands) is shown in the figure below using the updated 2018 metadata (van Deventer *et al.*, 2018), where the dominant condition (A/B, C or D/E/F) is indicated. The majority of the wetlands within the study area have a condition status of D/E/F.

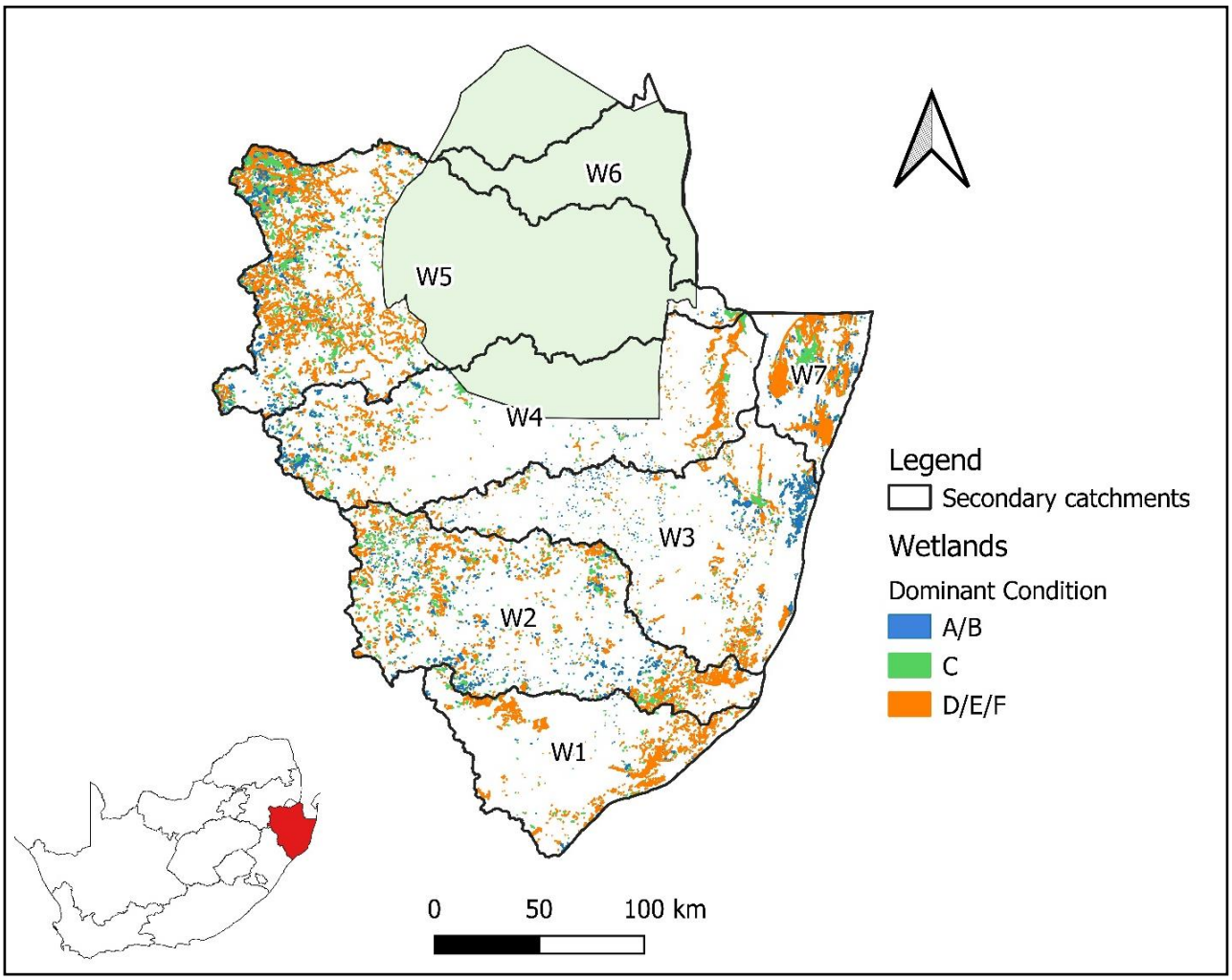


Figure 1 Dominant wetland condition within the study area (2018 updated wetland map 5; van Deventer *et al.*, 2018)

ECOLOGICAL ESTUARY STATE

Nine estuaries occur in the study areas, with the uMhlathuze estuarine lake system subdivided to create an estuarine bay (Richards Bay) and a Predominantly open system (uMhlathuze Sanctuary) to accommodate a port development in the 1970s. Most of the systems in the study area are in a degraded state (D to E Category), under high to very high pollution, habitat loss and fishing pressure (see table below). Most estuaries are not under high flow modification pressure with the exception of iSiyaya and Richards Bay. Only four estuaries are in a near-natural state (A/B to B Category), namely aMatigulu/iNyoni, uMlalazi, uMgobezeleni and Kosi.

Table 4 The condition and degree of pressure on estuaries in study area

	Estuary Name	PES	Pressure							
			Cumulative	Flow	Pollution	Habitat loss	Fishing Effort	Invasive alien plants	Alien Fish	Artificial Breaching
W11	aMatigulu/ iNyoni	B	L	L	L	L	H		N	Y
W13	iSiyaya	E	VH	VH	VH	VH	M		N	

	Estuary Name	PES	Pressure							
			Cumulative	Flow	Pollution	Habitat loss	Fishing Effort	Invasive alien plants	Alien Fish	Artificial Breaching
W13	uMlalazi	B	L	M	L	M	H	M	H	Y
W12	uMhlathuze	D	H	L	VH	VH	VH		H	
W12	Richards Bay	D/E	H	H	H	VH	VH		N	
W12	iNhlabane	E	VH	M	H	VH	H		N	Y
W2	iMfolozi /uMsunduze	D	H	L	VH	VH	VH	H	N	Y
W3	St Lucia	D/E	H	L	M	M	VH	M	N	Y
W7	uMgobezeleni	B	L	L	L	L	H		N	Y
W7	Kosi	A/B	L	L	L	L	VH	L	N	

*VH=Very high, H=High, M=Medium, L=Low, Y=Yes, N=No

IUA AND RU DELINEATION AND STATUS QUO

Integrated Units of Analysis (IUAs) are ***homogenous catchments*** or linear river reaches that can be managed as an entity. SQRs are nested within RUs which are nested within an IUA which represents a larger catchment and can include various rivers. Water resource use, economics, ecosystem services and ecological status information has been collated and all this information is used to identify catchments that are similar in terms of these specific components.

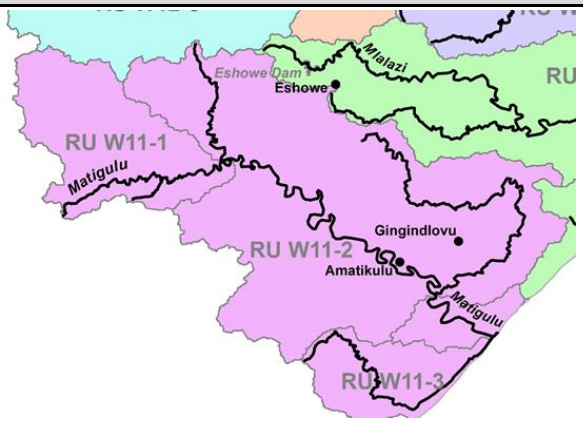
Resource Units (RUs) are the delineation of a river used for an Ecological Water Requirement (EWR) determination and for the setting of Resource Quality Objectives (RQOs). The RUs represent homogenous sections of a river/s. The starting point for RU delineation is the SQR (Sub-Quaternary Reache - which represents a single stretch of river defined by inflows of tributaries). The status of each SQR is known, as well as land cover, and water resource management and operation. SQRs are therefore nested within RUs and using the available information, were grouped into RUs. The table below provides the IUAs per secondary catchment.

Table 5 Integrated Unit of Analysis per secondary catchment

Secondary Catchment	IUA No	IUA Descriptive Name	RU (& SQRs where relevant)
W1	W11	Matigulu	W11-1, W11-2, W11-3, SQR W11C-03893, Estuary
	W12-a	Upper Mhlathuze	W12-1, W12-2 W12-3, W12-4
	W12-b	Mfule, Mhlatuzane, Nseleni Tributary systems	W12-5, W12-7, W12-8
	W12-c	Lower Mhlathuze	W12-6, W12F-03494, W12F-03511, W12F-03611 (Lake Cubhu) Mhlathuze Estuary
	W12-d	Lake Nhlabane	W12-9, W12J-03390, Lake Nhlabane and Estuary
	W12-e	Lake Msingazi	W12-10, W12J-03501, W12J-03493, W12J-03485,W12F-03509, (Lake Msingazi and Mhlathuze Estuary connection)
	W13	Mlalazi	W13-1, W13-2, SQR W13B-03673, Estuary
W2	W21	Upper and Middle White Umfolozi	W21-1, W21-2, W21-3, W21-4, W21-5, W21-6, W21-7
	W22	Upper Black Umfolozi	W22-1, W22-2, W22-3, W22-4
	W23	Umfolozi Hluhluwe Game Reserve	Nyalazi and Mzinene Tributaries
W3	W31-a	Upper Mkuze	W31-1, W31-2, W31-2

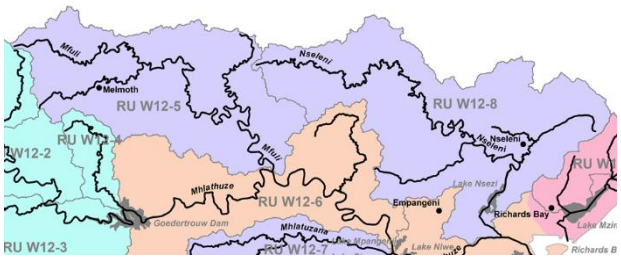
Secondary Catchment	IUA No	IUA Descriptive Name	RU (& SQRs where relevant)
	W31-b	Lower Mkuze	W31-4, W31-5, W31-6, W32-1
	W32-a	Upper Hluhluwe	W32-2
	W32-b	Nyalazi and Mzinene Tributaries	W32-3, W32-4, W32-5, W32-6
W4	W41	Bivane River	W41-1, W41-2
	W42-a	Upper Pongola	W42-1, W42-2
	W42-b	Middle Pongola (Ithala)	W41-3, W42-3, W42-4, W42-5
	W44	Middle Pongola (Grootdraai)	W44-1
	W45	Lower Pongola (Floodplain)	W43-1, R45-1
W5	W51	W5 Upstream major dams	W51-1, W53-1, W53-2, W54-1
	W52	W5 Downstream major dams & Hlelo River	W51-2, W51-3, W51-4, W52-1, W53-3, W54-2
	W55	Mpuluzi & Lusushwana River systems	W55-1, W55-2
	W57	Lower Usutu River	W57-1
W7	W70-a	Kosi Bay	W70-1, W70-2
	W70-b	Sibaya	W70-3
W2 & W3	IUA St Lucia	St Lucia	W23-3, W32H-02998, W32H-03048, W32H-02854, W32F-02835, W32B-02535

Table 6 Status quo of each IUA

IUA Status Quo	IUA map
W1 Catchment (Main River: Mhlathuze)	
IUA W11 Matigulu ▪ Farm dams and river runoff. No major dams. ▪ Groundwater Stress index: < 0.05. ▪ Large area of subsistence agriculture. ▪ Low water quality impact. ▪ Tribal Trust land and Entumeni Nature Reserve. ▪ River PES largely C and C/D EC. Roads, extensive agriculture, vegetation clearing, alien vegetation, small dams. ▪ Most wetlands in a D to F condition. ▪ Matigulu estuary in a B.	
IUA W12-a Upper Mhlathuze ▪ Farm dams and river runoff. Transfers from Thukela catchment. ▪ Groundwater Stress index: < 0.05. ▪ Subsistence agriculture & forestry. ▪ Low water quality impacts. ▪ Heart of Shaka and Zulu Kingdom. ▪ River PES largely C EC. Roads, extensive agriculture, sand mining, alien vegetation, forestry. ▪ Most wetlands in a C condition.	

IUA W12-b Mfule, Mhlatuzane, Nseleni Tributaries

- Farm dams and river runoff. Lake Nsezi supplying Mhlathuze Water.
- Groundwater Stress index: < 0.05.
- Tribal subsistence farming.
- High water quality impact (WWTW discharges and mining).
- Lower section is Melmoth area and Ingonyama Trust.
- River PES largely C and B EC. Rural settlements, forestry, dams in tributaries, alien vegetation, dams & WWTW.
- Most wetlands in a D-F condition. Notable wetland is Nsezi.

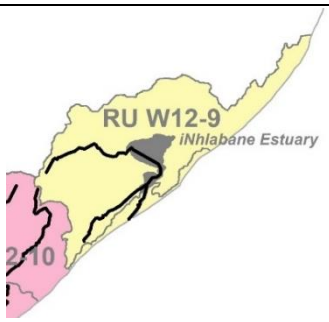


IUA W12-c Lower Mhlathuze

- Releases from Goedtrouw Dam, Lake Cubhu supplying Eikhaweni.
- Groundwater Stress index :< 0.05.
- Extensive irrigated sugar cane, fruit and vegetable production, forestry, industrial (paper mill, Richards Bay Port.).
- Water quality impacts (high sedimentation, turbidity, settlements, and industrial impacts).
- Nkwaleni valley (commercial farms and land reform) and Ingonyama Trust.
- River PES highly modified due to Goedertrouw releases, extensive irrigated cultivation, alien vegetation, sand mining – lower section canalised.
- Most wetlands in a D-F condition. Notable wetlands are Mhlatuze swamp system and floodplain, Cubhu, Thulazihleka.
- Estuary in a D/E EC (cumulative pressure, port development, habitat destruction, pollution, overfishing.

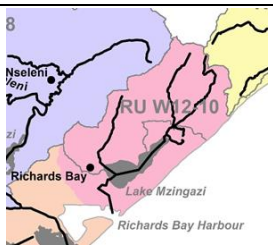
IUA W12-d Nhlabane

- Lake Nhlabae supplying Richard Bay Minerals.
- Groundwater Stress index: < 0.05
- Minor tourism activity.
- Moderate water quality impacts.
- Highly contested area and heavily populated.
- River PES largely C due to extensive forestry.
- Most wetlands in a D-F condition. Notable wetland is Mzingazi.
- Estuary in an E EC (cumulative pressure, weir cutting off lake, mining, habitat destruction, pollution, overfishing.



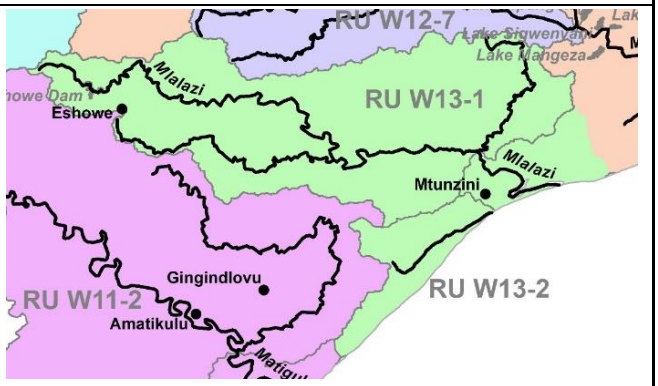
IUA W12-e Msingazi

- Lake Mzingazi supplying Richard Bay.
- Groundwater Stress index: < 0.05.
- Minor tourism activity.
- Water quality impacts from RBM smelter impacts.
- Highly contested area and heavily populated.
- River PES largely C (extensive forestry, storm water runoff, RMB smelter, urban areas).



IUA W13 Mlalazi

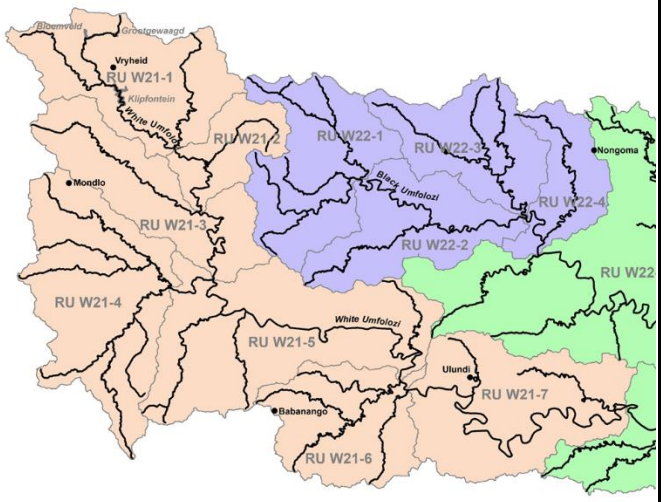
- Farm dams and river runoff. Eshowe and Rutledge Dam provide water to Eshowe town.
- Groundwater Stress index: < 0.05.
- Emerging and subsistence agriculture.
- Moderate water quality impacts.
- Ingonyama Trust.
- River PES largely C due to extensive formal agriculture, WWTW, dams, subsistence agriculture.
- Most wetlands in a D-F condition. Notable wetland is Mlalazi.
- Mlalazi Estuary in a B EC. In Umlalazi Nature Reserve.
- Siyaya Estuary in an E EC. High cumulative pressure, flow modification, pollution, habitat destruction.



W2 Catchment (Main River Umfolozi)

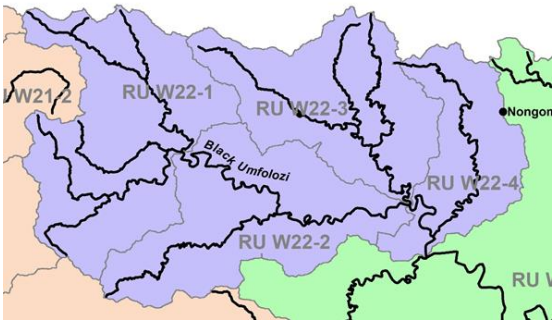
IUA W21 Upper and Middle White Umfolozi

- Klipfontein Dam and smaller dams supplying Vryheid and Ulundi.
- Groundwater Stress index :< 0.01-0.11.
- Commercial and subsistence farming. Forestry Hluhluwe iMfolozi Game Reserve.
- High water quality impact, nine priority areas, impacts from coal mine pollution, dysfunctional WWTW, urban impacts, gully erosion and sedimentation.
- South western portion Ingonyama Trust. Rural settlements.
- River PES largely C (Upper White Umfolozi – forestry, dams, agriculture, rural developments, irrigation, erosion, sedimentation, mine dumps). Nondweni largely in a D (overgrazing erosion, sedimentation, urban areas, WWTW). Middle Umfolozi in a B/C and B within the Hluhluwe iMfolozi Game Reserve.
- Most wetlands in a D to F condition. Notable wetlands: Stilwater Vlei, Blomveld Vlei, Lenjani Vlei, Grootgewaagd Vlei.



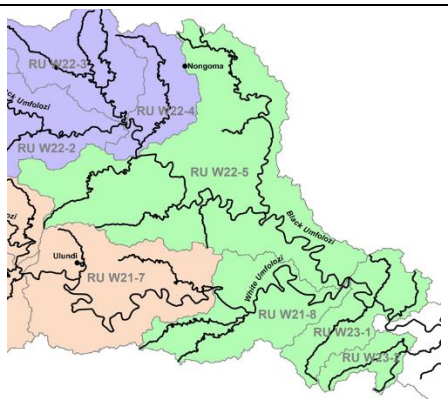
IUA W22 Upper Black Umfolozi

- Vuna and Vokwena Dams supplying Nongoma
- Groundwater Stress index: < 0.01-0.12.
- Subsistence farming. Forestry.
- Moderate water quality impacts.Acid mine drainage impacts.
- Scattered rural homesteads, land claim farms, closer rural settlements and dense settlement proximate to Nongoma.
- River PES upstream of Hluhluwe iMfolozi Game Reserve in a B/C and a B within or bordering the Park.
- Most wetlands in a D to F condition. Notable wetland: Aloeboom Vlei.



IUA W23 Upper Umfolozi

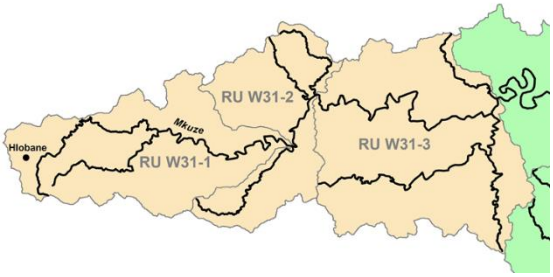
- Farm dams and river runoff
- Groundwater Stress index: < 0.05.
- Coal mining, sugar cane, saw mill, tourism, forestry.
- High water quality impacts. Mining operations, dysfunctional WWTW, irrigation return flows.
- River PES a B EC within or bordering the Park.
- Most wetlands in a D to F condition. Notable wetlands: Fuyeni Reedbed, Mvamazi Pan, Umfolozi riverine floodplain.



W3 Catchment (Main River Mkuze)

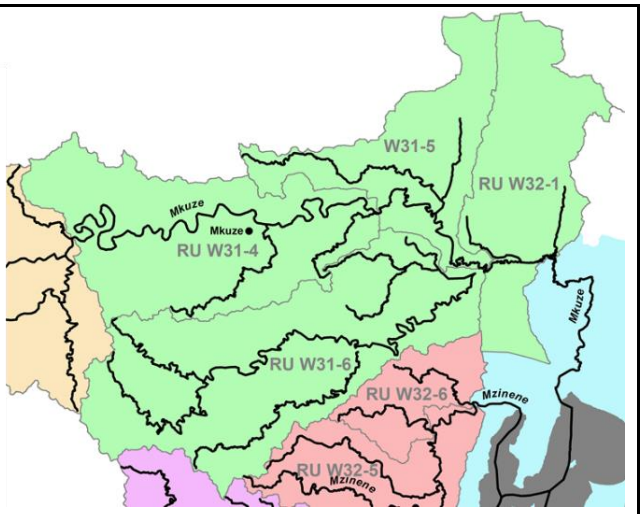
IUA W31-a Upper Mkuze

- Vaalbank Dam, Boulder Dam and smaller dams.
- Groundwater Stress index: < 0.05.
- Subsistence agriculture
- Low to moderate water quality impacts. Impacts from the Mfolozi into upper Mkhuze (mine-water decant).
- Ingonyama Trust.
- River PES ranges from C to B EC. Forestry, coal mining, instream dams, rural areas, irrigated crops, alien vegetation, erosion, sedimentation.
- Most wetlands in a D to F condition.



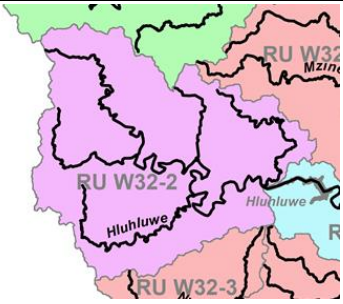
IUA W31-b Lower Mkuze

- Blackie Dam receives water from Pongolapoort Dam for irrigation and communities.
- Groundwater Stress index: < 0.05.
- Irrigated sugar cane, vegetable, cotton, citrus, maize and some tourism.
- Variable water quality impacts with one dysfunctional WWTW.
- Ingonyama Trust. Closer settlements bordering private farms and game parks.
- River PES ranges from C (outside Mkhuze Game Park – town, irrigation, subsistence farming, erosion, canals to B EC (Mkhuze Game Park).
- Most wetlands in an A to B condition. Notable wetlands: Nhlonhlela Pan, Hlonhlela, Mkuze Gr Airstrip Pans, Nsumu Pan, Muzi (South), Neshe, Yengweni, St Lucia – Manzibomvu, Mdlaze Pan, Mpanze Pan, Tshanetshe



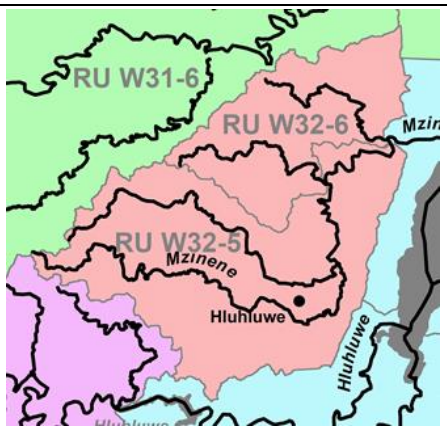
IUA W32-a Upper Hluhluwe

- Hluhluwe Dam at outlet.
- Groundwater Stress index: < 0.05.
- Tourism.
- Low water quality impacts.
- Denser rural settlement in vicinity of Sangonya.
- River PES ranges largely in a B EC (Hluhluwe iMfolozi Game Reserve).
- Most wetlands in a D to F condition. Notable wetland: Enseleni.



IUA W32-b Nyalazi and Mzinene

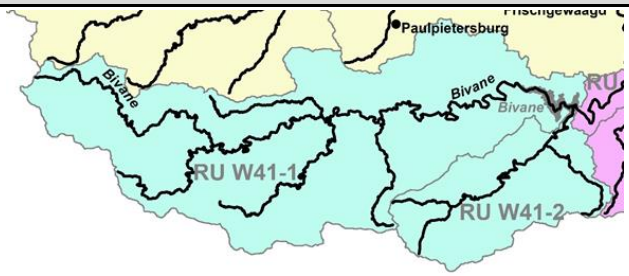
- Farm dams and river runoff.
- Groundwater Stress index: < 0.01-0.11
- Large commercial farming
- Low water quality impacts with one dysfunctional WWTW.
- Southern portion: Denser rural settlement in vicinity of KwaSithole and Ensolweni and dense rural and closer settlement, virtually all within the Ingonyama areas, Shikishela. Northern portion includes Ingonyama Trust.
- River PES largely C EC. Sand mining, overgrazing, subsistence farming, erosion, sugarcane, urban, instream dams and levees.
- Notable wetland: Hluhluwe Floodplain.



W4 Catchment (Main River Pongola)

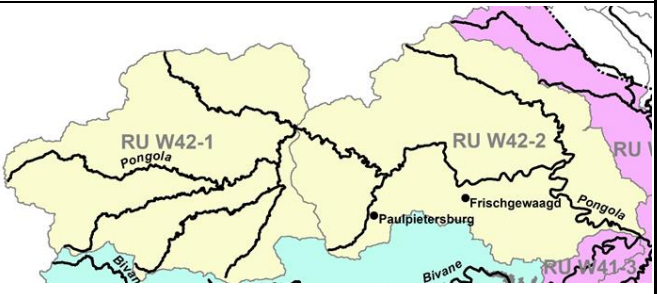
IUA W41 Bivane

- Bivane Dam at outlet (releases for commercial irrigation).
- Groundwater Stress index :< 0.05.
- Forestry, commercial and subsistence farming.
- Low water quality impacts.
- Ingonyama Trust.
- River PES C EC. Forestry, agriculture.
- Most wetlands in a D to F condition.



IUA W42-a Upper Pongola

- Edumbe Dam (Paul Pietersburg). River abstraction for Frischgewaagd communities.
- Groundwater Stress index: < 0.05.
- Forestry.
- Moderate water quality impacts.
- Some tribal trustland associated with Ntombe tributary. Downstream of Frischgewaard is tribal trustland.
- River PES largely C EC. Forestry, agriculture, Paul Pietersburg water quality issues.
- Most wetlands in a D to F condition. Also large portion in A to B condition.

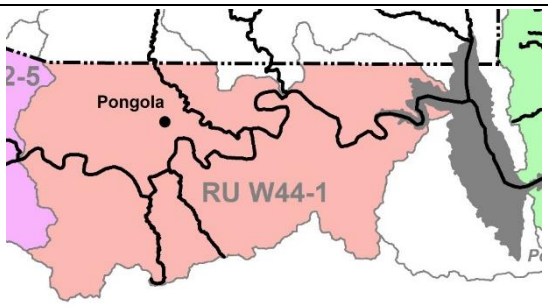


IUA W42-b Middle Pongola (Ithala)

- Smaller tributaries supply Sidlangentsha Central communities.
- Groundwater Stress index: < 0.05.
- Sugar cane, maize and summer vegetable production.
- Low water quality impacts.
- Mostly Ingonyama Trust and Tribal Trust areas. Dense settlement in lower part of catchment.
- River PES in C EC (tributaries with instream dams, forestry, agriculture, alien vegetation, overgrazing, sand mining). Pongola and Mozana River in a B EC (borders and within Ithala Game Reserve).
- Most wetlands in a C condition.

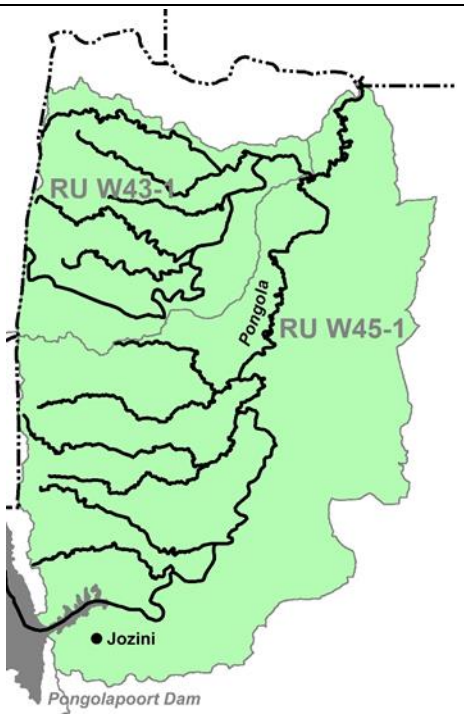
IUA W44 Middle Pongola

- Canal diversion for irrigation, Pongola Town and communities. Pongolapoort Dam situated at outlet.
- Groundwater Stress index: < 0.05.
- Sugar cane and some maize.
- High water quality impacts (extensive irrigated agriculture, dysfunctional WWTW and urban impacts).
- River PES D EC. Impacts associated with Impala Irrigation Board canal system and Grootdraai Weir – extensive flow regulation.



IUA W42-a Lower Pongola (Floodplain)

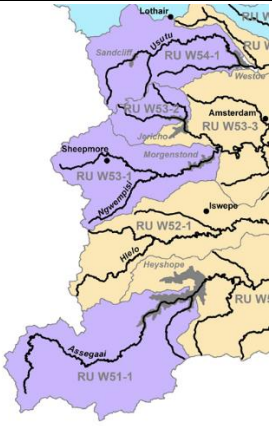
- Releases from Pongalapoort Dam to supply downstream communities and new Shemula WWTW.
- Groundwater Stress index: < 0.05.
- Irrigated and dryland cotton production.
- Moderate to high water quality impacts. Dysfunctional WWTWs, extensive irrigated agriculture and dense settlements.
- Tribal trust areas.
- River PES largely C EC. Changes in flow regime, subsistence agriculture, forestry, sedimentation. Short section bordering Ndumo Game Reserve.
- Most wetlands in a D to F condition. Notable wetlands: Mtoti Pan, Pongolo Floodplain, Msenyeni Pan, Balamhlanga, Mandlankunzi Pan, Ndumo Game Reserve, Bumbe Pan, Khanganzeni Pan, Nhlole Pan, Shalala Pans, Tete Pan



W5 Catchment (Main River Usutu)

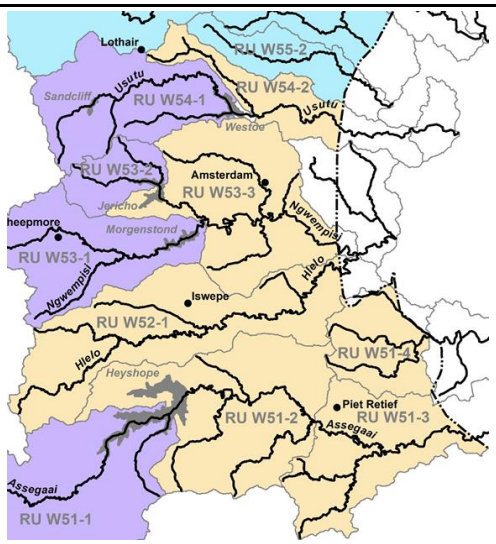
IUA W51 W5 upstream major dams

- Major Dams (Westoe, Jericho, Morgenstond, Heyshope). Transfers from these dams to Vaal and Olifants power stations.
- Groundwater Stress index 0 - 0.13.
- Maize and winter vegetables, commercial forestry.
- Low water quality impacts.
- Some denser settlements.
- River PES ranges from C to D EC (forestry, alien vegetation, agriculture).
- Most wetlands in a D - F condition. Notable wetlands: Langfontein Pan 3, Liefgekozen.



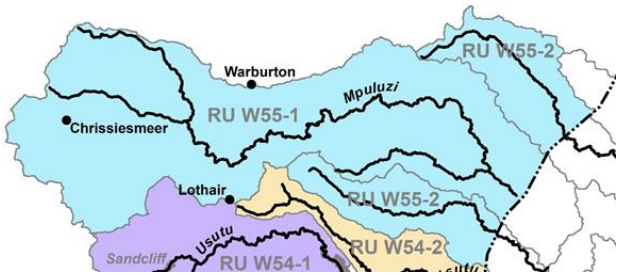
IUA W52 W5 downstream major dams & Hlelo

- Farm dams and river runoff
- Groundwater Stress index :< 0.05.
- Maize and winter vegetables, commercial forestry.
- Variable water quality state. Dysfunctional WWTW and urban impacts from Piet Retief and surrounds.
- Some scattered rural tribal trust areas in upper areas.
- River PES largely C (upstream dams and flow changes, forestry, alien vegetation, agriculture, mining).
- Most wetlands in a D - F condition.



IUA W55 Mpuluzi & Lusushwana

- Farm dams and river runoff.
- Groundwater Stress index: <0.05.
- Commercial agriculture.
- Moderate water quality impacts. Priority area in lower reaches due to dysfunctional WWTW and extensive settlements.
- Dense tribal trust areas on border of Eswatini.
- River PES in Mpuluzi B/C (small dams, forestry) and in Lusushwana C EC (forestry, dams, subsistence farming.
- Most wetlands in a D - F condition. Many notable wetlands which includes Lake Chrissie.



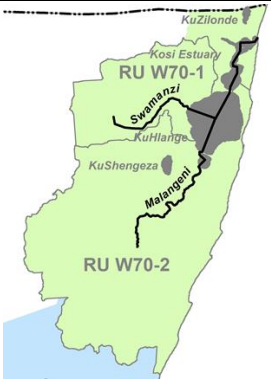
IUA W57 Lower Usutu

- Groundwater Stress index: <0.05.
- Subsistence agriculture.
- Low water quality impacts.
- River PES B/C EC (borders Ndumo Game Reserve).
- Most wetlands in a C condition. Notable wetlands: Shokwe Pan and Banzi Pan in Ndumo.

W7 Catchment (Kosi and Sibaya Lakes)

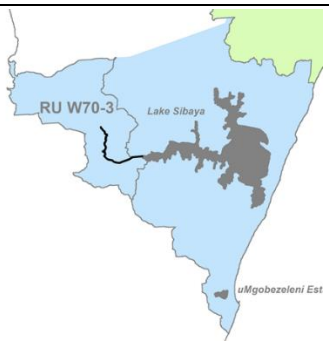
IUA W70-a Kosi

- Small streams and Lake Shengesa supplying surrounding communities.
- Groundwater Stress index: 0 - 0.1.
- Forestry, tourism.
- Moderate water quality impacts (urban impacts and a dysfunctional WWTW).
- Dense rural area.
- River PES B in iSimangaliso Wetland Park and C EC outside (urban areas, WWTW, forestry).
- Most wetlands in a D to F condition. Many notable wetlands including the Kosi Lakes.
- Estuary in A/B PES.



IUA W70-b Sibaya

- Lake Sibaya supplying Mseleni and Mbaswane.
- Groundwater Stress index: 0 - 0.1.
- Forestry, tourism.
- Moderate water quality impacts (extensive settlements and elevated nutrients).
- River PES D EC (water quality impacts from township and hospital).
- Most wetlands in a D to F condition. Many notable wetlands including Sibaya Lake.
- uMgobezeleni Estuary in B PES.



W2 & W3

IUA St Lucia

- Transfer from lower Umfolozi to Mhlathuze catchment. Run of river abstraction for Mtubatuba Town and sugar mill.
- Tourism activities.
- River PES for feeder rivers low. Main purpose is to ensure that the management objectives of St Lucia are achieved.
- Notable wetlands: Notable wetlands: Teza, Lake Teza, Umfolozi Swamp, Mavuya Pan, Lake Mfuthululu, Mfuthululu, Collin's Lake, St Lucia – Mbazwana, Mfula Pan, Siphudwini, Mhlazi Pan, St Lucia – Manzibomvu, Mdlaze Pan, Mpanze Pan, Mkuze Floodplain, Mkuze Swamp System, Ntshangwe Lake, Ku Ndlebeni, Tshanetshe.
- Estuary: D to D/E PES. Flow reduction, extensive mouth manipulation, formal & subsistence agriculture, pollution, overfishing, invasive alien vegetation. Lake St Lucia is threatened by rising salinity levels during drought cycles.

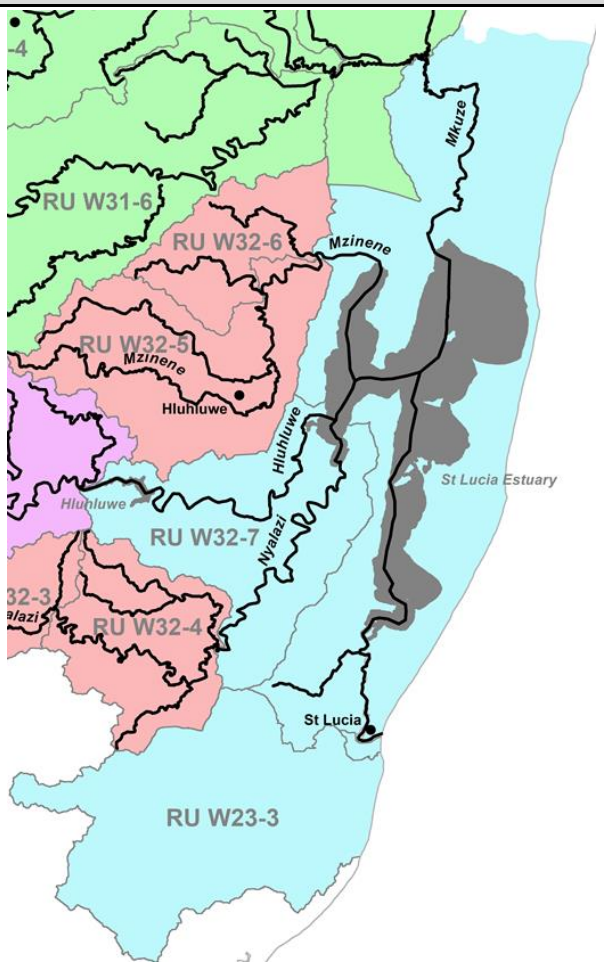


TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

TERMINOLOGY AND ACRONYMS

AMD	Acid Mine Drainage
CD: WEM	Chief Directorate: Water Ecosystems Management
CLP	Compulsory Licensing Process
CR	Critically Endangered
CRR	Cumulative Risk Rating
DEA	Department of Environmental Affairs
DFFE	Department of Forestry, Fisheries and the Environment
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EC	Ecological Categories
EGSA	Ecological Goods, Services and Attributes
EHI	Estuarine Health Index
EI	Ecological Importance
EN	Endangered
ES	Ecological Sensitivity
ETS	Ecosystem Threat Status
EWR	Ecological Water Requirement
FEPA	Freshwater Ecosystem Priority Areas
GDP	Gross Domestic Product
GIS	Geographic Information System
GRIP	Groundwater Resource Information Project
GRU	Groundwater Resource Unit
HGM	Hydrogeomorphic
IRIS	Integrated Regulatory Information System
ISP	Internal Strategic Perspective
IUA	Integrated Unit of Analysis
IUCMA	Inkomati-Usutu Catchment Management Agency
KZN	KwaZulu-Natal
l/c/d	litre/capita/day
mamsl	Metres above mean sea level
MAR	Mean Annual Runoff
mbgl	Metres below ground level
MEA	Millennium Ecosystems Assessment
MRSS	Mhlathuze Reconciliation Strategy Study
MWAAS	Mhlathuze Water Availability Assessment Study
NNMP	Nama-Natal Structural and Metamorphic Province
NFEPA	National Freshwater Ecosystem Priority Area
NBA	National Biodiversity Assessment
NGA	National Groundwater Archive
NIWIS	National Integrated Water Information System
NSBA	National Spatial Biodiversity Assessment
NWA	National Water Act
NWM5	National Wetland Map version 5
PES/EI/ES (or PESEIS or PES/EIS)	Present Ecological State, Ecological Importance and Ecological Sensitivity

POPs	Persistent Organic Pollutants
RBM	Richards Bay Minerals
RQO	Resource Quality Objectives
RSS	Reconciliation Strategy Study
RU	Resource Unit
RWQO	Resource Water Quality Objective
SAIAB	South African Institute of Aquatic Biodiversity
SAIIAE	South African Inventory of Inland Aquatic Ecosystems
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SQR	Sub-quaternary Reach
STW	Sewage Treatment Works
UWAAS	Usutu Water Availability Assessment Study
WARMS	Water use Authorization and Registration Management System
WMS	Water Management System
WQPL	Water Quality Planning Limit
WRC	Water Research Commission
WRCS	Water Resource Classification System
WRPM	Water Resources Planning Model
WRYM	Water Resources Yield Model
WUA	Impala Water User Association
WWF	Worldwide Fund for Nature
WWTW	Waste Water Treatment Works

SELECTED SPELLING FOR THIS STUDY

There are multiple variations for the spelling of names for the Rivers, Lakes, Dams and Estuaries in the catchment/study area. For the purpose of this study the following table presents the commonly accepted variations of spelling for the place names of concern, which are discussed in the reports. The names were derived from information from different sources in the region.

Selected Spelling for this Study	Alternate spellings
Usutu River	Usuthu River
Mhlathuze River	Mhlatuze, uMhlatuze River
Pongola (river, Town & Pongolapoort Dam)	Phongola, Phongolo
Lake Sibaya	Lake Sibiya, Lake Sibhayi, Lake Sibhaya
Eswatini	eSwatini
Umfolozi River	Mfolozi River
Amatigulu River	Amatikulu, Matigulu River
Goedertrouw Dam	Lake Phobane
Mfuli River	Mefule River
aMatigulu/iNyoni Estuary	
Sibiya Estuary	
Mlalazi Estuary	
uMhlathuze /Richards Bay Estuary	
iNhlabane Estuary	
uMfolozi/uMsunduze Estuary	
St Lucia Estuary	
uMgobezeleni Estuary	
Kosi Estuary	
Hluhluwe Game Reserve	
iMfolozi Game Reserve	
Ithala Game Reserve	
Ndumo Game Reserve	
Tembe Elephant Reserve	
iSimangaliso Wetland Park	
Kosi Bay and Coastal Forest Area	
uMkhuze Game Reserve	

Note:

The spelling of the Rivers, Lakes, Dams and Estuaries provided in the DWS PESEIS (https://www.dws.gov.za/iwqs/rhp/eco/PESEIS_secondary.aspx) database will not be changed based on the above when used in presentation of database tables and results from the database.

GLOSSARY

Ecological Water Requirements (EWR)	The flow patterns (magnitude, timing and duration) and water quality needed to maintain a riverine ecosystem in a particular condition. This term is used to refer to both the quantity and quality components.
Integrated Unit of Analysis (IUAs)	An IUA is a homogeneous area that can be managed as an entity. It is the basic unit of assessment for the Classification of water resources, and is defined by areas that can be managed together in terms of water resource operations, quality, socio-economics and ecosystem services.
Resource Quality Objectives (RQOs)	RQOs are numeric or descriptive goals or objectives that can be monitored for compliance to the Water Resource Classification, for each part of each water resource. "The purpose of setting RQOs is to establish clear goals relating to the quality of the relevant water resources".
Scenario	Scenarios, in the context of water resource management and planning, are plausible definitions (settings) of factors (variables) that influence the water balance and water quality in a catchment and the system as a whole. Each scenario represents an alternative future condition, generally reflecting a change to the present condition.
Sub-quaternary reaches (SQR)	A finer subdivision of the quaternary catchments (the catchment areas of tributaries of main stem rivers in quaternary catchments), to a sub-quaternary reach or quinary level.
Target Ecological Category (TEC)	This is the ecological category towards which a water resource will be managed once the Classification process has been completed and the Reserve has been finalised. The draft TECs are therefore related to the draft Classes and selected scenario.
Water Resource Class	The Water Resource Class (hereafter referred to as Class) is representative of those attributes that the DWS (as the custodian) and society require of different water resources. The decision-making toward a Class requires a wide range of trade-offs to be assessed and evaluated at a number of scales. Final outcome of the process is a set of desired characteristics for use and ecological condition of the water resources in a given catchment. The WRCS defines three management classes, Class I, II, and III, based on extent of use and alteration of ecological condition from the predevelopment condition.

1 INTRODUCTION

1.1 BACKGROUND

Chapter 3 of the National Water Act, 1998 (NWA) (Act 36 of 1998), deals with the protection of water resources. Section 12 of the NWA requires the Minister to develop a system to classify water resources. In response to this, the Water Resource Classification System (WRCS) was gazetted on 17 September 2010 and published in the Government Gazette no. 33541 as Regulation 810. The WRCS is a step-wise process, whereby water resources are categorised according to specific classes that represent a management vision of a particular catchment. This vision takes into account the current state of the water resource, the ecological, social, and economic aspects that are dependent on the resource. Once significant water resources have been classified through the WRCS, Resource Quality Objectives (RQOs) have to be determined to give effect to the class. The implementation of the WRCS, therefore, assesses the costs and benefits associated with utilisation versus protection of a water resource. Section 13 of the NWA requires that Water Resource Classes and RQOs be determined for all significant water resources.

The Chief Directorate: Water Ecosystems Management (CD: WEM) of the Department of Water and Sanitation (DWS), initiated a study to determine the Water Resource Classes and RQOs for all significant water resources in the Usutu to Mhlathuze Catchment. The Usutu to Mhlathuze Catchments are amongst many water-stressed catchments in South Africa. These catchment areas are important for conservation, and contain a number of protected areas such as natural heritage sites, cultural and historic sites, as well as other conservation areas that need protection. There are five RAMSAR[1] sites within the catchment, which includes the world heritage site, St Lucia. The others are Sibaya, Kosi Bay, Ndumo Game Reserve and Turtle Beaches.

1.2 STUDY AREA

The study area is the Usutu to Mhlathuze Catchment, which has been divided into six drainage areas, as well as secondary catchment areas. These areas are indicated on the locality map of the study area in **Figure 1.1**, which shows the secondary catchments covered by the study as coloured blocks:

- W1 catchment (main river: Mhlathuze).
- W2 catchment (main river: Umfolozi).
- W3 catchment (main river: Mkuze).
- W4 catchment (main river: Pongola) - part of this catchment area falls within Eswatini.
- W5 catchment (main river: Usutu) - much of this catchment falls within Eswatini.
- W7 catchment (Kosi Bay and Lake Sibaya).

Note that all assessments within Eswatini were excluded except for the hydrological modelling required to assess any downstream rivers in South Africa that either run through Eswatini or originate in Eswatini.

[1] A Ramsar site is a wetland site designated to be of international importance under the Ramsar Convention, also known as "The Convention on Wetlands", an intergovernmental environmental treaty established in 1971 by UNESCO in the Iranian city of Ramsar, which came into force in 1975.

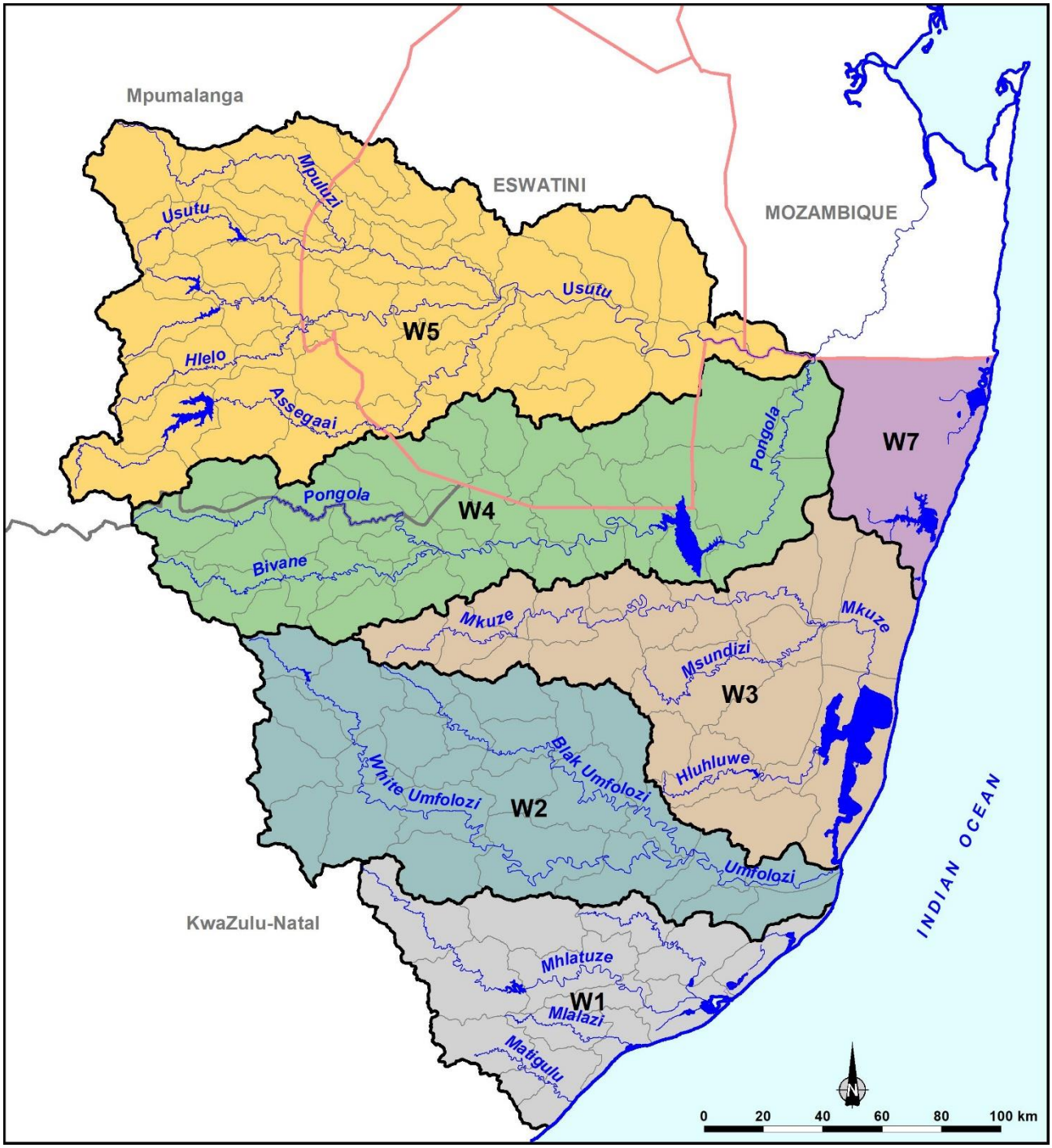


Figure 1.1 Locality Map of the Study Area

1.3 PURPOSE OF THIS REPORT

The Purpose of this report is to describe the status quo of the water resources in the Usutu to Mhlathuze Catchment in terms of the water resource system. The report is to documents the results of Task 1: Delineate Integrated Units of Analysis (IUAs) and Resource Units (RU) and describe the status quo of the Usutu to Mhlathuze Catchment. **Figure 1.2** provides the project plan for this study and illustrates where Step/Task 1 fits into the project plan.

The objective of this task is to define IUAs, and to provide a status quo description of each IUA. An IUA is a homogenous catchment, or a linear section of river, that is based on the similarity of ecological state, system operation, land characteristics, etc. The status quo description, therefore, provides the information on a broad scale to describe the delineation of the IUAs. Note that the

emphasis of the status quo lies on the current use and operation of the system and the status of these activities. It also includes the ecological status quo of the system which reflects changes in the ecological state from perceived natural conditions and the reasons why the system has changed. This step includes the following:

- **Information and data collection:** Most of this work will be obtained as part of the gap analysis and information gathering during the Inception Phase. Additional spatial and related data, census information, and the Present Ecological State, Ecological Importance and Ecological Sensitivity (PES/EI/ES; also referred to as PES/EIS or PESEIS) (DWS, 2014e) desktop, wetland (National Freshwater Ecosystem Priority Area (NFEPA) and National Wetland Map version 5 (NWM5)) and estuary databases will be accessed.
- **Assessment of surface water resource system components:** The surface water resources in the study area will be defined and described following a catchment-by-catchment approach and identifying key river reaches, where the flow is controlled by current or future operational activities. The following will be undertaken as part of this task:
  - A description of water resource infrastructures.
  - The identification of water users and sources.
  - The identification of water quality areas of high importance, e.g. hotspot areas.
  - The definition of the network of significant resources.
  - The identification of controlled river reaches.
  - The description of the water resource status quo (including water quality).
- **Assessment of Groundwater resources:** Groundwater Resource Units (GRUs) will be defined, described and delineated, based on quaternary catchment boundaries, aquifer type, and other physical, management and/or functional criteria. The following actions will be required:
  - Description of water resource infrastructures.
  - Identification of water users and sources.
  - Identification of water quality problem areas.
  - Definition of the area of significant resources.
  - Definition of the surface groundwater interaction areas.
  - Description of the groundwater quantity and quality status quo.
- **Assessment of Rivers:** The Present Ecological State (PES) for the study area will be determined in terms of the A - F Ecological Categories (ECs) which informs the delineation of IUAs. A review and update of the PES/EIS study for the specific study area at sub-quaternary reach (SQR) scale will be undertaken. The actions performed during this task will be:
  - A description of the PES (desktop) baseline per SQR.
  - The identification of the pressures and impacts (review and update the PES baseline).
  - Grouping similar rivers into Resource Units (RUs) based on similar PES impacts.
- **Assessment of Wetlands:** Groups of wetlands will be identified and typed/categorized, and the ecological state broadly described per group. The following actions will be undertaken:
  - The spatial distribution and extent of wetlands will be indicated.
  - Typing/categorization in terms of EcoRegions and hydrogeomorphic (HGM) types.
  - Identified wetland groups based on type, condition and Ecological Importance (EI) will be indicated.
- **Assessment of Estuaries:** The PES for the nine estuaries in the study area will be broadly determined in terms of the ECs (A to F) which will delineate the IUAs. The detailed work required is as follows:

- Delineation of individual estuary RUs ensuring alignment with the Estuarine Functional Zones (EFZ).
- A description of estuary PES categories.
- Identify key flow and non-flow pressures on individual estuaries.
- Estuaries will be grouped along the coast based on ecological condition and function, pressures (current and future), and management boundaries (local authorities and water management).

- **Assessment of Economics:** The information needed to quantify and describe the socio-economic benefits that are derived from utilising the water resources in each of the UIAs in the study area will be collated to inform/indicate the following:
  - The present socio-economic status and key drivers.
  - Delineate economic zones based on relevant data.
  - Qualify and assess the risk of the different scenarios formulated by the environmental team, with respect to change from the status quo for aquatic ecosystems (risk-based approach).
  - A description and economic value of the status quo market and/or commercial use of the water resource in the study area.
- **Define IUAs:** Utilising all the above information and information collated during Task 1, IUAs will be defined and then be presented to stakeholders for comment.

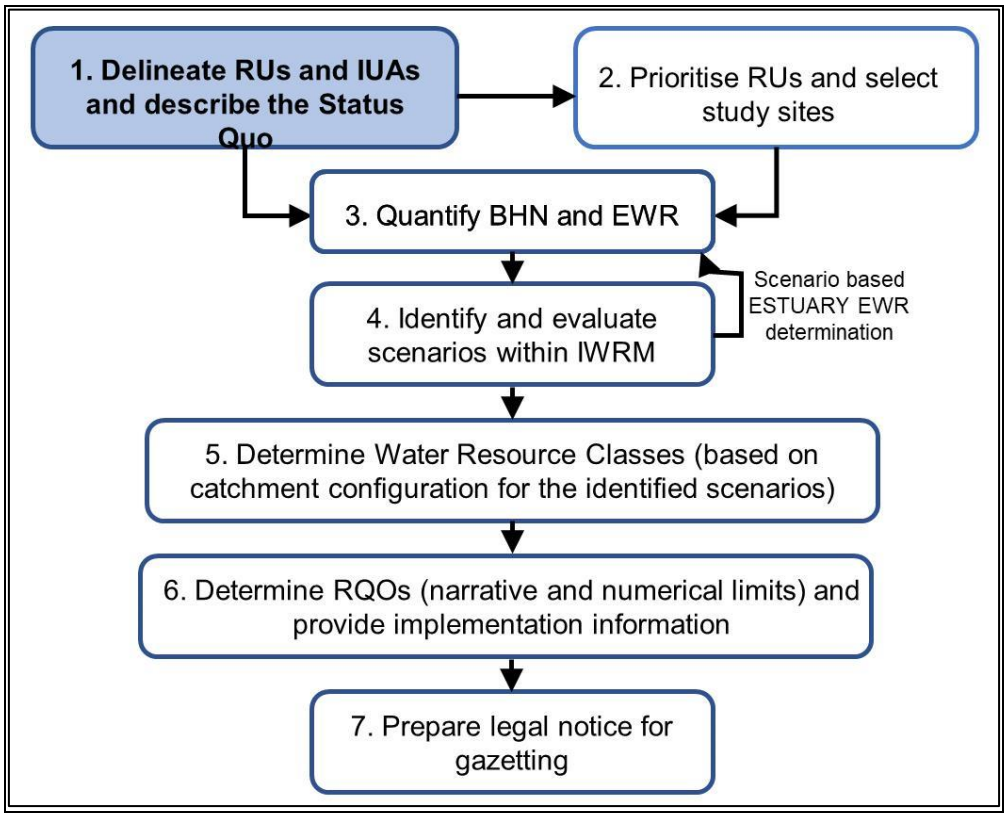


Figure 1.2 Project Plan and Tasks for the Usutu-Mhlathuze Classification Study

1.4 REPORT OUTLINE

- **Chapter 1** provides general background information on the study area as well as the Project Plan and Tasks for the Usutu-Mhlathuze Classification Study.
- **Chapters 2 – 10** 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 Usutu to Mhlathuze Catchment.

- **Chapters 11** provides the IUAs per secondary catchment as well as a description of each IUA.
- **Chapters 12** provides a summary of the status quo for each IUA identified and delineated.
- **Chapter 13:** References

2 STATUS QUO ASSESSMENT: SURFACE WATER RESOURCES

2.1 INTRODUCTION

This chapter describes the status quo of each secondary catchment included in the Study Area of this Classification Study, from a surface water resources perspective. The following secondary catchments are described below and see also **Figure 1.1**:

- W1 catchment (Main River: Mhlathuze)
- W2 catchment (Main River: Umfolozi)
- W3 (Main River: Mkuze)
- W4 (Main River: Pongola (excluding Eswatini))
- W5 (Main River: Usutu (excluding Eswatini))
- W7 (Kosi Bay and Lake Sibaya)

Surface water information included in each description is as follows:

- Catchment area.
- Natural Mean Annual Runoff.
- Main Rivers (tertiary catchments).
- Major impoundments (dams).
- Main urban and industrial users.
- Irrigation use.
- Extent of afforestation (land allocated for the forestry industry).
- Inter-catchment transfers (water transfer both in and out of areas).
- Rainfall.

A summary table (**Table 2.2 – Section 2.3**) provides all the status quo information, after the detailed descriptions for reference sources for surface water resources information are provided in **Table 2.1** (**Section 2.2**) for the applicable sub-sections.

2.2 APPROACH

The approach to develop a description, and determine the status quo of each secondary catchment, involved obtaining information from the most recent detailed water resource studies undertaken on/in/pertaining to the catchments. **Table 2.1** provides a summary of the studies referred to, and provides details regarding the water resources models available, which will be used as a basis reference for this Study.

Table 2.1 Reference sources for surface water resources information

Secondary catchment	Source Hydrology Study	Source Water Resources Model configuration
W1	A detailed hydrology assessment was carried out as part of the Mhlathuze Water Availability Assessment Study (MWAAS) (DWAF, 2009) and the hydrology specifications were produced using the Pitman Model. Updates to the hydrology of catchments W12J1, W12J2 and W12F2 were produced as part of the Mhlathuze Reconciliation Strategy Study (DWS, 2021) using improved methods for the groundwater-surface water interaction. Updates to the hydrology of catchments W13A1,	The latest model configurations are from the Mhlathuze Reconciliation Strategy Study (MRSS) (DWS, 2021). A Water Resources Yield Model (WRYM) and a Water Resources Planning Model (WRPM) are available. These two models were first configured in the MWAAS, and were also used for water resources analyses, and as part of the Compulsory Licensing Process (CLP) that was undertaken in the catchment. It has further been refined as part of the Reconciliation Strategy Study (RSS).

Secondary catchment	Source Hydrology Study	Source Water Resources Model configuration
	W13A2 and W13A3 were produced as part of the Development of Operating Rules for Water Supply and Drought Management for Stand-Alone Dams and Schemes: Eastern Cluster: The Eshowe Water Supply Scheme: Rutledge and Eshlazi Dams Study (DWS, 2016), and, therefore, superseded the MWAAS hydrology.	
W2		
W3	The Umfolozi to Pongola catchment hydrology is currently being developed in a detailed assessment as part of the Reconciliation Strategy Study - RSS (DWS, 2022). The Pitman Model will be used to produce the hydrology specifications, which are planned to be available by May 2022.	The WRYM will be configured as part of the Reconciliation Strategy Study (DWS, 2022). This WRYM configuration will be available in time for scenario analyses as part of this Study
W4		
W5	For the portion of the catchment falling within the borders of South Africa, a detailed hydrology assessment was carried out as part of the Usutu Water Availability Assessment Study (UWAAS) (IUCMA, 2016) and hydrology was produced using the Pitman Model. For the portion of the catchment falling within Eswatini, the latest available hydrology was derived from the Joint Maputo River Basin Water Resources Study (TPTC, 2008).	The WRYM was configured in the UWAAS for the portion of the catchment falling within South Africa. For the Eswatini portion, the latest WRYM was configured as part of the Mpakeni Dam Feasibility Study (ADB, 2020), and included the upstream UWAAS hydrology.
W7	The W7 catchment hydrology is currently being developed in a detailed assessment as part of the Reconciliation Strategy Study (DWS, 2022). The Pitman Model will be used to produce the hydrology, which is planned to be available by May 2022.	The WRYM will be configured as part of the Reconciliation Strategy Study (DWS, 2022). This WRYM configuration will be available in time for scenario analyses as part of this Study

2.3 DESCRIPTION AND STATUS QUO PER SECONDARY CATCHMENT

The following sub-sections provide an overview from a surface water resources perspective for each secondary catchment included in this Classification Study. This includes information relating to surface water resources (impoundments/dams), inter-catchment transfers, surface runoff (Mean Annual) and main water users. **Table 2.2** provides an overall summary of the information provided for ease of comparison between secondary catchments.

Table 2.2 Summary of Surface Water Resources and use

Secondary catchment	Area (km^2)	MAR (million m^3/a)	Dam capacity (million m^3)	Main impoundments	Domestic & Industrial use (million m^3/annum)	Afforestation area (ha)	Irrigation use (million m^3/annum)	Transfers in	Transfers out
W1	5 661	816	314	Goedertrouw Dam, Lake Nsezi, Lake Mzingazi, Lake Nhlabane, Lake Cubhu	107	64 072	140	From Thukela From Umfolozi (Thukela: current capacity: 38 million m^3/a, future to be doubled, Umfolozi: 8 million m^3/a)	-
W2	10 008	825	35	Vuna Dam,	30	57 846	53	-	To

Secondary catchment	Area (km^2)	MAR (million m^3/a)	Dam capacity (million m^3)	Main impoundments	Domestic & Industrial use (million m^3/annum)	Afforestation area (ha)	Irrigation use (million m^3/annum)	Transfers in	Transfers out
				Vokwena Dam, Klipfontein Dam					Mhlathuze (8 million m^3/a)
W3	9 545	578	48	Hluhluwe Dam	4	38 042	85	From Pongola (20 million m^3/a)	-
W4	11 714	1104	2571	Pongolapoort Dam	26	75 610	275	-	To Mkuze (20 million m^3/a)
W5*	7 627	949	695	Westoe Dam, Jericho Dam, Morgenstond Dam, Heyshope Dam,	11	226 510	12	-	To Vaal & Olifants (from Jericho: 74 million m^3/annum, from Heyshope, 135 million m^3/annum.
W7	2 589	143	0	Lake St Lucia	3	24 591	0	-	-

1 Mean Annual Runoff

* The information in the table above refers only to the RSA portion of the study.

The DWS National Integrated Water Information System (NIWIS, 2022) provides information relating to climate change in the study area. **Table 2.3** provides a summary of the potential difference in streamflow between the 1975-2006 historical period, and the future period between 2016 - 2045. A negative difference indicates a decrease in streamflow and a positive difference indicates an increase in streamflow. Based on the climate change scenario used, the overall study area will have less approximately 15% less streamflow due to climate change.

Table 2.3 Possible percentage change in streamflow due to climate change (NIWIS, 2022)

Quat.	% Change	Quat.	% Change	Quat.	% Change	Quat.	% Change
W11A	-13%	W21A	-19%	W31A	2%	W41A	-14%
W11B	-21%	W21B	1%	W31B	1%	W41B	-16%
W11C	-17%	W21C	4%	W31C	-7%	W41C	-18%
W12A	7%	W21D	8%	W31D	3%	W41D	0%
W12B	-13%	W21E	-21%	W31E	3%	W41E	0%
W12C	-18%	W21F	3%	W31F	4%	W41F	0%
W12D	-12%	W21G	11%	W31G	-15%	W41G	3%
W12E	-17%	W21H	-1%	W31H	-10%	W42A	-11%
W12F	-33%	W21J	9%	W31J	-10%	W42B	-15%
W12G	-21%	W21K	-5%	W31K	-26%	W42C	-12%
W12H	-27%	W21L	-8%	W31L	-13%	W42D	-25%
W12J	-34%	W22A	-3%	W32A	1%	W42E	0%
W13A	-14%	W22B	-3%	W32B	-45%	W42F	-6%

Quat.	% Change	Quat.	% Change	Quat.	% Change	Quat.	% Change
W13B	-25%	W22C	-10%	W32C	-22%	W42G	4%
Avg	-18%	W22D	-3%	W32D	-31%	W42H	2%
		W22E	-11%	W32E	-31%	W42J	2%
		W22F	-11%	W32F	-34%	W42L	4%
		W22G	-18%	W32G	-33%	W42M	-5%
		W22H	-18%	W32G	-45%	W43F	-18%
		W22J	-19%	W32H	-16%	W45A	5%
		W22K	-24%	Avg	-16%	W45B	-7%
		W22L	-27%			W44D	-16%
		W23A	-28%			W44E	-19%
		W23B	-27%			W45A	-17%
		W23C	-39%			W45B	-30%
		W23D	-44%			W57K	-6%
		Avg	-12%			W70A	-35%
						Avg	-9%

Figure 2.1 presents the map of the study area indicating the potential change in rainfall as a result of climate change (NIWIS, 2022). The study area mainly indicates a -5% - 0% change in rainfall for the future scenario. Landuse maps are provided in **Appendix A**.

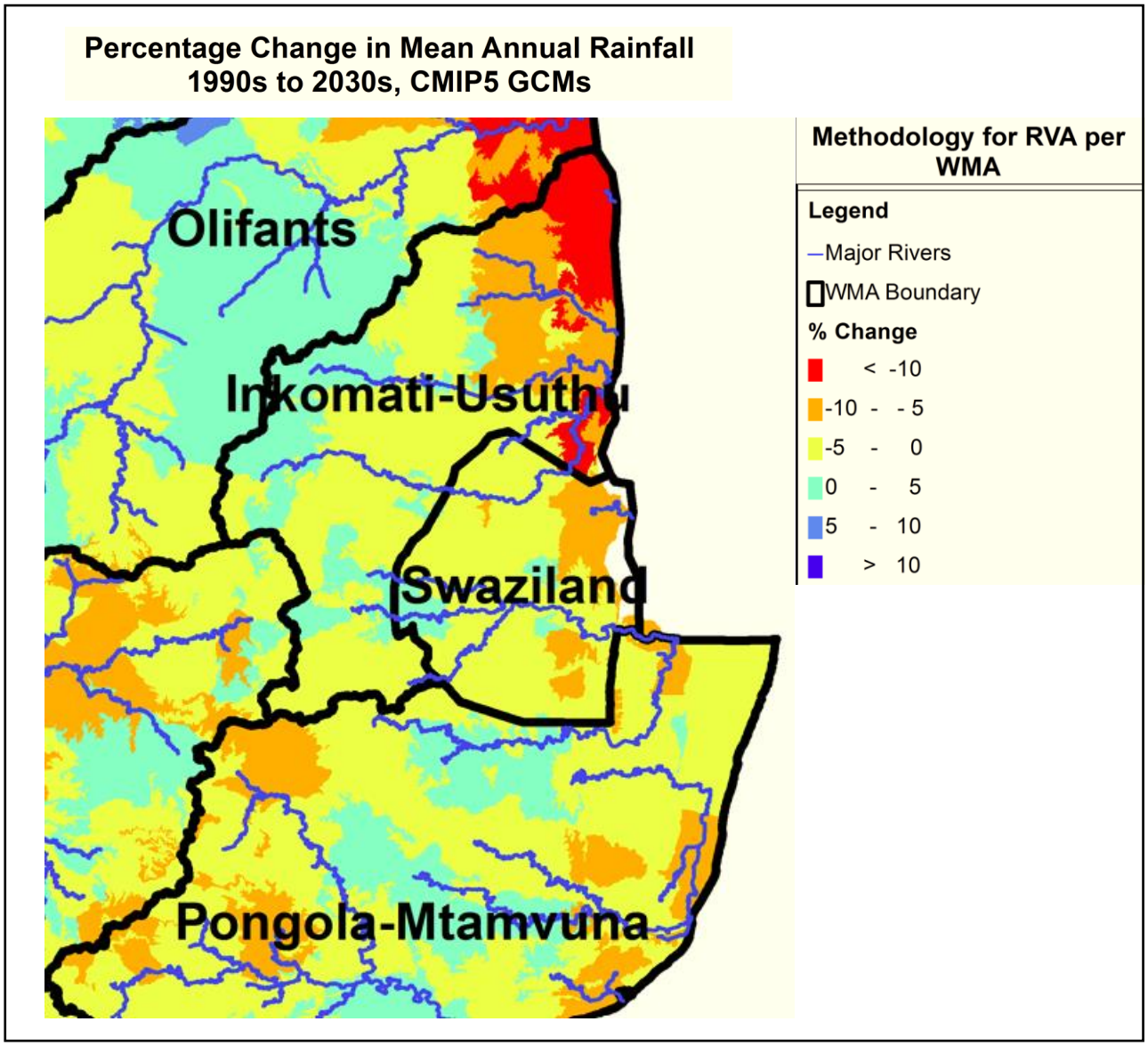


Figure 2.1 Percentage Change in Mean Annual Rainfall for the Study Area

2.3.1 W1 Catchment (Main River: Mhlathuze)

The W1 Catchment consists of tertiary catchments W11, W12 and W13. The main rivers in these catchments areas are the Amatigulu River (W11), the Mhlathuze River (W12) and the Mlalazi River (W13). **Figure 2.2** provides a general locality map showing the main landmarks of the catchment.

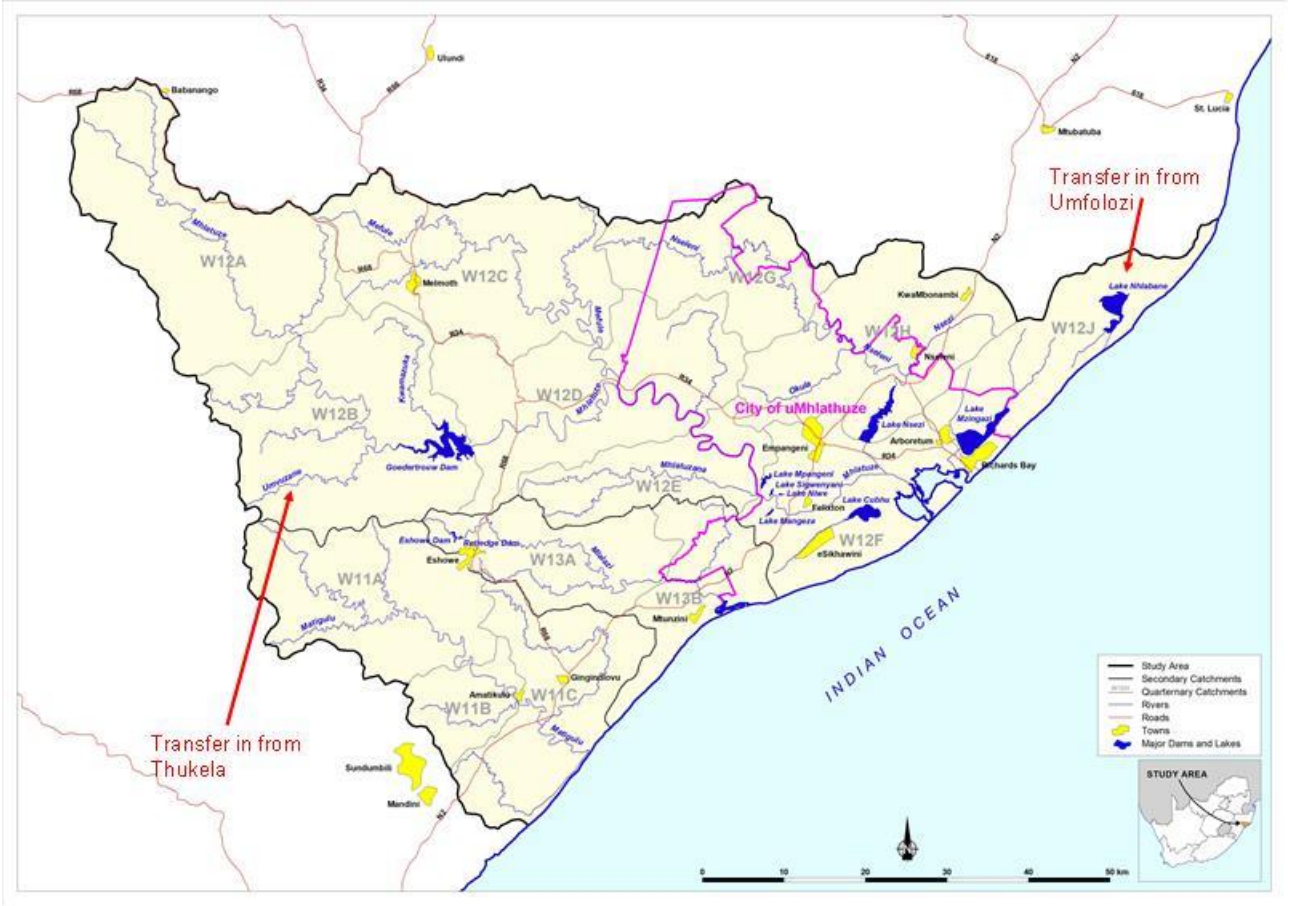


Figure 2.2 Surface Water Locality Map: W1

The W1 Catchment covers a total surface area of 5 661 km^2. The secondary catchment includes 14 quaternary catchments with a total average natural runoff of 816.3 million m^3/annum. Average rainfall throughout the catchment ranges from 799 mm to 1324 mm, with an overall average of 1079 mm.

The main surface water impoundments in the catchment area are the Goedertrouw Dam in the Mhlathuze Catchment and the Eshowe-Rutledge Dam in the Mlalazi Catchment. The Goedertrouw Dam, located relatively far up in the catchment, releases water for users located at the coast, which is abstracted from the Mhlathuze Weir. Additional surface water resources are obtained from natural coastal lakes, namely Lake Nhlabane, Lake Cubhu, Lake Nsezi and Lake Mzingazi.

Primary use for domestic consumption occurring within the W1 Catchment is mainly centred on the urban area of Richards Bay, including Empangeni, Esikhaleni, Nseleni and Ngwelezane. Smaller domestic users in the catchment area include the towns of Eshowe, Mtunzini, Gingindlovu, Melmoth and Nkandla.

The Richards Bay area is well known for its industries and nearby mines. The main users from this sector are Richards Bay Minerals, Tronox, Foskor, Mondi, Tongaat and Mpact.

Irrigated agriculture is also a main user within the W1 Catchment. Both sugar cane and citrus crops are cultivated in this area. The irrigation sector is managed by several Irrigation Boards, including Nkwalini, and Heatonville being the largest contributor to management activities.

Commercial afforestation is also a main water user within the catchment. Large plantation areas exist in both the upper catchment areas as well as towards the coast.

Water transfers do not occur outside of the W1 Catchment; however, two transfers occur within the catchment. One is from the Thukela Catchment to the south. Water is transferred from the Middleldift Scheme on the Thukela River and delivered into a tributary upstream of the Goedertrouw Dam. The second transfer is from the Umfolozi Catchment to the north from which water is transferred for use by Richards Bay Minerals.

2.3.2 W2 Catchment (Main River: Umfolozi)

The W2 Catchment covers a total surface area of 10 008 km^2. The secondary catchment includes 26 quaternary catchments with a total average natural runoff of 824.8 million m^3/annum. Average rainfall throughout the catchment ranges from 721 mm to 1136 mm, with an overall average of 848 mm. **Note** that these figures are based on the current available WR2012 information, and are currently being updated as part of the hydrology Task of the Reconciliation Strategy Study (RSS). The latest information, once available, will be incorporated in the Hydrology Report of this Study.

The W2 Catchment consists of the tertiary catchments W21, W22 and W23. The main rivers in the catchments are the White Umfolozi River (W21) and the Black Umfolozi River (W22). These join to form the Umfolozi River (W23). **Figure 2.3** provides a general locality map showing the main landmarks of the catchment area.

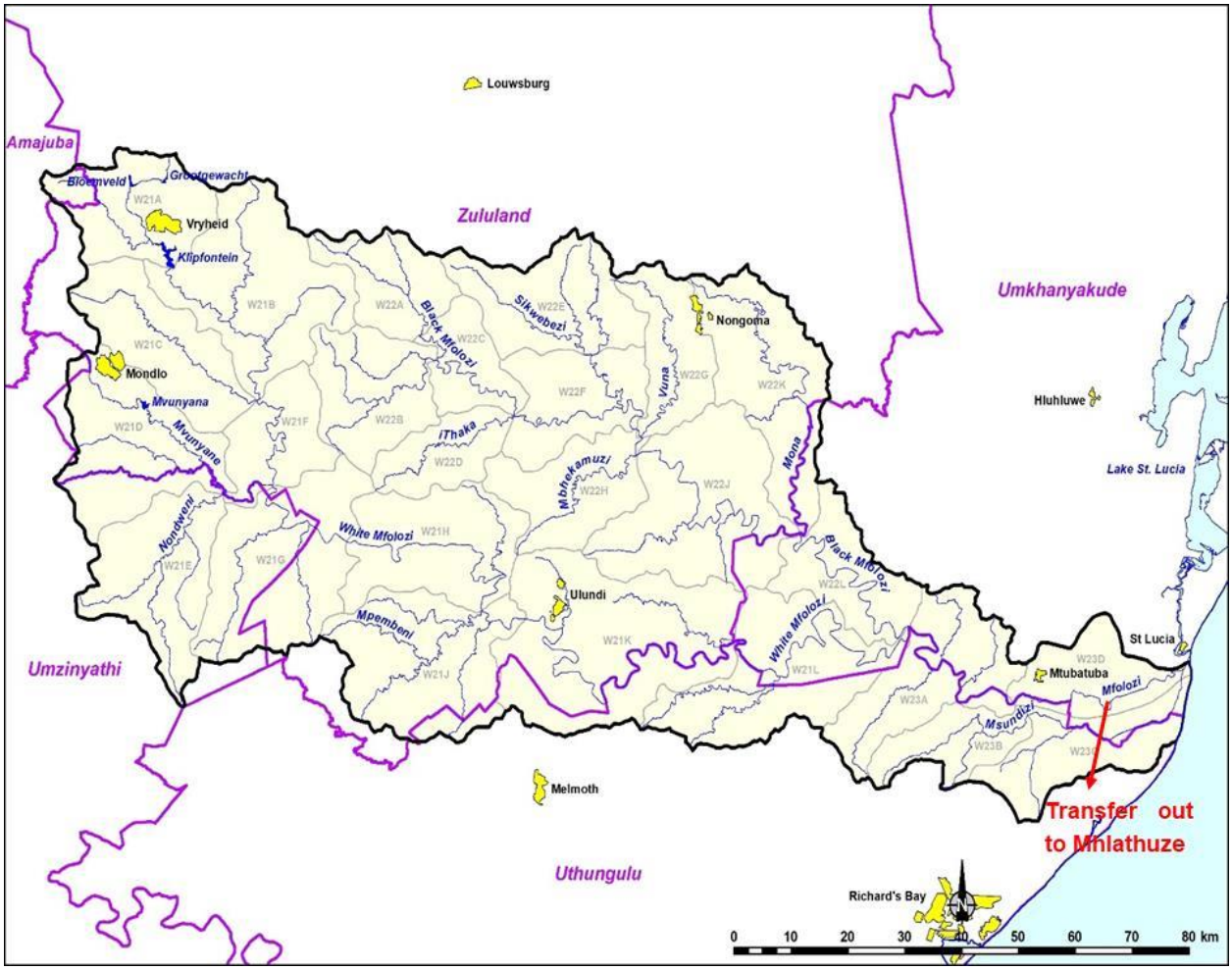


Figure 2.3 Surface Water Locality Map: W2

The main surface water impoundments in the catchment area are the Klipfontein, Bloemveld and Grootgewacht Dams supplying the domestic area of Vryheid with water. Releases from the Klipfontein Dam also supply downstream users in the Mpungamhlope and Ulundi districts with water. The Vuna and Vokwena Dams are the main impoundments in the Black Umfolozi catchment area. These dams supply water to nearby Nongoma.

The main urban centre, receiving water, in the W2 Catchment is the town of Vryheid. Additional domestic water supply schemes also supply water users in the catchment area, which include Emondli, Ulundi, Nongoma, Ceza, Mpungamhlope and Matubatuba. Zululand Anthracite Coal also makes some use of the water resource for mining purposes. While irrigated agriculture does occur within the catchment, it is not as prominent as in surrounding catchments. The main irrigators in this area are located towards the east closer to the eastern coastal areas. Commercial afforestation is also propagated in the area, but to a lesser extent.

The W2 Catchment also provides a transfer scheme for water out of this catchment into the W1 Catchment area, closer to the eastern KwaZulu Natal coast, in order to supply Richards Bay Minerals.

2.3.3 W3 Catchment (Main River: Mkuze)

The W3 Catchment covers a total surface area of 9 545 km^2. The secondary catchment includes 19 quaternary catchments with a total average natural runoff of 577.6 million m^3/annum. The average rainfall throughout the catchment ranges from 643 mm to 948 mm, with an overall average of 767 mm. **Note** that these figures are based on the current available WR2012 information, and are currently being updated as part of the hydrology Task of the RSS. The latest information, once available, will be incorporated in the Hydrology Report of this Study.

The W3 Catchment consists of the tertiary catchments W31 and W32. The main rivers in these catchments are the Mkuze River (W31) and the Hluhluwe River (W32). **Figure 2.4** provides a general locality map showing the main landmarks of the catchment area.

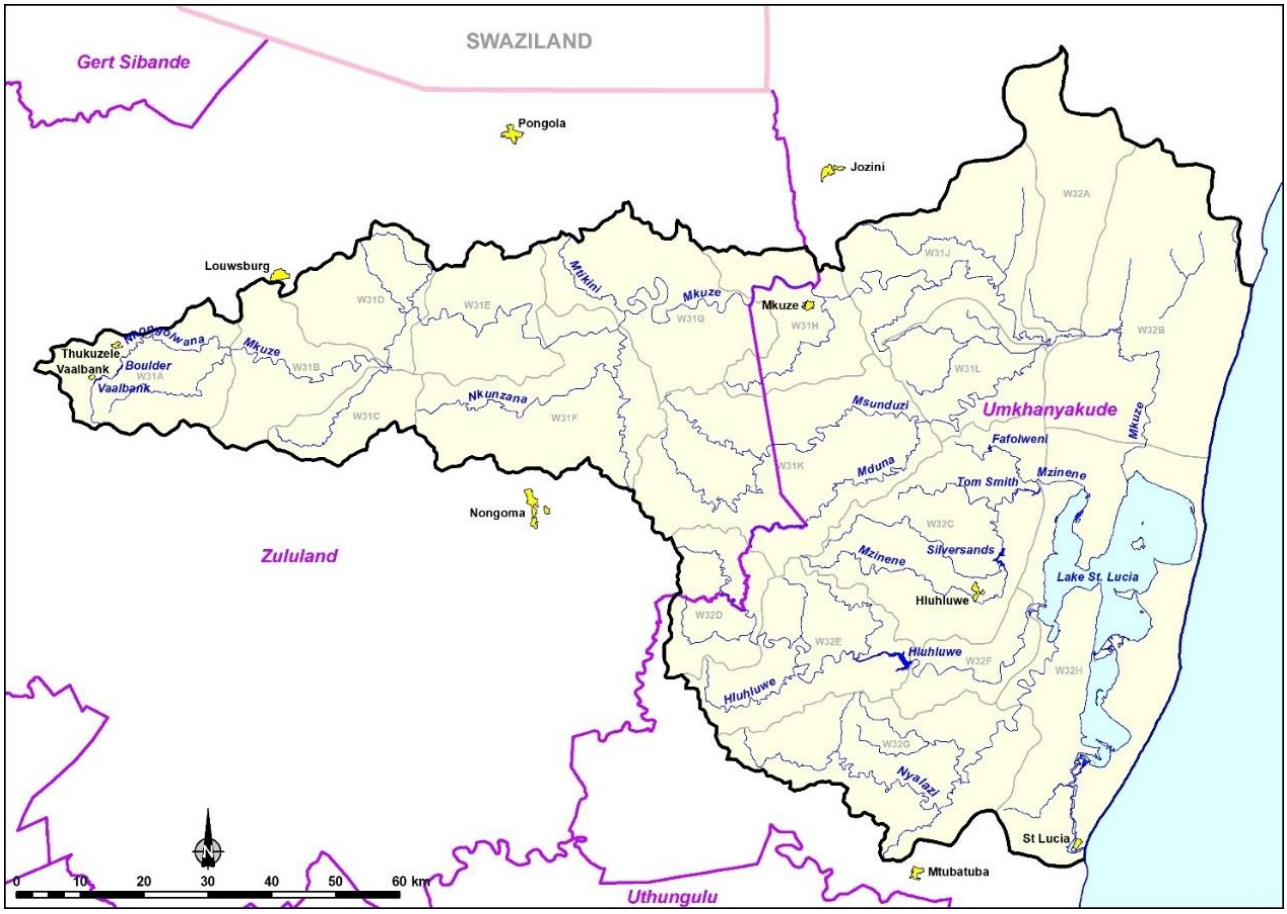


Figure 2.4 Surface Water Locality Map: W3

Only minor dams exist in the Mkuze Catchment, with the largest of these being the Vaalbank and Boulder Dams, supplying domestic users. The Blackie Dam receives water from the northern Pongola catchment and supplies water for domestic and irrigation usage. The Hluhluwe Dam is the main dam in the Hluhluwe Catchment. Additional surface water resources are obtained from Lake St Lucia.

The villages of Mkuze and Hluhluwe, as well as the domestic water supply scheme to Mandlakazi, are the main primary users within the W3 Catchment. A small amount of mining occurs in this upper catchment.

Significant irrigated agriculture exists in the Mkuze Catchment, with the main water use registered to Mr. Charl Senekal as well as to the Sibuyela Ekhaya Communal Property Trust. Some commercial afforestation is promulgated in the upper catchment, as well as areas to the east and south-west of Lake St Lucia.

The irrigation activities mentioned above are largely supported by an inter-catchment transfer from the northern Pongolapoort Dam in the W4 Catchment.

2.3.4 W4 Catchment (Main River: Pongola - excluding Eswatini)

The W4 Catchment covers a total surface area of 11 714 km^2. The secondary catchment includes 26 quaternary catchments with a total average natural runoff of 1103.8 million m^3/annum. The average rainfall throughout the catchment ranges from 564 mm to 1061 mm, with an overall average of 736 mm. **Note** that these figures are based on the current available WR2012

information, and will be updated as part of the hydrology Task of the RSS. The latest information, once available, will be incorporated in the Hydrology Report of this Study.

The W4 Catchment consists of tertiary catchments W41, W42, W43, W44 and W45. The main rivers in these catchment areas are the Bivane River (W41), the Ngwavuma River (W43) and the Pongola River (W42, W44 and W45). **Figure 2.5** provides a general locality map showing the main landmarks of the catchment.

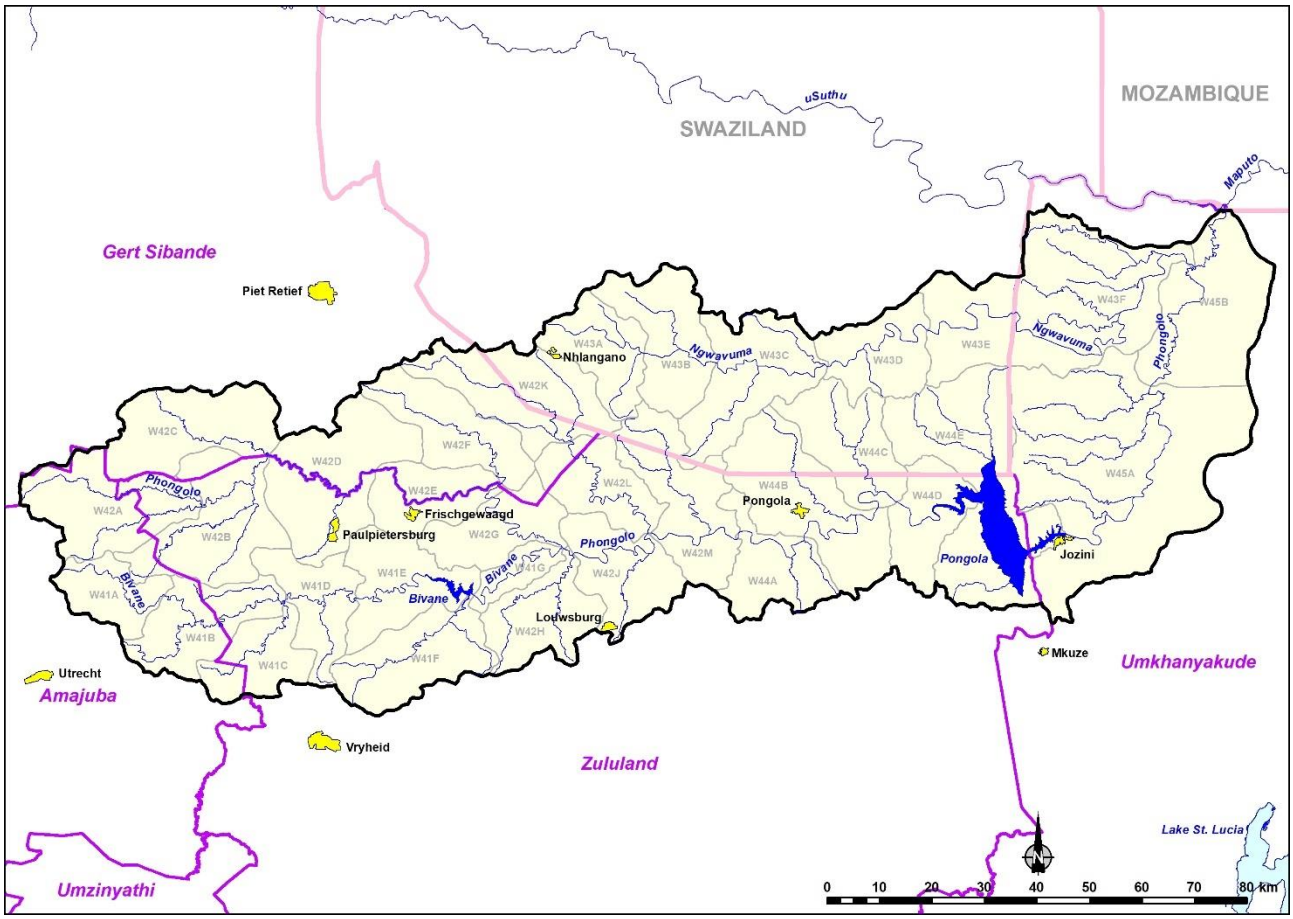


Figure 2.5 Surface Water Locality Map: W4

Pongolapoort Dam is the fifth largest dam in South Africa and is located in the Pongola Catchment. The only other main surface water impoundments occurring in the area are the Bivane Dam, built to augment irrigation supply around the town of Pongola, and the Edumbe Dam supplying the town of Paul Pietersburg.

Primary domestic users within the W4 Catchment include Paul Pietersburg, Louwsburg, Pongola Town, Simdlangentsha West (Frischgewaagd) and East, Khiphunyano, Msibi, Belgrade, Shemula and Jozini. The large RCL Sugar Mill outside Pongola Town is the main industrial user in the catchment. Some mining exists in the upper catchment.

The Impala Water User Association is the main user in the catchment, covering a large irrigated area around the town of Pongola and upstream of the Pongolapoort Dam. Downstream of Pongolapoort Dam is the Mjindi Irrigation Scheme, also a large water user, making use of a canal infrastructure in the area. The western part of the catchment consists of a significant amount of commercial afforestation.

In terms of catchment transfers, the Pongolapoort Dam supplies water for irrigation use mainly in the area, and water to a small domestic component to the neighbouring Mkuze Catchment to the south.

2.3.5 W5 Catchment (Main River: Usutu - excluding Eswatini)

The W5 Catchment covers a total surface area of 16 697 km^2, of which 7 627 km^2 is located within South Africa. This secondary catchment includes 47 quaternary catchments, 24 of which are in South Africa. The total average natural runoff of these catchments within South Africa is 949.3 million m^3/annum. The average rainfall throughout the catchment ranges from 763 mm to 923 mm, with an overall average of 868 mm.

The W5 Catchment consists of tertiary catchments W51, W52, W53, W54, W55 and W56. The main rivers in these catchments are the Assegaai River (W51), the Hlelo River (W52), the Ngwempisi River (W53), the Usutu River (W54), the Mpuluzi River (W55), and the Lusushwana River (W56). **Figure 2.6** provides a general locality map showing the main landmarks of the catchment.

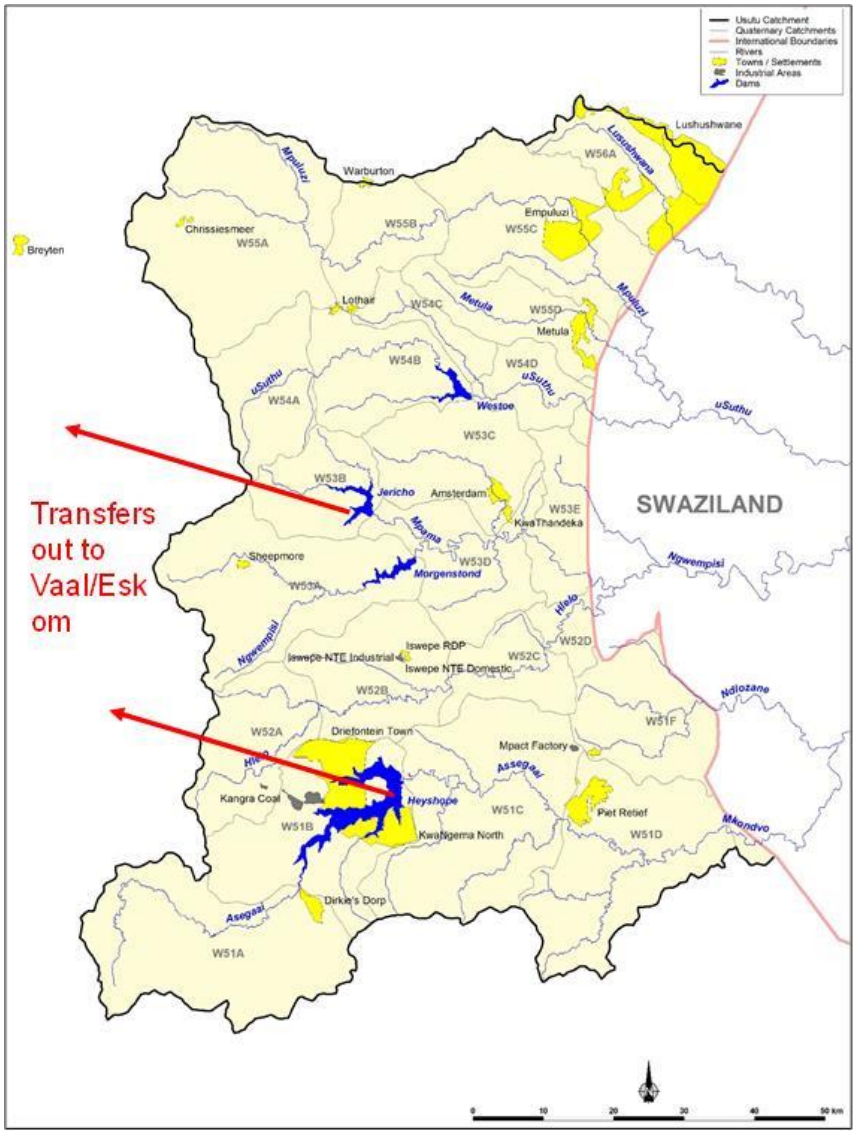


Figure 2.6 Surface Water Locality Map: W5 (RSA portion only)

Four main dams occur in the Usutu Catchment, namely Jericho Dam, Westoe Dam, Heyshope Dam and Morgenstond Dam. These dams are all used to supply strategic users (such as Eskom) located outside the Usutu Catchment in both the Vaal and Olifants Catchments.

The domestic users within the W5 Catchment area are small towns and villages, namely Malobeni, Amsterdam, Piet Retief, Iswepe, Empuluzi and Lushushwane. Mpact paper also has a factory in the catchment.

A relatively small amount of irrigation occurs within the catchment. The main user is commercial afforestation, which covers almost 30% of the surface area of the portion of the catchment, falling within South Africa.

The W5 Catchment is a major exporter of its water resources, including transfers from Jericho Dam, averaging about 68 million m^3. The Heyshope Dam transfer scheme is dependent on the storage capacity of Grootdraai Dam, and will typically only transfer water to Grootrdraai Dam if this dam's level drops below 75% from its full storage capacity. The maximum possible water transfer based on the infrastructures in the region's capabilities is 135 million m^3 in a year.

2.3.6 W7 Catchment (Kosi Bay and Lake Sibaya)

The W7 Catchment covers a total surface area of 2 589 km^2. Only one quaternary catchment is considered in this study area, which has a total average natural runoff of 142.8 million m^3/annum. The average rainfall throughout the catchment is 769 mm. **Note** that these figures are based on the current available WR2012 information, and are currently being updated as part of the hydrology Task of the RSS. The latest information, once available, will be incorporated in the Hydrology Report of this Study.

One quaternary catchment is considered in the W7 secondary catchment. The catchment contains only minor streams, namely Swamanzi and Malangeni, which enter Kosi Bay. **Figure 2.7** provides a general locality map showing the main landmarks of the catchment.

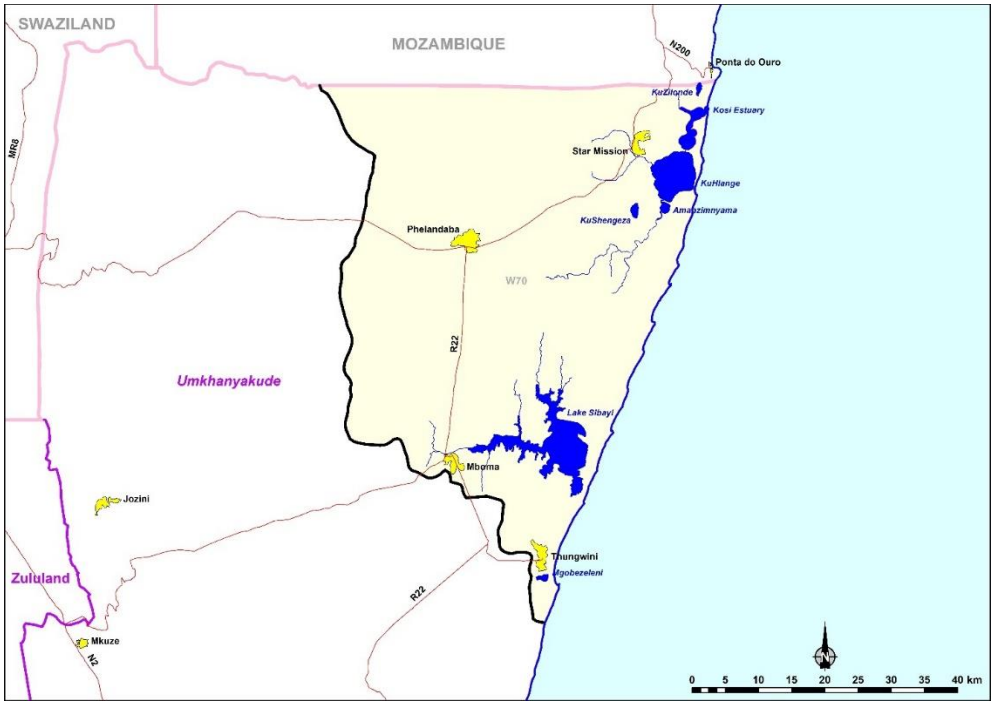


Figure 2.7 Surface Water Locality Map: W7

Primary domestic users within the W7 Catchment include the towns and surrounding communities of Mbazwane, Mseleni and Manguzi.

Limited irrigation is registered in the W7 Catchment, and it does not originate from surface water resources. Commercial afforestation cultivation activities nearby Lake Sibaya form part of a large water consuming entity in the catchment. The declining water levels of Lake Sibaya as seen in recent years are attributed to water usage by afforestation and related forestry activities.

3 STATUS QUO ASSESSMENT: GROUNDWATER RESOURCES

3.1 INTRODUCTION AND DESCRIPTION

The hydro-geology of the Usutu to Mhlathuze Catchment was first documented on a broad scale by the DWS KwaZulu-Natal Groundwater Resources Mapping and Characterisation Project in the 1990s. A broad overview is also given by the DWS 1:500 000 Hydro-geological Map Series: 2530 Nelspruit; 2730 Vryheid; and the 2928 Durban map sheets.

The Usutu to Mhlathuze Catchment is approximately 45 000 km² in total area. Of this, about 6000 km² comprises the Zululand Coastal Plain along the north-eastern coast. The elevation in the area varies from sea level in the east to an average of some 100 m over the width of the Zululand Coastal Plain. Inland, the north-south trending Lebombo range bounds this plain and rises to some 700 m, decreasing to the south. West of the Lebombo, the surface falls abruptly to only some 250 m in the similarly north-south trending Lowveld. Further inland the land rises progressively to a maximum elevation of some 2000 m on the Great Escarpment on the north-western boundary of the WMA.

Physio-graphically, the inland portion of the Usutu to Mhlathuze Catchment comprises a number of east or south-east trending basins of the major rivers that are separated by elevated interfluve ridges. The coastal portion of the area in the south, and the inland portion of the area west of the Zululand Coastal Plain, are generally characterised by steep and strongly dissected topographies.

Rainfall over the Usutu to Mhlathuze Catchment varies from about 1000 mm to 1200 mm annually along the coast, and on the elevated ridges and escarpments in the interior, to about 600 mm to 700 mm in the major river basins and valleys of the interior. It is similar on the inner margin of the Zululand Coastal Plain and in the Lowveld, and inland of the Lebombo Mountain Range. On the elevated crest of the Lebombo Mountains the rainfall increases to over 800 mm/annum.

Geologically, the Usutu to Mhlathuze Catchments comprises three structurally distinct provinces.

3.1.1 Zululand Coastal Plain

In the east, the Zululand Coastal Plain is underlain mainly to be an eastward-thickening wedge of unfaulted Cretaceous marine sediments covered by a relatively thin veneer of unconsolidated, mainly Aeolian sandy sediments of Neogene age. The plain lies below 100 metres above mean sea level (mamsl) and widens progressively towards the north. It is bounded in the west by the Lebombo range, which is of Jurassic age.

The unfaulted wedge, of Cretaceous sediments, consists of gently seaward-dipping marine siltstones originating from the Makatini, Mzinene and St Lucia Formations. These formations are un-conformably overlain by younger, mainly unconsolidated, sandy Aeolian sediments of Miocene to Holocene age formations (i.e. Uloa, Umkwelane, Port Durnford, Kosi Bay, Kwambonambi and Sibayi Formations), that rest as a thin veneer consisting of a few tens of metres in thickness on the upper crust. In places along the inner margin of the coastal plain, deeply weathered dunes can be found that form Berea-type red sand.

In proximity to the coastline, the lower courses of the major rivers, and the coastal Kosi Lake and Lake Sibayi drainage systems are underlain by a considerable thickness of alluvial and estuarine

sediments, the former being characteristically consisting of a sandy sediment and the latter consisting of a clay type sediment, as in the Richard's Bay estuary (sandy) and the St Lucia Lake system (clay). Such sediments also underlie the course of the Pongola and Usutu Rivers and constitute the inner margins of the northern parts of the river plains. A characteristic of all the lower courses of these rivers is the formation of shallow marginal lakes, some of considerable extent, which represent alluvium rich marginal tributary valleys.

3.1.2 Southern Lebombo and Lowveld

Inland of the Zululand Coastal Plain and to the south of it, is the Lowveld with the Lebombo range separating them. The structure comprises fault blocks that are tilted increasingly steeply between major strike faults in a general easterly to south-easterly or seaward direction. This includes the major seaward dipping Lebombo structure which is a faulted 'monocline'. In this portion of the Usutu to Mhlathuze Catchment the geology is complex due to the faulting that is Gondwana-breakup related and of Late-Jurassic age. In the southern faulted portion of the region, unconformably overlying the basement rocks, are a diverse rock-type assemblage of the Nama-Natal Structural and Metamorphic Province (NNMP). To the north of them are the sandstones of the Natal Group. In the central region are the rocks of the Pongola Supergroup, exposed where the overlying Karoo rocks have been removed. The remainder of the area is underlain by a down faulted sedimentary and Karoo dolerite-intruded succession of the Karoo Supergroup, which is capped by the Lebombo structure, and by the very thick faulted and Karoo dolerite dyke intruded volcanic Letaba basalt and Jozini rhyolite-dacite succession.

3.1.3 Middleveld and Escarpment

In the western portion of the Usutu to Mhlathuze Catchment, west of the Lowveld, the geology is generally gently westward-dipping and unfaulted Karoo Supergroup sedimentary rocks that lie unconformably overlie Archaean and Proterozoic rocks of the Kaap-Vaal craton. They are of various types and granite-intruded. They outcrop over much of the study area, especially in the northwest. The Karoo Supergroup rocks have at their base the Dwyka Group, which is largely tillite. It outcrops mostly in the south. It is overlain by a thick assemblage of sub horizontal shales, sandstones and mudstones of the Ecca and Beaufort Groups. These rocks are intruded by sheets, and dykes, of Karoo dolerite.

3.1.4 Aquifer types

The western or inland portion of the Usutu to Mhlathuze Catchment, and a limited portion south of the Zululand Coastal Plain at Mtunzini comprises hard rock fractured and weathered aquifers with secondary porosity. Faults, joints, and intrusive Karoo dolerite sheet and dyke contacts are zones of significant groundwater occurrence. These fractured and weathered aquifers include deeply weathered granite and granite-gneiss rocks, and the rocks of the Karoo Supergroup. The Natal Group and the Dwyka Tillites form fractured aquifers with little storage.

By contrast, the aquifers of the Zululand Coastal Plain are of the primary porosity or intergranular type. The Cretaceous siltstones which underlie the coastal plain at depth are an extremely poor groundwater aquifer. The minimal groundwater present is generally highly saline.

Two primary porosity aquifers underlie portions of the coastal plain. Immediately overlying the Cretaceous sediments, but subject to variable thickness and erratic areal distribution, are the karst-weathered shelly coquina and calcarenites of the Mio-Pliocene age Uloa and Umkwelane Formations, which constitute the 'deep' coastal plain aquifer. It is generally 30 to 40 metres below

ground level (mbgl). Where present, the sandy lower portion of the overlying Kosi Bay Formation can contribute materially to this Aquifer as a leaky layer. By contrast, the shallow coastal plain aquifer comprises saturated fine sand at the base of the surficial Kwambonambi Formation, and occurs at 1 - 6 mbgl, perched above the much less permeable and more clayey Kosi Bay and Port Durnford Formations. It is not present over the western drier portions of the coastal plain.

In terms of groundwater-surface water interaction, several aspects need to be highlighted:

- Baseflow from high-lying springs as interflow.
- Baseflow from aquifers as groundwater baseflow.
- Interaction of groundwater and lakes.
- Wetlands.

It should be noted that abstraction from lakes and wetlands largely dependent on groundwater is a groundwater use, and abstraction of groundwater from aquifers could deplete groundwater baseflow to these systems.

The interaction of groundwater with surface water depends on the physiography, geology, and climate setting of the region. The factors of importance include topography, aquifer type, groundwater levels, rainfall and recharge, and permeability.

Interactions can be expressed as rivers (or lakes) gaining baseflow from groundwater, rivers losing water to groundwater, or riverine vegetation evapotranspirating groundwater in shallow groundwater regions.

Hydrographs indicate where baseflow exists. Hydrographs can consist of three components: direct surface runoff, interflow from temporary perched or high lying springs that respond rapidly to rainfall but are above the regional groundwater level, and groundwater baseflow from the saturated zone that can be impacted by groundwater abstraction. The term baseflow is the delayed flow component from the latter two sources. Interflow is generally not affected by groundwater abstraction since it occurs in high lying areas separated from the regional aquifer by impermeable layers.

3.2 SOURCES OF DATA

The literature sources and databases accessed for groundwater information are shown in **Table 3.1**.

Table 3.1 Literature sources and databases accessed during this study

Type of Data	Data	Source
Catchment delineation	Quaternary catchment boundaries	WR2012
Population	Population	Stats SA
Climatic data	Rainfall and evaporation	WR2012
Geology	Lithology and structures	CGS geological maps
Hydrology	Baseflow	GRA II (DWAF, 2006)
Geohydrology	Harvest Potential Exploitation Potential Recharge Hydrochemistry Water levels Borehole yields	GRA II (DWAF, 2006) GRA II (DWAF, 2006) GRA II (DWAF, 2006) ZQM and Water Management System (WMS) database National Groundwater Archive (NGA) NGA
Groundwater Infrastructure	Type of Pump	Water Services Data base, Groundwater Resource Information Project (GRIP)

Type of Data	Data	Source
Groundwater use	Lawful water use	Water use Authorization & Registration Management System (WARMS)
	Municipal water use	
	Schedule 1 water use	Stats SA
	Livestock water use	GRA II (DWAF, 2006)

The National Groundwater Archive (NGA) was used to collect information on borehole yield and the depth of water strike. Since this database contains data on blow yields when boreholes were established, it does not include subjective bias on sustainable yield, or recommendations, but is a measure of maximum borehole delivery and is thus generally higher than the sustainable yield of boreholes. Borehole yields were investigated by median yield and the percentage of boreholes yielding more than specified yield values to provide an indication of exploitability.

Borehole blow yields as listed in the NGA were grouped by lithology and per quaternary catchment to derive the geometric and median borehole yield, and the percentage of boreholes yielding more than a specified yield. Yields above 2 l/s are considered economical for motorised and reticulated water supply, while yields greater than 1 l/s are suitable for local water supply or wellfields. Yields below 0.5 l/s do not warrant exploitation for water supply at greater than a household level.

The Groundwater Resource Information Project (GRIP) data base provides information on infrastructure and recommended pumping rates. It thus reflects the sustainable capacity of existing boreholes, which may or may not be the rate the borehole is currently utilised at. This database is used to estimate current infrastructure capacity. It does not cover the entire area, and yields are recommended yields, hence are not directly comparable with NGA blow yields. Recommendations also include a subjective bias.

The GRAII data base (DWAF, 2006b) provided information on baseflow, recharge, aquifer storage and available resources on a quaternary catchment level. The estimation of recharge is used to calculate both the stress index and the available groundwater volume for allocation per unit. This allocable volume ultimately determines whether or not additional groundwater use can be approved after considering the Reserve and other users. Because of the presence of high-lying springs, which occur due to the presence of diabase sills or low permeability layers, much of the recharge on the Escarpment re-emerges in high-lying areas and is lost as interflow before reaching the regional aquifer. Hence total recharge in a catchment is not a good indicator of the groundwater resources. Consequently, the estimate of aquifer recharge (recharge that reaches the aquifer after the subtraction of interflow) should be utilised for deriving aquifer resources and stresses. However, total recharge should be used to estimate baseflow and the groundwater component of the Reserve.

GRAII (DWAF, 2006b) provided a methodology for calculating the Groundwater Resource Potential, which provides estimates of the maximum volumes of groundwater that are potentially available for abstraction on a sustainable basis based on recharge, baseflow, aquifer storage and a drought index. This calculation was revised based on recalculations of storage and the volumes of water held in aquifer storage in the aquifer, and the recharge from rainfall, less the natural baseflow.

It is however not possible to abstract all the ground water available. This is mainly due to economic and/or environmental considerations. The main contributing factor is the hydraulic conductivity or transmissivity of the aquifer systems. One of the most important of these is the

inability to establish a network of suitably spaced production boreholes to 'capture' all the available water in an aquifer system or on a more regional scale. The factors limiting the ability to develop such a network of production boreholes, includes the low permeability or transmissivity of certain aquifer units, accessibility of terrain to drilling rigs, and unknown aquifer boundary conditions. The Exploitability Factor based on borehole yield and the probability of drilling boreholes of greater than 2 l/s was utilised to calculate the Groundwater Exploitation Potential.

The Water use Authorization & Registration Management System (WARMS) database was used to tabulate existing lawful water use per quaternary catchment. Schedule 1 water use was estimated from the percentage of household's dependent on boreholes (excluding regional schemes) and the 2021 population at a consumption of 60 litre/capita/day (l/c/d).

The South Africa Water Quality Water Management System database characterizes groundwater quality per catchment and identifies water quality issues.

The concept of stressed water resources is addressed by the NWA but is not defined quantitatively. The groundwater stress index is used to reflect water availability versus groundwater used. The Stress Index for an assessment area is defined as follows:

Stress Index = Groundwater use/Recharge

In calculating the Stress Index, the variability of annual recharge is taken into account in the sense that not more than 65% of average annual recharge should be allocated on a catchment scale without caution and monitoring (stress index = 0.65). Stress index is calculated as groundwater use relative to aquifer recharge since the majority of recharge in the study area is lost as interflow and is not available as a groundwater resource to boreholes. Classification of stress is based on the DWS methodology (**Table 3.2**).

Table 3.2 Classification of groundwater by stress

Present Class	Description	Present Status Category	Stress Index
I	Minimally used	A	≤0.05
		B	0.05 - 0.2
II	Moderately used	C	0.2 - 0.4
		D	0.4 - 0.65
III	Heavily used	E	0.65 - 0.95
		F	>0.95

3.3 REVISIONS TO DATABASES

It was found that significant errors exist in GRAII (DWAF, 2006), especially in international catchments. It appears variables were scaled incorrectly and did not account for trans-border resources. This results in some parameters being grossly underestimated because they are averaged over a much larger area than the portion of the catchment in South Africa. In addition, unrealistic storage parameters were found. This affected the following:

- Storativity, which affects groundwater resource and exploitation potential as well as aquifer storage.
- Exploitation factor which affects exploitation potential.
- Only groundwater baseflow was considered in exploitation potential calculations, while all of the recharge was utilised, even the component lost as interflow. This results in a large over

estimation of exploitation potential in mountainous regions with a large interflow component, causing mountainous catchments to appear as having very large groundwater volumes.

- It was found that in many cases recharge in GRAII was less than baseflow, which is not possible and leads to a negative exploitation potential. This was corrected by utilising recharge and baseflow from WR2000 to ensure a water balance.

Revisions undertaken include the following:

- Upscaling parameters in catchments straddling international boundaries.
- Storativity (S) was recalculated for each catchment based on groundwater region, and the highest and lowest value in each region was verified.
- Only the groundwater stored in the upper 5 m, whether the weathered or fractured zone or a combination of the two was utilised to calculate Groundwater Resource Potential.
- The static water level used to calculate Storativity was the weighted mean depth of the saturated weathered and fractured zone.
- Total baseflow was used including interflow when calculating exploitation potential, since the recharge values in GRAII include recharge that drives interflow.
- Where corrected recharge values were available, these were used in preference to GRAII.

Total recharge for the study area is 2998 Mm^3/a, of which 1836 Mm^3/a is aquifer recharge. Baseflow is 2319 Mm^3/a. Groundwater use is less than 20 Mm^3/a.

3.4 GROUNDWATER REGIONS

The study area covers several groundwater regions (**Figure 3.1**). These are described in **Table 3.3**.

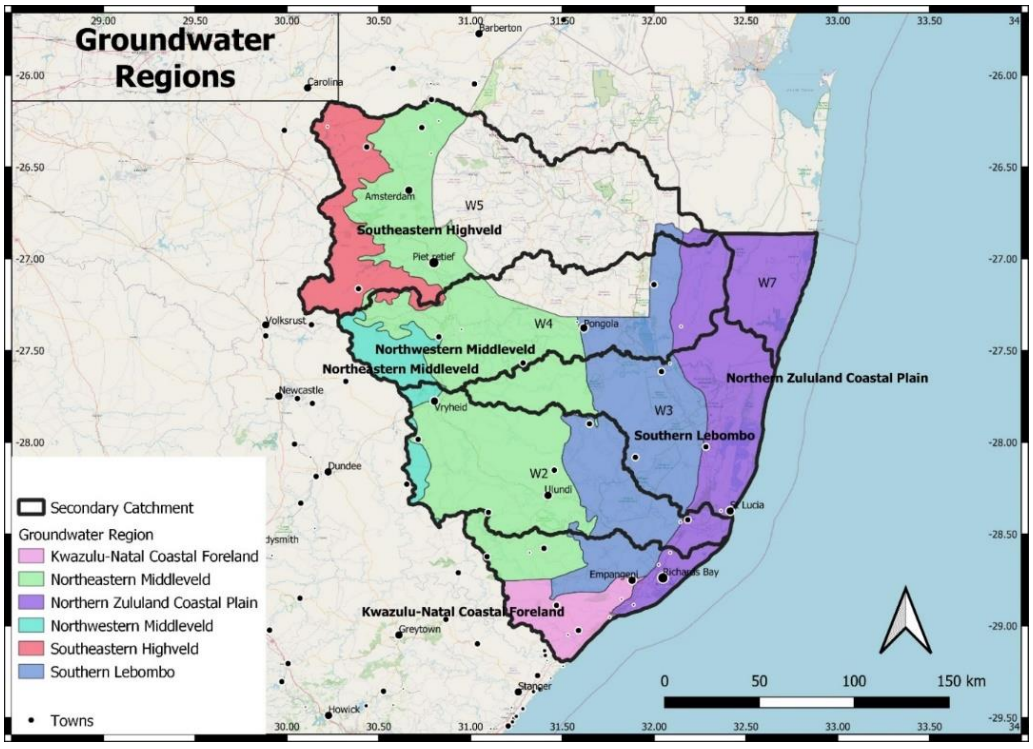


Figure 3.1 Groundwater Regions of the Usutu to Mhlathuze Catchment

Table 3.3 Groundwater Regions of the Usutu to Mhlathuze Catchment

Groundwater Region	Description
Northern Zululand Coastal Plain	Primary aquifers of the Maputoland Group conglomerates, calcarenite, limestone and sand underlain by Cretaceous Zululand Group low permeability Formations
Southern Lebombo	Karoo SuperGroup shale, sandstone, mudstone, siltstone, basalt, rhyolite with inliers of Swazian metamorphics and granite, and Natal Group sandstone.
Northwestern Middleveld	Carbo-Triassic weathered and fractured aquifers from the Ecca Group to Drakensberg basalt. Consists of shale, sandstone, mudstone, siltstone, capped by basalt.
Kwazulu-Natal Coastal Foreland	A structural province consisting of Namibian age rocks of the Tugela terrane. These are the Ntingwe, Mfongozi and Tugela Groups. They are partially covered by Natal Group sandstone overlain by Dwyka tillite.
Southeastern Highveld	Compact Karoo and Ecca shales, sandstones, mudstones, dolerite.
Northeastern Middleveld	Swazian lavas and volcanics, sandstone, shale, conglomerate, Nondweni quartzite, schist and other metamorphics, various Swazian granites and gneisses, Randian gabbro, granite, quartzite, shale, Ordovician Natal Group sandstone and shale, Carboniferous Dwyka tillite and Ecca shale.

The distribution of Groundwater regions per secondary catchment is shown in **Table 3.4**.

Table 3.4 Groundwater Regions by Catchment

Catchment	Groundwater Region
W1	Kwazulu-Natal Coastal Foreland, Northern Zululand Coastal Plain, Southern Lebombo, Northeastern Middleveld.
W2	Northern Zululand Coastal Plain, Southern Lebombo, Northeastern Middleveld, Northwestern Middleveld.
W3	Northern Zululand Coastal Plain, Southern Lebombo, Northeastern Middleveld.
W4	Northern Zululand Coastal Plain, Southern Lebombo, Northeastern Middleveld, Northwestern Middleveld.
W5	Northeastern Middleveld, Southeastern Highveld.
W7	Northern Zululand Coastal Plain.

3.5 DESCRIPTION AND STATUS QUO PER SECONDARY CATCHMENT

3.5.1 W1 Catchment (Main River: Mhlathuze)

Borehole Yield

Median yields of 0.8 - 2 l/s are found in the Northern Zululand Coastal Plain. Moderate yields of above 1 l/s are also encountered in the KwaZulu-Natal Coastal Foreland except where it is underlain by Natal Group sandstone. The Southern Lebombo has low yields (< 0.6 l/s). The Northeastern Middleveld has moderate yields of 0.8 - 1 l/s, except where underlain by Natal Group sandstone **(Figure 3.2**). The distribution of yields by catchment is shown in **Table 3.5**.

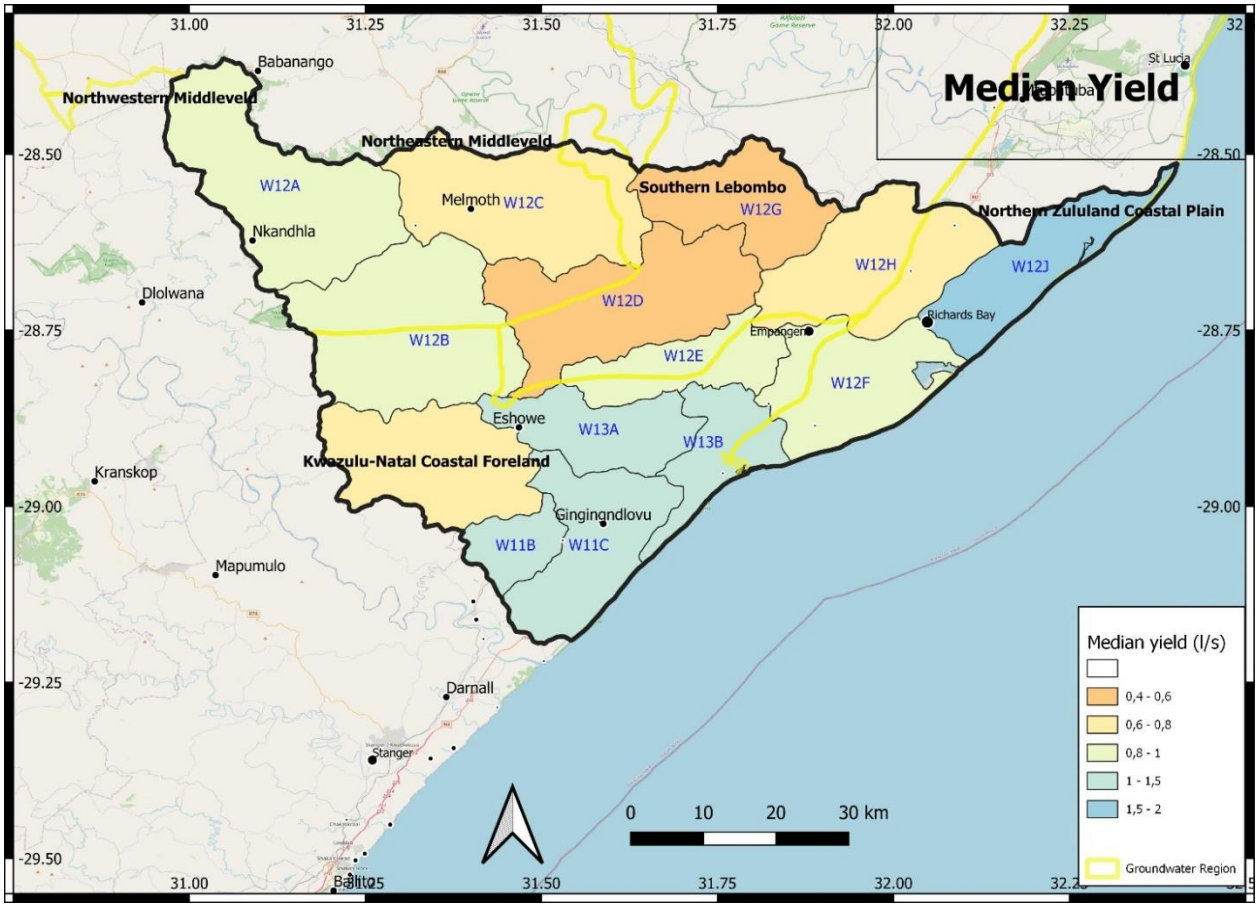


Figure 3.2 W1 Catchment: Median yields

Table 3.5 W1 Catchment: Borehole yield distribution

Quat	Average (l/s)	Median (l/s)	% > 0.5 l/s	% > 2 l/s	% > 5 l/s
W11A	1.30	0.70	67.3	18.7	3.3
W11B	1.70	1.40	92	36.1	0
W11C	1.66	1.26	81.6	32.7	0.9
W12A	1.64	0.99	70	24.5	6.7
W12B	1.18	0.90	62.7	18.6	0
W12C	1.88	0.76	79	26.4	4.6
W12D	0.89	0.49	49.5	10.2	1.9
W12E	1.17	0.86	71.8	16.3	0
W12F	2.20	0.87	71.5	13.8	9
W12G	0.78	0.46	48.4	6.9	1.1
W12H	0.94	0.68	64	10.7	0
W12J	5.72	1.63	83.4	44.5	21.9
W13A	1.75	1.06	73.5	22.5	4.1
W13B	1.77	1.28	72.5	40.5	0

Recharge

Recharge can be considered in terms of:

- Total recharge, which drives baseflow and recharges aquifers; and
- groundwater recharge which recharges the aquifers and is available to boreholes. This excludes the recharge that generates interflow from high-lying springs.

Recharge for the W1 Catchment is provided in **Table 3.6**. Recharge declines from over 200 mm/a on the Northern Zululand Coastal Plain to 50 - 60 mm/a inland. Aquifer recharge is 100 - 150 mm/a on the coastal plain and only 2 0- 40 mm/a inland.

Use

The groundwater recharge, exploitation potential and use for the W1 Catchment is described in **Table 3.6**.

Table 3.6 W1 Catchment: Groundwater recharge and exploitation potential

Quat	Area (km^2)	Recharge (Mm^3/a)	Aquifer recharge (Mm^3/a)	Exp. Pot (Mm^3/a)	GRAII Exp. Pot. (Mm^3/a)	Harvest Pot. (Mm^3/a)	Use (Mm^3/a)
W11A	445.15	39.56	12.80	3.12	12.23	34.40	0.35
W11B	126.82	11.00	3.73	1.28	4.51	5.30	0.06
W11C	383.02	40.52	10.68	3.82	17.24	8.60	0.23
W12A	623.31	27.23	18.91	4.64	7.48	21.29	0.16
W12B	656.33	35.93	18.81	4.96	10.84	34.38/	0.12
W12C	570.07	23.38	17.82	4.22	5.94	10.52	0.08
W12D	568.94	25.02	13.32	3.77	8.01	27.30	0.26
W12E	248.59	20.45	6.71	1.95	6.46	7.02	0.04
W12F	387.31	53.37	45.38	20.70	18.68	84.99	0.41
W12G	326.36	14.24	10.01	3.19	4.71	4.33	0.06
W12H	484.57	44.68	13.02	15.46	14.98	37.23	0.40
W12J	332.85	46.59	42.57	25.19	22.70	117.31	0.09
W13A	275.84	28.35	6.47	2.04	9.76	12.16	0.22
W13B	222.76	31.00	4.75	3.30	10.26	10.42	0.05

Groundwater use per sector is listed in **Table 3.7**. The stress index calculated from the total present use and aquifer recharge is shown in **Figure 3.3**, together with the location of known motorised pump systems. Groundwater is minimally used and the stress index is below 0.05.

Table 3.7 W1 Catchment: Groundwater use per sector

W1	m^3/a	%
Industry rural	2088	0.07
Industry urban	1460	0.05
Irrigation	1106660	36.78
Livestock	23000	0.76
Recreation	1825	0.06
Schedule 1	14080	0.47
Water supply service	1859364	61.80
Total Use	**3008477**	**100.00**

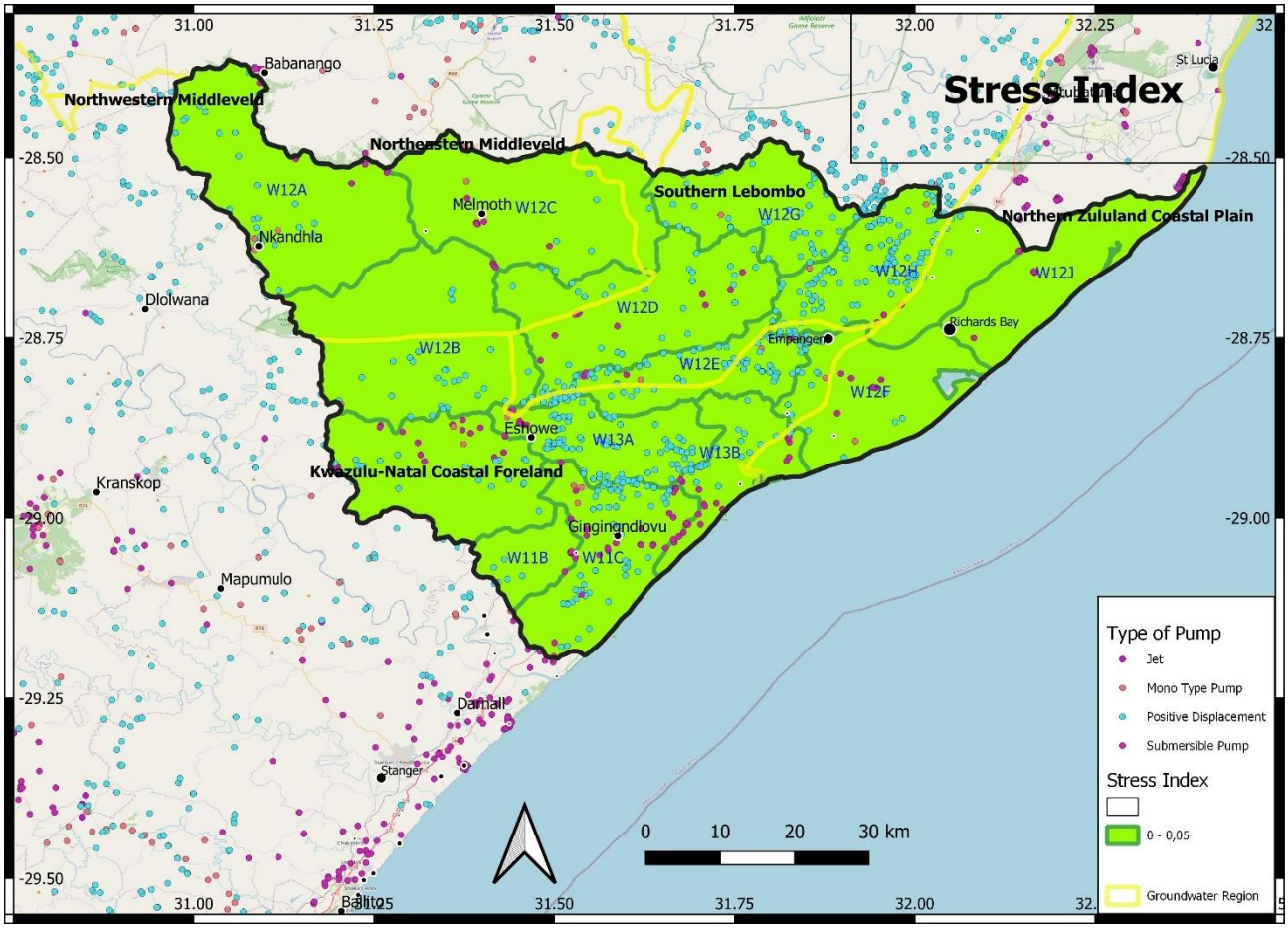


Figure 3.3 W1 Catchment: Stress Index

3.5.2 W2 Catchment (Main River: Umfolozi)

Borehole Yield

Median yields of 1 - 1.5 l/s are found in the Northern Zululand Coastal Plain. The Southern Lebombo and Northeastern Middleveld regions have very variable yields depending on lithology and structure, with the lowest yields in the Letaba Formation (**Figure 3.4**). The distribution of yields by catchment is shown in **Table 3.8.**

Table 3.8 W2 Catchment: Borehole yield distribution

Quat	Average (l/s)	Median (l/s)	% > 0.5 l/s	% > 2 l/s	% > 5 l/s
W21A	1.21	0.71	72.5	22.8	0
W21B	2.34	1.30	84.9	25.8	6.1
W21C	1.50	1.01	70.9	21.6	4
W21D	1.85	0.85	64.3	25.8	10
W21E	3.07	0.62	57.8	19.2	5.7
W21F	1.23	0.81	72.6	7.9	3.5
W21G	1.41	0.84	77.8	30.1	0.3
W21H	1.58	0.77	69.8	18.8	5.9
W21J	1.29	0.94	69.1	17.7	0
W21K	4.97	1.97	79.3	49.1	30.2
W21L	3.30	1.50	81.3	45.7	11.8
W22A	1.38	1.50	58.7	30	0
W22B	0.92	0.67	57.7	13	0
W22C	1.86	0.88	71.8	23.1	6.7
W22D	0.34	0.44	0	0	0
W22E	1.02	0.50	53.9	15.4	0
W22F	0.68	0.50	50	4.1	0

Quat	Average (l/s)	Median (l/s)	% > 0.5 l/s	% > 2 l/s	% > 5 l/s
W22G	5.02	2.15	72	51.2	17.2
W22H	1.45	0.88	60	23.4	4.3
W22J	1.51	0.67	61.6	23.9	3.9
W22K	1.48	0.52	50.6	20.9	4.7
W22L	2.64	2.64	0	71	0
W23A	2.32	0.39	43.8	18.6	9.2
W23B	2.45	0.71	60	20	8.2
W23C	1.14	1.13	78.9	9.2	0
W23D	1.34	1.09	86.8	17.6	0

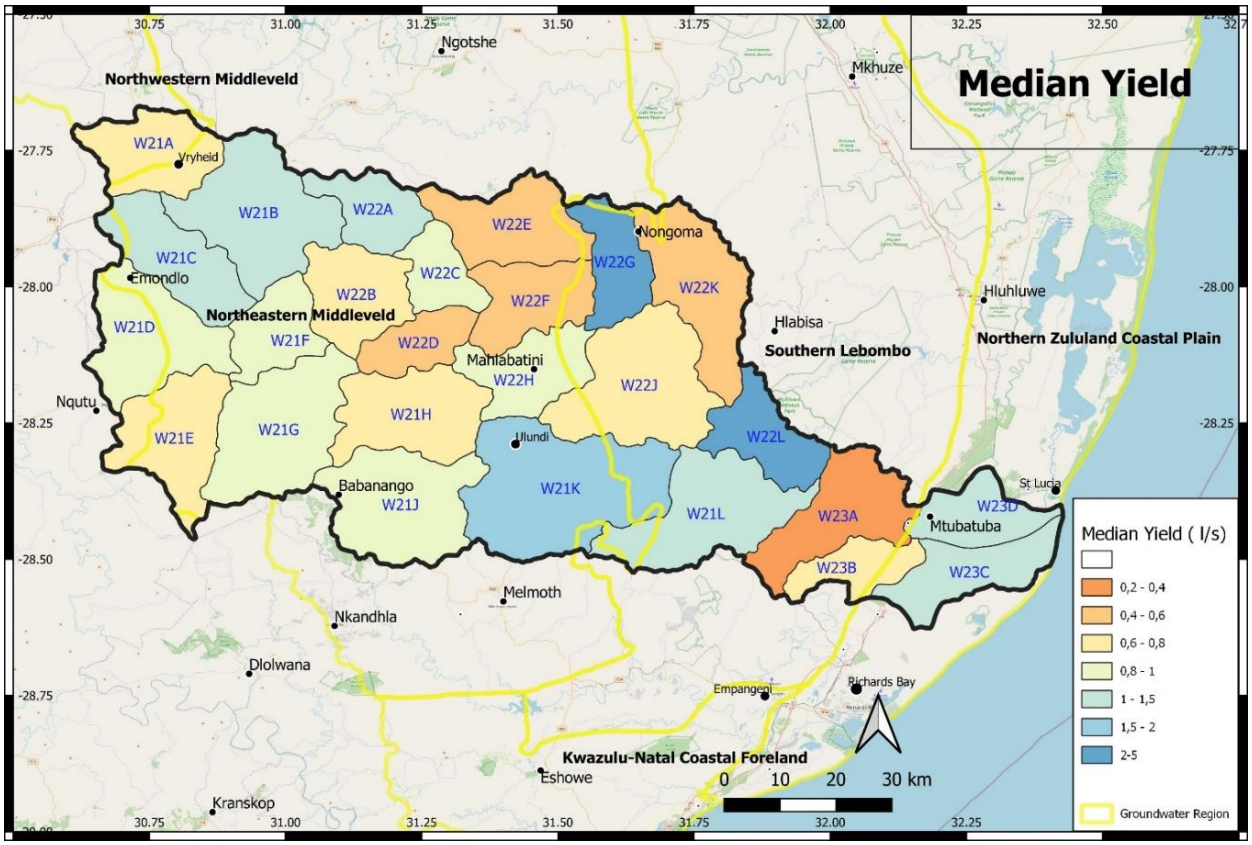


Figure 3.4 W2 Catchment: Median borehole yields

Recharge

Recharge can be considered in terms of

- Total recharge, which drives baseflow and recharges aquifers; and
- groundwater recharge to the aquifers, which is available to boreholes, but excludes the recharge that generates interflow from high lying springs.

Recharge declines from over 200 mm/a on the Northern Zululand Coastal Plain to 30 - 40 mm/a inland on the Lowveld and Middleveld. Aquifer recharge is over 150 mm/a on the coastal plain. It declines rapidly to less than 40 mm/a inland and is only 10 - 20 mm/a over the Middleveld and Lowveld.

Use

The groundwater recharge, exploitation potential and use for the W2 Catchment is described in **Table 3.9**.

Table 3.9 W2 Catchment: Groundwater recharge and exploitation potential

Quat	Area (km2)	Recharge (Mm3/a)	Aquifer recharge (Mm3/a)	Exp. Pot (Mm3/a)	GRAII Exp. Pot. (Mm^3/a)	Harvest Pot. (Mm^3/a)	Use (Mm3/a)
W21A	340.14	19.37	5.66	1.64	6.89	5.72	0.12
W21B	580.39	26.67	7.52	2.83	8.55	9.03	0.34
W21C	369.64	10.63	4.29	1.54	3.54	5.93	0.15
W21D	468.70	13.33	6.67	2.18	5.07	8.57	0.14
W21E	415.98	12.85	5.22	1.80	4.45	7.54	0.62
W21F	242.75	7.43	3.03	1.34	2.50	4.87	0.06
W21G	562.85	22.60	7.29	4.34	7.38	13.53	0.22
W21H	432.82	17.79	5.51	2.52	6.01	10.65	0.07
W21J	530.05	21.19	6.05	2.01	7.25	18.92	0.09
W21K	797.46	26.27	11.37	3.02	8.14	43.71	0.10
W21L	532.82	17.41	7.74	2.99	6.56	11.75	0.08
W22A	238.71	13.45	3.92	0.70	4.10	3.89	0.04
W22B	331.69	13.58	5.57	1.00	3.60	4.55	0.07
W22C	185.61	9.91	2.58	0.66	3.13	2.69	0.03
W22D	197.48	8.15	3.19	1.15	2.43	2.69	0.03
W22E	385.42	30.34	4.60	0.94	9.10	5.78	0.24
W22F	312.04	11.67	5.37	1.31	3.25	4.71	0.06
W22G	249.36	8.37	4.39	1.21	2.20	3.39	0.08
W22H	306.12	10.81	4.80	1.65	3.28	4.17	0.58
W22J	604.95	16.85	10.92	3.19	4.53	8.23	0.12
W22K	475.54	13.81	12.99	4.03	4.24	6.47	1.32
W22L	279.30	8.40	5.47	1.69	2.71	3.80	0.07
W23A	413.72	17.15	15.12	4.65	5.36	5.54	0.56
W23B	192.79	11.44	7.09	4.56	3.89	13.87	0.09
W23C	312.69	37.46	50.74	27.46	15.70	103.71	0.22
W23D	247.88	26.32	47.13	22.86	9.21	42.07	0.57

Groundwater use per sector is listed in **Table 3.10**. The stress index calculated from the total present use and aquifer recharge is shown in **Figure 3.5**, together with location of known motorised pump systems. Groundwater is minimally used and the stress index is below 0.2.

Table 3.10 W2 Catchment: Groundwater use per sector

W2	m^3/a	%
Industry(non-urban)	24380	0.65
Industry(urban)	13213	0.35
Agriculture: irrigation	1010681	27.07
Agriculture: wat. Livestock	103156	2.76
Mining	1120000	30.00
Recreation	6168.5	0.17
Schedule 1	7070	0.19
Water supply service	1449269	38.81
Total Use	**3733937.5**	**100.00**

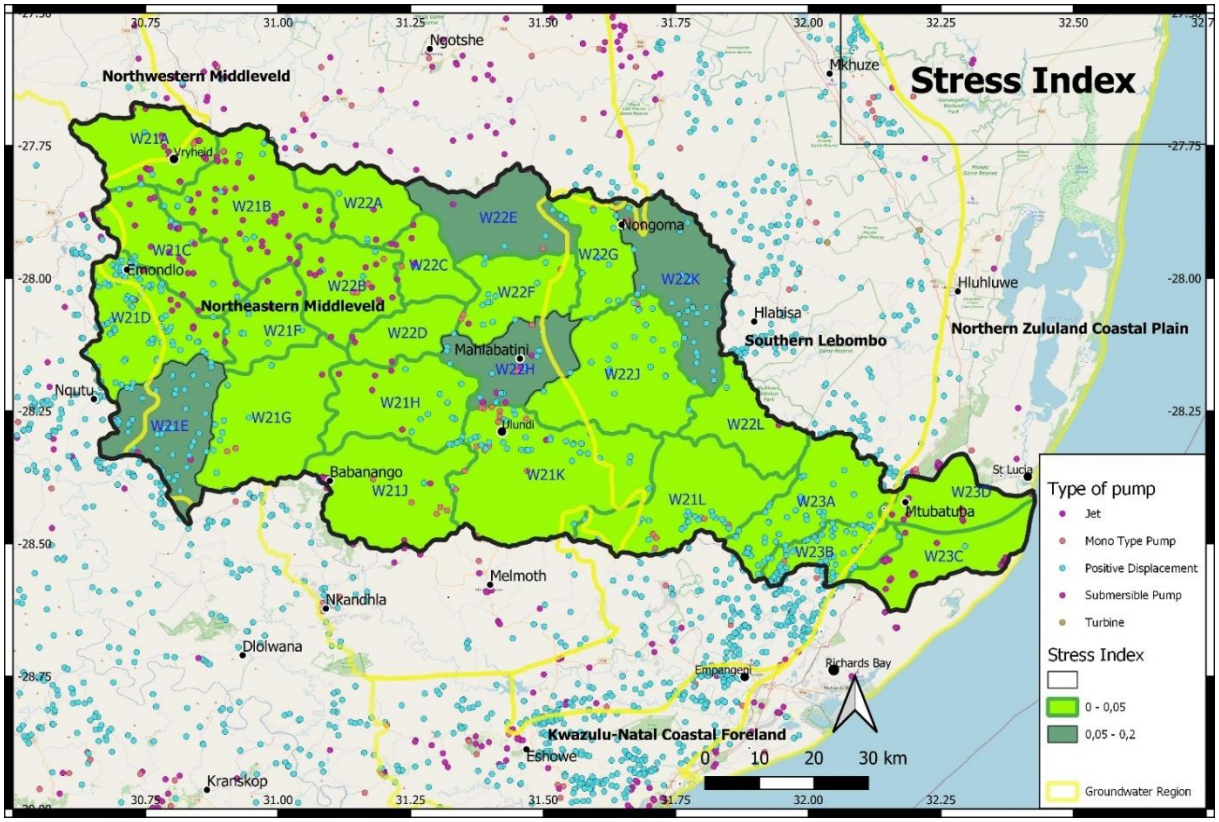


Figure 3.5 W2 Catchment: Stress Index

3.5.3 W3 Catchment (Main River: Mkuze)

Borehole Yield

Median yields are low to moderate (0.6 - 1 l/s) in the Northern Zululand Coastal Plain. The Southern Lebombo has yields of below 0.8 l/s and is the lowest yielding Groundwater Region. The Northeastern Middleveld region has yields above 1 l/s except in the headwater area (**Figure 3.6**). The distribution of yields by catchment is shown in **Table 3.11**.

Table 3.11 W3 Catchment: Borehole yield distribution

Quat	Average (l/s)	Median (l/s)	% > 0.5 l/s	% > 2 l/s	% > 5 l/s
W31A	1.10	0.72	70.2	20.7	0
W31B	2.16	1.25	67.6	39	11.8
W31C	2.99	2.99	0	0	0
W31D	1.69	1.11	79.1	38.5	0
W31E	4.79	1.60	79.3	14.3	12.8
W31F	0.79	0.50	48.4	5.4	0
W31G	1.05	0.82	59.9	13.3	0.7
W31H	1.56	0.61	58.6	19	7.7
W31J	1.89	1.29	76	44.1	4
W31K	1.39	0.61	58.7	17.7	2.7
W31L	1.05	0.62	58.9	11.4	0
W32B	1.70	0.94	81	26.9	4.2
W32C	1.86	0.73	64.8	10.1	1.8
W32D	0.98	0.55	60	11.2	0
W32E	0.94	0.28	31.6	12.7	0
W32F	1.14	0.78	79	15.8	0
W32G	1.87	0.83	70.3	24.7	9.2
W32H	1.39	0.75	66.7	6.7	4.2

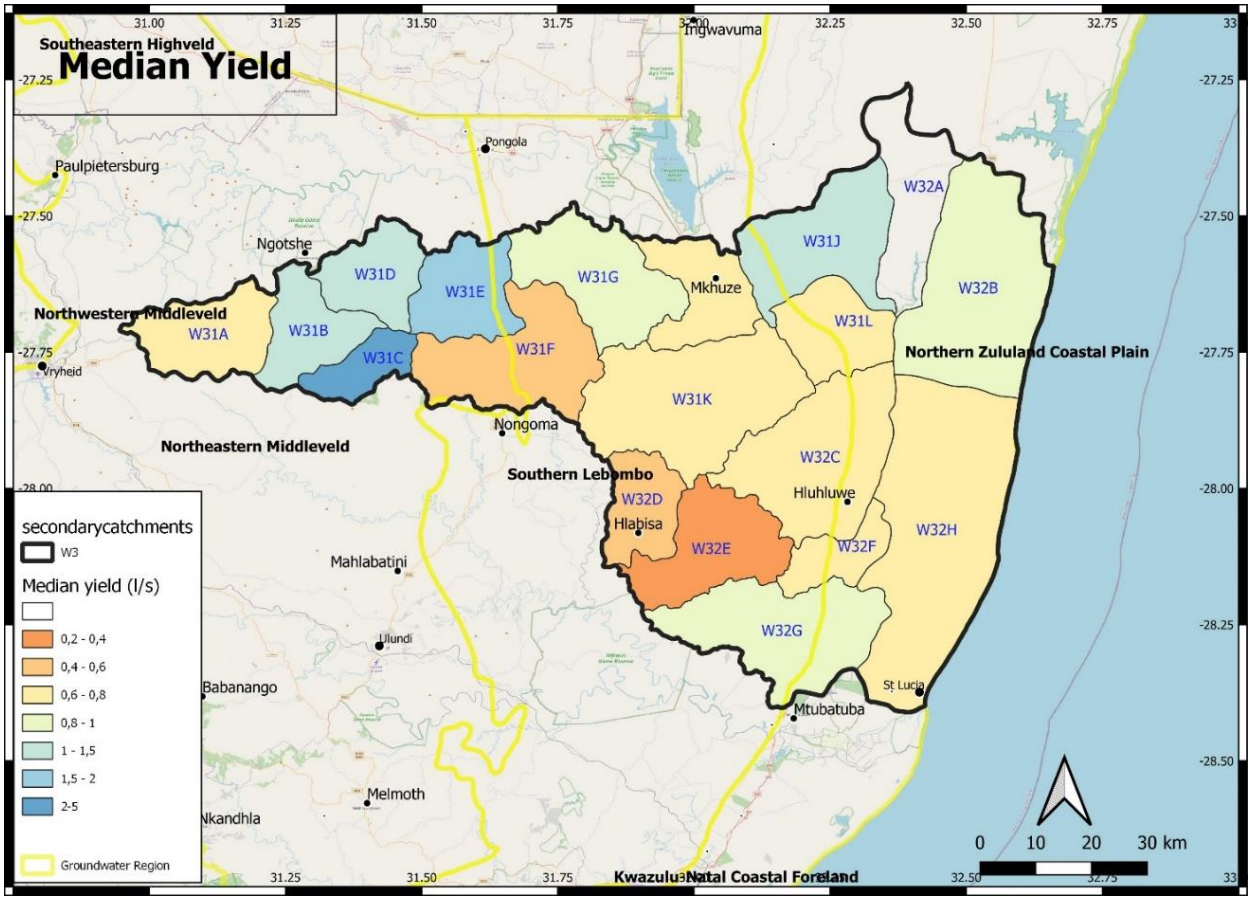


Figure 3.6 W3 Catchment: Median yield of boreholes

Recharge

Recharge can be considered in terms of:

- Total recharge, which drives baseflow and recharges aquifers, and
- groundwater recharge to the regional aquifers, which is available to boreholes, and excludes the recharge that generates interflow from high lying springs.

Recharge declines from 150 - 200 mm/a on the Northern Zululand Coastal Plain to 20 - 30 mm/a inland on the Lowveld and Middleveld. Aquifer recharge is 100 - 190 mm/a on the sandy coastal plain where interflow is minor, and decreases from 40 mm/a to 10 mm/a inland.

Use

The groundwater recharge, exploitation potential and use for the W3 Catchment is described in **Table 3.12**.

Table 3.12 W3 Catchment: Groundwater recharge and exploitation potential

Quat	Area (km^2)	Recharge (Mm^3/a)	Aquifer recharge (Mm^3/a)	Exp. Pot (Mm^3/a)	GRAII Exp. Pot. (Mm^3/a)	Harvest Pot. (Mm^3/a)	Use (Mm^3/a)
W31A	369.72	16.76	5.85	1.71	5.41	5.92	0.07
W31B	304.28	12.66	4.31	1.12	3.85	4.21	0.06
W31C	171.56	9.10	3.38	0.81	2.90	2.33	0.06
W31D	294.57	12.49	4.22	1.27	3.57	4.00	0.18
W31E	334.19	9.65	3.63	2.61	2.98	4.14	0.05
W31F	583.35	14.01	6.68	4.90	5.65	7.93	0.15
W31G	519.77	11.26	5.73	5.26	5.45	6.90	0.18
W31H	322.59	6.94	4.11	2.82	3.21	4.62	0.06

Quat	Area (km^2)	Recharge (Mm^3/a)	Aquifer recharge (Mm^3/a)	Exp. Pot (Mm^3/a)	GRAII Exp. Pot. (Mm^3/a)	Harvest Pot. (Mm^3/a)	Use (Mm^3/a)
W31J	552.60	12.78	19.79	11.59	4.65	60.48	0.13
W31K	855.31	18.77	10.94	8.22	8.98	11.35	0.26
W31L	321.38	8.03	11.53	12.79	3.11	19.25	0.06
W32A	417.40	18.75	45.16	27.72	7.88	80.69	0.10
W32B	934.44	89.22	142.13	87.84	42.39	234.12	0.21
W32C	728.23	21.55	19.48	21.74	8.76	27.64	0.13
W32D	267.22	8.67	6.04	2.51	3.51	3.63	0.11
W32E	455.92	16.99	6.79	5.43	6.68	6.11	0.09
W32F	187.34	9.56	7.51	9.71	3.46	10.68	0.05
W32G	647.50	36.63	25.78	23.34	13.15	25.39	0.22
W32H	1276.01	113.79	188.09	94.63	40.97	252.66	0.60

Groundwater use per sector is listed in **Table 3.13**. The stress index calculated from the total present use and aquifer recharge is shown in **Figure 3.7**, together with location of known motorised pump systems. Groundwater is minimally used and the stress index is below 0.05.

Table 3.13 W3 Catchment: Groundwater use per sector

W3	m^3/a	%
Industry(non-urban)	2400	0.33
Industry(urban)	2847	0.39
Agriculture: irrigation	104600	14.17
Agriculture: wat. Livestock	12295	1.67
Schedule 1	19060	2.58
Water supply service	596879.2	80.87
Total	**738081.2**	**100.00**

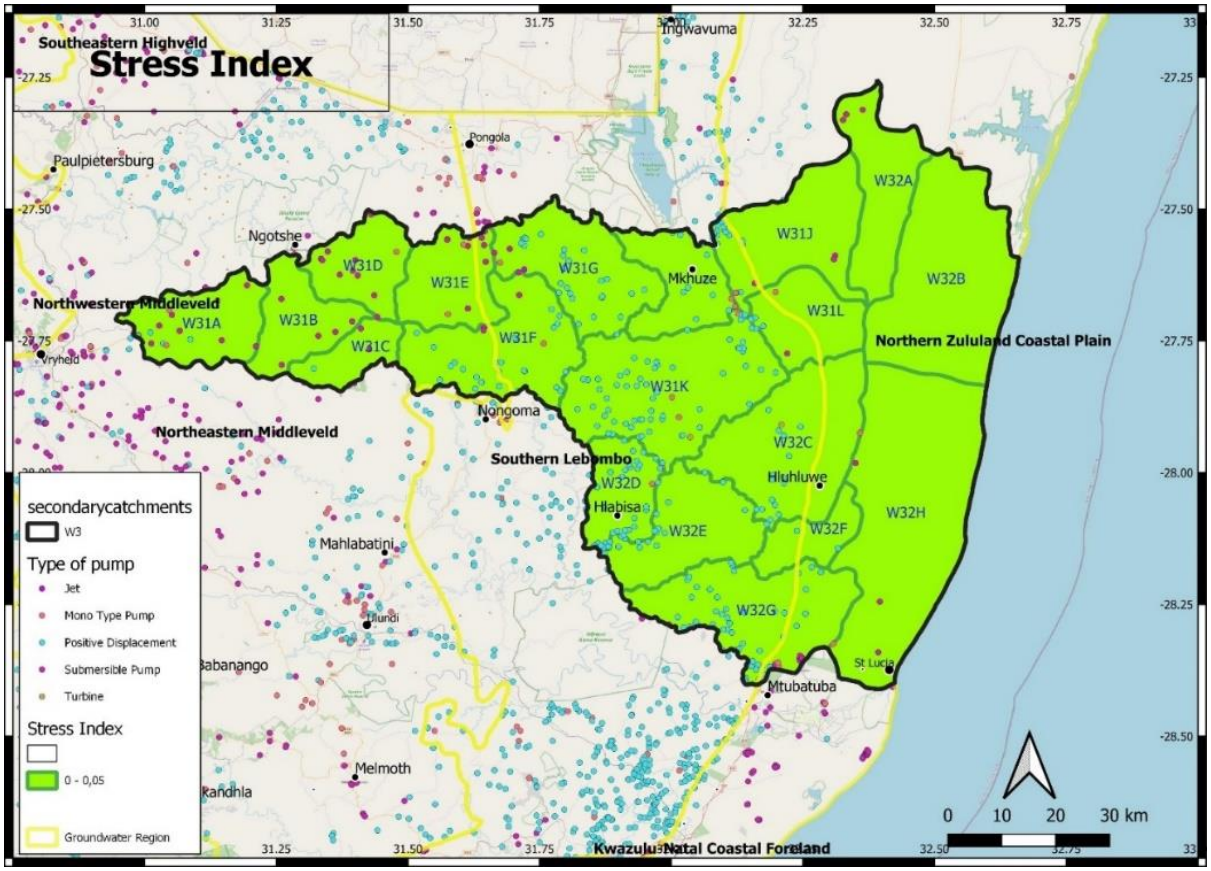


Figure 3.7 W3 Catchment: Stress Index

3.5.4 W4 Catchment (Main River: Pongola - excluding Eswatini)

Borehole Yield

Median yields are low in the western portion of the Northern Zululand Coastal Plain, where calcarenites do not exist. The Southern Lebombo has moderate yields of below 0.8 l/s. The Northeastern Middleveld region has variable yields, dependent on geology, but yields are higher towards the west. The escarpment area of the Northwestern Middleveld has yields of below 1 l/s (**Figure 3.8**). The distribution of yields by catchment is shown in **Table 3.14.**

Table 3.14 W4 Catchment: Borehole yield distribution

Quat	Average (l/s)	Median (l/s)	% > 0.5 l/s	% > 2 l/s	% > 5 l/s
W41A	0.01	0.01	0	0	0
W41B	1.78	0.71	53.7	25.2	9.6
W41C	2.01	0.70	58.7	14	5.9
W41D	1.11	0.84	62.5	18.2	0
W41E	2.50	1.51	85.5	35.1	15.9
W41F	2.11	1.46	81	26.6	10.2
W41G	3.28	3.28	95.5	70.9	21.8
W42B	3.21	0.82	75	29.2	16.7
W42C	1.98	2.16	0	69.2	0
W42D	1.97	1.30	80.5	37.5	5.3
W42E	1.66	1.33	88.7	25	2.7
W42F	1.54	1.01	78	18.7	3.3
W42G	1.60	0.43	48	14.2	6.9
W42H	1.68	1.20	73.7	33.2	0
W42J	2.35	0.44	46.6	23.8	15.9
W42K	1.14	0.79	81	11.8	0
W42L	1.38	1.01	63.7	18.2	3
W42M	0.52	0.32	36.5	0	0
W43F	1.09	0.34	36.9	20.7	0
W44A	1.30	0.60	58.2	15.9	4.1
W44B	1.36	0.72	61.2	19.6	3
W44C	9.00	9.00	0	0	0
W44D	1.50	0.84	76.5	20.4	5.9
W44E	2.41	0.78	63.3	17.7	5.4
W45A	1.10	0.55	51.7	15.1	1.9
W45B	1.11	1.11	0	0	0

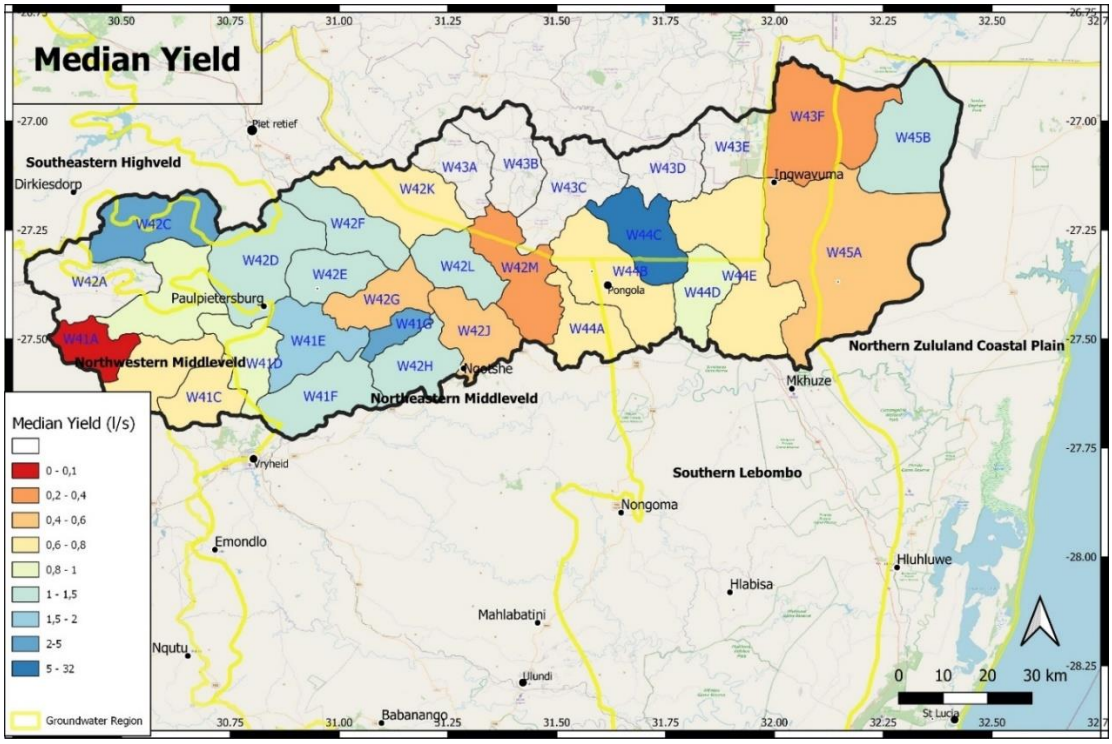


Figure 3.8 W4 Catchment: Median borehole yields

Recharge

Recharge can be considered in terms of:

- Total recharge, which drives baseflow and recharges aquifers; and
- groundwater recharge to the regional aquifers which is available to boreholes, and which excludes the recharge that generates interflow from high lying springs.

Recharge is only 10 - 20 mm/a on the drier Lowveld west of the Lebombo range. The highest recharge is on the escarpment of the Northwestern Highveld, where it reaches 100 - 150 mm/a. Aquifer recharge is over 40 mm/a on the Northern Zululand Coastal Plain, but only 10 - 15 mm/a in the Lowveld. It is 15 - 30 mm/a in the Northeastern and Northwestern Middlevelds.

Use

The groundwater recharge, exploitation potential and use for the W4 Catchment is described in **Table 3.15**.

Table 3.15 W4 Catchment: Groundwater recharge and exploitation potential

Quat	Area (km2)	Recharge (Mm^3/a)	Aquifer recharge (Mm^3/a)	Exp. Pot (Mm^3/a)	GRAII Exp. Pot. (Mm^3/a)	Harvest Pot. (Mm^3/a)
W41A	187.61	20.57	3.34	0.76	7.39	3.16
W41B	305.61	29.37	5.48	1.35	10.72	5.41
W41C	217.31	20.67	3.95	0.99	7.44	3.84
W41D	238.02	20.33	5.02	1.19	7.09	6.68
W41E	303.17	23.74	4.75	1.72	9.16	4.84
W41F	343.46	25.49	5.21	1.59	7.95	4.76
W41G	95.80	6.39	1.58	0.31	1.53	1.07
W42A	397.37	46.75	6.65	1.70	17.68	9.87
W42B	416.55	39.21	8.50	2.23	14.50	12.28
W42C	376.56	41.61	7.34	2.25	15.71	11.05
W42D	489.41	41.79	10.27	2.96	15.55	18.68
W42E	231.74	18.00	5.04	1.37	6.52	5.73

W42F	305.53	23.96	6.94	1.76	8.21	8.76
W42G	248.17	18.34	4.00	1.01	5.42	2.78
W42H	272.90	17.99	4.67	1.01	4.50	3.37
W42J	290.46	17.61	4.94	1.07	4.54	4.11
W42K	415.98	30.16	6.33	1.89	5.85	6.70
W42L	250.66	16.23	4.43	0.90	3.78	2.81
W42M	391.57	23.11	9.31	1.44	4.71	8.77
W43C	395.08	26.24	11.86	2.74	0.09	9.88
W43F	631.45	14.33	9.24	11.69	5.83	28.76
W44A	254.71	7.45	3.12	1.97	2.38	4.07
W44B	486.09	11.96	5.85	4.04	3.55	7.98
W44C	314.30	6.29	3.78	2.95	0.70	5.16
W44D	236.43	4.38	2.64	2.07	2.08	2.73
W44E	711.45	13.68	8.05	6.51	3.52	10.52
W45A	1289.09	23.41	69.60	34.80	7.84	84.62
W45B	508.13	13.09	31.43	21.09	6.77	74.18

Groundwater use per sector is listed in **Table 3.16**. The stress index calculated from the total present use and aquifer recharge is shown in **Figure 3.9**, together with location of known motorised pump systems. Groundwater is minimally used and the stress index is below 0.05.

Table 3.16 W4 Catchment: Groundwater use per sector

W4	m^3/a	%
Industry(non-urban)	1000	0.10
Industry(urban)	72000	7.34
Agriculture: irrigation	655950	66.83
Agriculture: wat. Livestock	196017	19.97
Mining	13700	1.40
Schedule 1	1500	0.15
Water supply service	41310	4.21
Total	**981477**	**100.00**

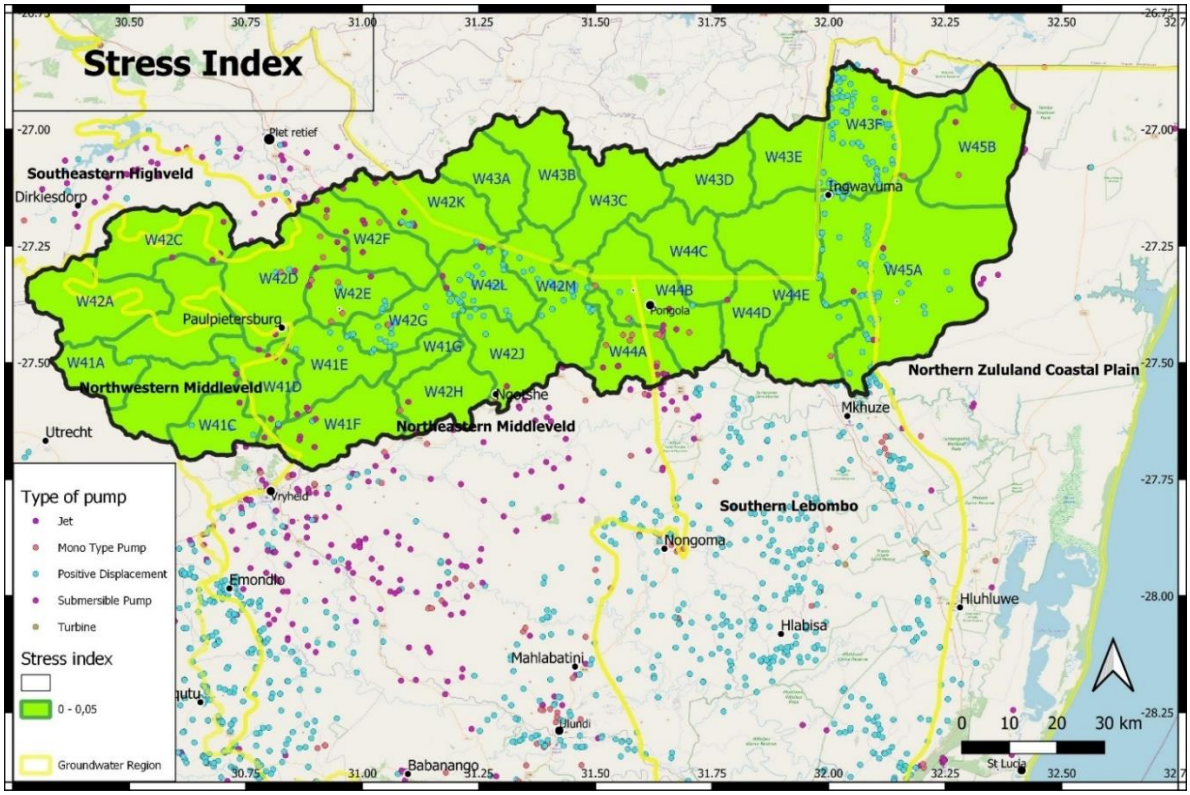


Figure 3.9 W4 Catchment: Stress Index

3.5.5 W5 Catchment (Main River: Usutu - excluding Eswatini)

Borehole Yield

The Northeastern Middleveld and Southeastern Highveld Regions have variable yields, dependent on geology (**Figure 3.10**). The distribution of yields by catchment is shown in **Table 3.17**.

Table 3.17 W5 Catchment: Distribution of borehole yields

Quat	Average (l/s)	Median (l/s)	% > 0.5 l/s	% > 2 l/s	% > 5 l/s
W51A	1.45	0.57	64.6	21.8	0
W51B	0.62	0.48	47	0	0
W51C	1.27	0.75	62.3	13.8	3.3
W51D	1.40	0.96	77.4	15.4	3.8
W51E	0.40	0.40	0	0	0
W51F	1.45	0.72	62.9	21.8	4.7
W52A	1.67	1.67	0	0	0
W52B	0.77	0.84	61.2	0	0
W52C	1.39	1.20	77.2	34.8	0
W53A	1.43	1.00	76.1	19.9	1.6
W53B	1.11	0.62	76.5	15	0
W53C	1.64	0.95	77.3	25.4	4.1
W53D	1.54	1.16	93	29.7	0
W53E	1.01	1.10	79.9	0	0
W54A	1.10	0.79	62.3	9	0
W54B	1.15	0.58	57.2	9.3	4.9
W54C	0.92	0.98	71.9	0	0
W54D	1.22	0.56	57.7	15.7	0
W54E	0.14	0.14	0	0	0
W55A	1.28	0.67	61.5	15.7	1.2
W55C	5.08	5.10	65.7	60.6	50.4
W55D	0.49	0.30	36.5	0	0
W56A	3.10	0.58	56.9	36.3	10.5
W56B	0.84	0.70	65.3	11.2	0

Quat	Average (l/s)	Median (l/s)	% > 0.5 l/s	% > 2 l/s	% > 5 l/s
W57J	1.70	1.26	0	26.6	0

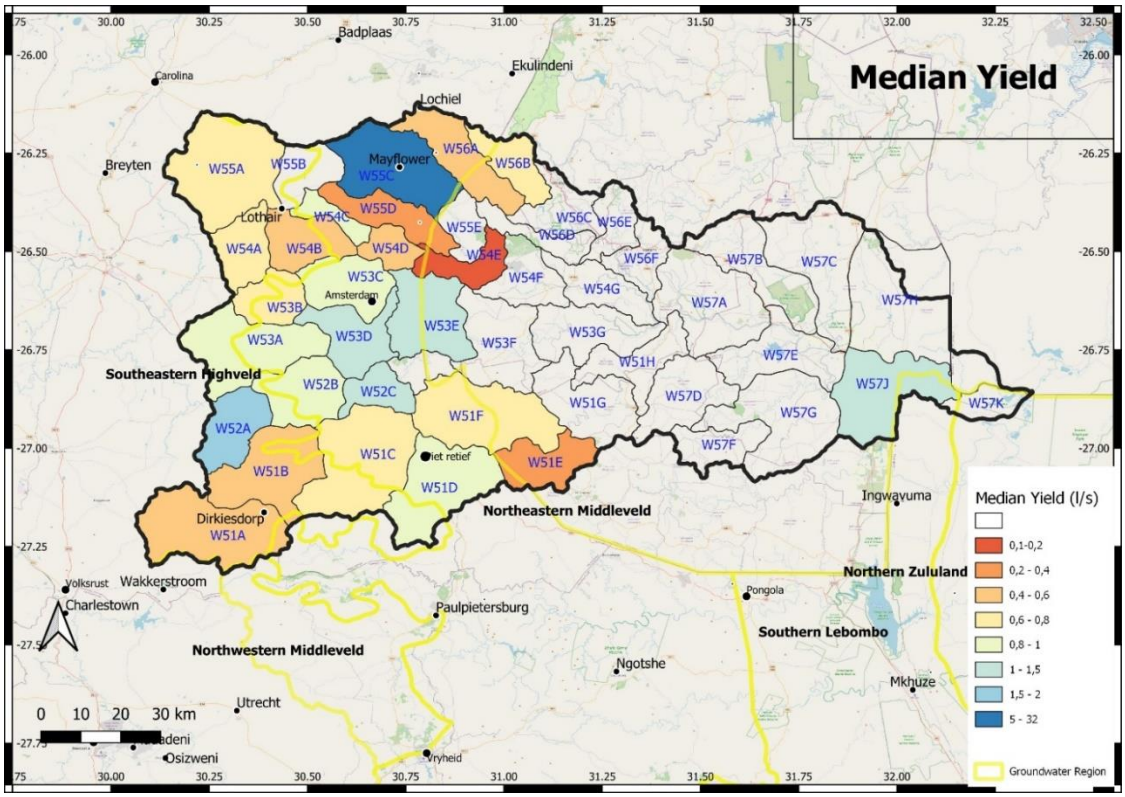


Figure 3.10 W5 Catchment: Median borehole yields

Recharge

Recharge can be considered in terms of:

- Total recharge, which drives baseflow and recharges aquifers; and
- groundwater recharge to the regional aquifers which is available to boreholes, and which excludes the recharge that generates interflow from high lying springs.

Recharge in the South African portion of the catchment ranges from 50 - 100 mm/a increasing eastward. Aquifer recharge is only 15 - 30 mm/a. Due to hilly nature of the catchment, much of the recharge is lost as interflow.

Use

The groundwater recharge, exploitation potential and use for the W5 Catchment is described in **Table 3.18**.

Table 3.18 W5 Catchment: Groundwater recharge and exploitation potential

Quat	Area (km^2)	Recharge (Mm^3/a)	Aquifer recharge (Mm^3/a)	Exp. Pot (Mm^3/a)	GRAII Exp. Pot. (Mm^3/a)	Harvest Pot. (Mm^3/a)	Use (Mm^3/a)
W51A	624.64	41.11	10.39	6.81	15.25	13.53	0.22
W51B	496.45	31.29	8.50	6.91	12.11	10.63	1.11
W51C	677.71	47.70	12.53	9.38	18.11	22.89	0.47
W51D	527.43	36.12	8.89	6.67	13.86	8.31	0.16
W51E	274.28	21.47	6.11	1.66	0.67	3.07	0.08
W51F	589.36	49.10	12.65	2.64	9.59	18.23	0.17
W52A	289.44	17.79	5.03	3.80	5.81	6.03	0.12
W52B	336.19	20.60	6.27	4.16	7.20	12.53	0.21

Quat	Area (km^2)	Recharge (Mm^3/a)	Aquifer recharge (Mm^3/a)	Exp. Pot (Mm^3/a)	GRAII Exp. Pot. (Mm^3/a)	Harvest Pot. (Mm^3/a)	Use (Mm^3/a)
W52C	177.84	10.71	3.35	2.33	3.86	6.71	0.07
W52D	119.29	9.37	2.38	0.59	2.32	1.34	0.01
W53A	547.48	34.42	10.25	7.87	11.47	17.25	0.48
W53B	218.54	15.48	4.09	3.51	5.26	5.67	0.02
W53C	315.62	24.97	5.82	5.09	8.91	7.55	0.09
W53D	314.71	21.45	5.86	4.54	7.83	6.38	0.06
W53E	421.87	36.96	8.96	2.39	5.53	9.29	0.06
W53F	447.34	39.19	10.48	2.76	0.03	11.18	0.00
W54A	251.08	15.73	3.99	4.01	5.26	5.47	0.06
W54B	281.94	19.73	4.38	4.53	6.78	4.70	0.03
W54C	107.45	7.72	1.85	1.58	2.53	4.55	0.01
W54D	138.75	12.20	2.71	0.69	4.01	5.63	0.05
W54E	194.12	19.62	3.68	1.39	0.72	8.54	0.00
W55A	688.70	39.75	11.10	12.04	15.62	15.16	0.15
W55B	217.83	14.66	3.44	3.10	4.87	7.21	0.03
W55C	532.20	48.66	15.02	2.51	14.29	21.41	0.14
W55D	270.86	24.39	7.70	1.38	6.04	11.92	0.02
W55E	161.23	15.43	4.50	1.19	0.11	7.09	0.00
W56A	359.72	65.68	13.91	2.08	13.33	15.83	0.01
W56B	224.66	45.02	10.55	1.80	2.62	9.89	0.00
W57J	519.42	12.87	6.29	6.01	0.91	18.46	0.01
W57K	137.42	2.42	1.71	4.24	0.92	10.64	0.02

Groundwater use per sector is listed in **Table 3.19**. The stress index calculated from the total present use and aquifer recharge is shown in **Figure 3.11**, together with the location of known motorised pump systems. Groundwater is minimally used and the stress index is below 0.2 (**Figure 3.11**).

Table 3.19 W5 Catchment: Groundwater use per sector

W5	m^3/a	%
Industry rural	139072	21.73
Industry urban	19240	3.01
Irrigation	216843	33.89
Livestock	97623	15.26
Power Generation	37230	5.82
Schedule 1	15725	2.46
Water supply service	114176	17.84
Total	**639909**	**100.00**

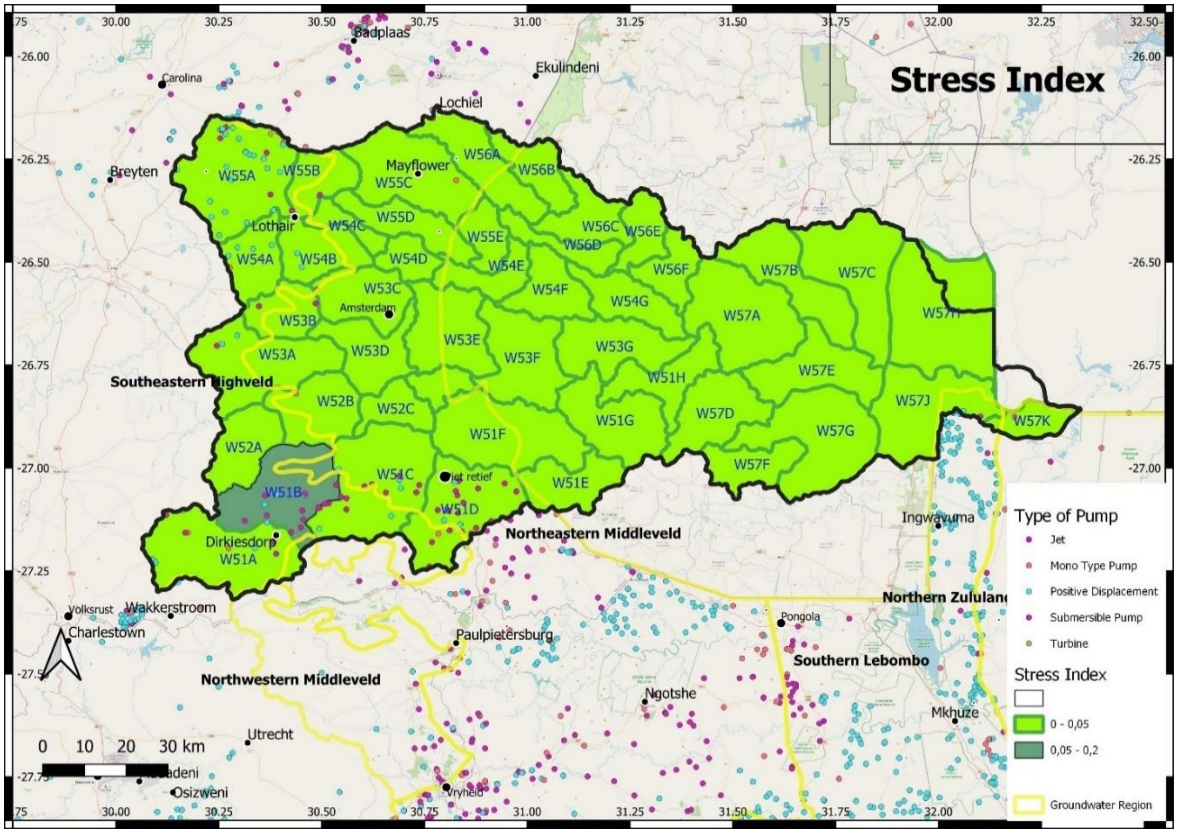


Figure 3.11 W5 Catchment: Stress Index

3.5.6 W7 Catchment (Kosi Estuary and Sibaya Lake)

Borehole Yield

The overlying Port Durnford and unconsolidated sands of the Kosi Bay, Kwabonambi and Sibayi Formations are fine grained with some coarser layers, and are generally low yielding but serve as storage and function as a leaky aquifer layer. The highest yielding aquifer is the basal Uloa calcarenite which can yield up to 15 l/s. However, it is intermittent which does not allow extensive development. The median yield is 1.5 – 2 l/s.

Recharge

Recharge to Q70A is 133 mm/a. Aquifer recharge is 132 mm/a. Due to the flat sandy nature of the catchment, interflow does not occur and all recharge percolates to the regional aquifer as aquifer recharge.

Use

The groundwater recharge, exploitation potential and use for the W7 Catchment is described in **Table 3.20**.

Table 3.20 W7 Catchment: Groundwater recharge and exploitation potential

Quat	Area (km^2)	Recharge (Mm^3/a)	Aquifer recharge (Mm^3/a)	Exp. Pot (Mm^3/a)	GRAII Exp. Pot. (Mm^3/a)	Harvest Pot. (Mm^3/a)	Use (Mm^3/a)
W70A	2577.95	205.55	340.15	216.18	97.08	649.41	2.34

Groundwater use per sector is listed in **Table 3.21**. The stress index calculated from the total present use and aquifer recharge is shown in **Figure 3.12**, together with location of known motorised pump systems. Groundwater is minimally used and the stress index is below 0.05.

Table 3.21 W7 Catchment: Groundwater use per sector

W7	m^3/a	%
Industry(non-urban)	10899	0.24
Agriculture: Irrigation	110650	2.46
Water supply service	4368572	97.29
Total	**4490121**	**100.00**

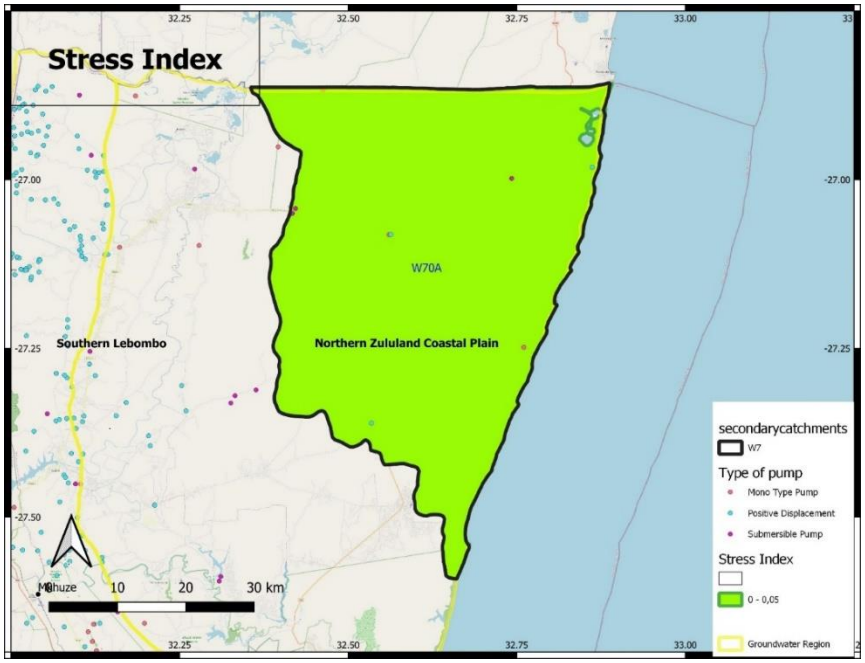


Figure 3.12 W7 Catchment: Stress index

3.6 DELINEATION APPROACH

3.6.1 Delineation of Groundwater Resource Units

The first step in the delineation process was to divide the study area into secondary catchments W1 - W7. Each tertiary catchment was then divided into smaller units based on quaternary catchments. Aspects taken into consideration were:

- Geology.
- Climate.
- Topography and geomorphology.
- Borehole yield.
- Recharge.
- Groundwater quality.
- Groundwater use (and stress).
- Groundwater-surface water interactions.

3.6.2 Groundwater Resource Units

In total, 49 groundwater resource units (GRUs) were delineated from 139 quaternary catchments, numbered according to their tertiary catchment (**Figure 3.13**). In order to maintain maximum compatibility with surface IUAs, the GRUs were delineated using a high-level approach, to fit with quaternary catchment boundaries.

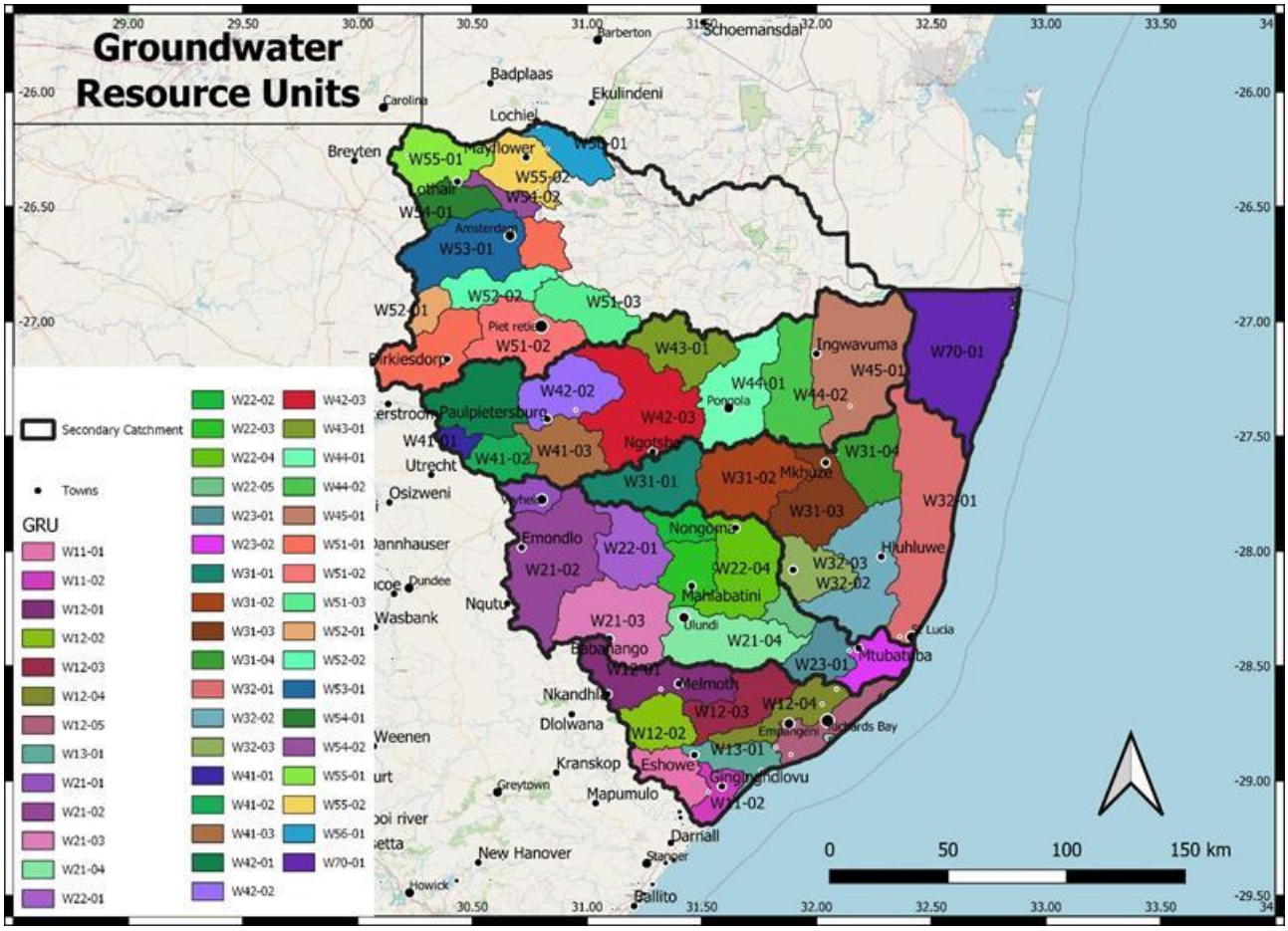


Figure 3.13 Groundwater Resource Units of the Usutu to Mhlathuze Catchment

4 STATUS QUO ASSESSMENT: ECONOMICS

4.1 INTRODUCTION

The economic status quo assessment will consist of; what the effect of the water resource has on the water users and the regional economy. The main water users are those who are directly dependent on the water resource and include agricultural irrigation schemes as well as commercial forestry activities. These components are divided into economically viable crops and various tree species plantations important to the trade industry.

The Usutu catchments are of importance for the economic wellbeing of the area in question. The agricultural produce and forestry products/yield from the primary sectors in the agricultural/forestry economy will either be transported directly to domestic markets or it will be exported to other regions or internationally. Irrigated sugar cane, for instance, will be harvested and transported to applicable sugar mills, and then it will be converted into various products to be sold to different markets. The same is applicable for the commercial forestry industry, where harvested trees are cut into sawlogs, which will be transported to sawmills, where it will be processed into different wood commodities to be sold. Paper mills, for instance, are also heavily dependent on commercial forestry in order to produce a variety of paper based products.

Economically the Usutu catchments are also of significance as desirable ecotourism attraction venues. The wellbeing of these catchments is dependent on the preservation of the nature reserves, dams, and lakes in the area to attract tourists.

4.2 APPROACH

The above-mentioned examples (4.1 Introduction) of viable agricultural and forestry ventures for sustainable economic gain, through a sustained water resource, are of relevance in this section for a variety of reasons. It highlights the economic importance of vegetable and fruit farming, and other agricultural and forestry products reliant on the water resource.

To establish the economic status quo of the catchments a detailed assessment of selected irrigated agricultural produce (i.e. fruit. and vegetables), and the commercial forestry and farming industry was conducted.

The following agricultural irrigation products were selected and their production assessed to determine the economic status quo of the area:

- Maize.
- Pineapples.
- Summer vegetables.
- Winter vegetables
- Bananas.
- Citrus (with the focus on Grapefruit).
- Irrigated Sugar Cane.
- Cotton.
- Forestry (the commercial forestry consists mainly of gum, pine and wattle trees).

The dominant water user indicators were noted following the parameters below, in order to assess the production statistics in terms of generated produce volume:

- Number of hectares.
- Ton per hectare.
- Total Tons produced.

4.3 DESCRIPTION AND STATUS QUO PER SECONDARY CATCHMENT

The main water users that drive the economy in the Usutu to Mhlathuze Catchment areas are shown in **Table 4.1** below.

Table 4.1 Usutu Catchment: Main water users, land use, and production in the catchment areas

Irrigation Agriculture	Maize	Pineapples	Summer Vegetables	Winter Vegetables	Bananas	Citrus (Grapefruit)	Irrigation Sugar Cane	Cotton	Total
Hectares	10 967	44	2 039	5 691	326	3 262	55 852	202	**78 381**
Tons	131 601	1 732	44 849	455 287	11 402	132 317	4 462 414	625	**5 240 227**
Commercial Forestry	**Gum**	**Pine**	**Wattle**						
Hectares	319 194	138 595	28 883						**486 671**
Tons	4 837 667	2 011 006	284 093						**7 132 766**

In the irrigation agriculture farming sector, sugar cane production consists of 71% (55 852 ha / 78 381 ha) of the land use, followed by maize with 14% and winter vegetables with a land use of 7%.

The output of the land use is expressed in tons, irrigated sugar cane production represents 85.2% (4 462 414t of 5 240 227 t) of the total production, followed by the winter vegetables (8.7%) and then the maize farmers with a 3% share of production. As the yield (ton/ha) of maize is much lower than the other crops, it resulted in the change of places between hectares proportions and tons.

Gum tree production comprises the largest component of land use of the commercial forestry in the catchment areas. The land use ratio of gum trees is 65% (319 194ha of 486 671ha) and its output is 80% (4 837 667 tons of 7 132 766 tons) compared to pine with 29% of hectares with 18% of tons output.

The production of sugar cane and forestry produce make the largest contribution in terms of value to the chain of irrigated economic activities in the catchment areas, with sugar, saw and paper mill activities. These sectors provide income for the households in the urban and rural households in the area. The local community is also dependent on the water resources for daily use and recreational activities. In this catchment no considerable mining activities occur (also a primary sector); however, it is also dependent on the water resource for the extraction and processing of coal and other minerals.

In terms of ecotourism the local nature reserves are reliant on the water resource for the tourist industry. Ecotourism stimulates economic growth.

Subsistence agriculture is directly dependent on the water resources.

4.3.1 W1 Catchment (Main River: Mhlathuze)

The primary water users, land use, and production in tons in Catchment W1 are shown in **Table 4.2**.

Table 4.2 W1 Catchment: Main water users of land and production

Irrigation Agriculture	Maize	Pineapples	Summer Vegetables	Winter Vegetables	Bananas	Citrus (Grapefruit)	Irrigation Sugar Cane	Cotton	Total
Hectares	-	-	158	294	326	3 040	14 343	-	**18 160**
Ton/ha	-	-	22	80	35	41	83	-	
Tons	-	-	3 482	23 513	11 402	123 313	1 195 213	-	**1 356 923**
Commercial Forestry	**Gum**	**Pine**	**Wattle**						
Hectares	38 403	22 844	2 825						**64 072**
Ton/ha	21	15	10						
Tons	787 635	331 465	27 791						**1 146 891**

From the table above, the largest irrigated agricultural crop production is sugar cane (in tons), which totals 88%, followed by citrus with 9%.

Gum tree production comprises the largest part of the land use area with almost 60%, contributing 69% tons of produce to the total commercial forestry production.

Ecotourism activities in the Nhlabane and Msingazi river areas are also of importance.

A major production area occurs in the Lower Mhlathuze area, which include the towns of Empangeni and Richards Bay. Manufacturing activities include a paper and sugar mill that contributes 46% to the economics in the area.

Dune mining activities, trade, private and public services are also dependent on the water resource. Shipping and port activities are also dependent on the produce supply from the primary and secondary sectors for export to specific markets.

4.3.2 W2 catchment (Main River: Umfolozi)

The primary water and land user stats and the production in tons of produce in Catchment W2 are shown in **Table 4.3**.

Table 4.3 W2 Catchment: Main water and land users, and their production

Irrigation Agriculture	Maize	Pineapples	Summer Vegetables	Winter Vegetables	Bananas	Citrus (Grapefruit)	Irrigation Sugar Cane	Cotton	Total
Hectares	2 196	-	1 088	1 049	-	-	10 712	-	**15 045**
Ton/ha	12	-	22	80	-	-	75	-	
Tons	26 358	-	23 925	83 894	-	-	803 400	-	**937 577**
Commercial Forestry	**Gum**	**Pine**	**Wattle**						
Hectares	35 403	19 694	2 749						**57 846**
Ton/ha	48	15	10						
Tons	1 699 347	285 765	27 034						**2 012 146**

Table 4.3 indicates the importance of the W2 catchment, in terms of the primary sectors, which make use of the Umfolozi River and its tributaries, in order to serve the irrigation schemes for crops, as well as forestry.

Irrigated sugar cane is the most prominent irrigated crop with a land use of 71%, and with a production rate that contributes 85% to the total tonnage of irrigated produce. Although maize crops occupy the second highest area with 15%, its output in tons is 2.8% of the total volume. The Winter Vegetable production contributes 9% to the total tonnage of the irrigated crop produce.

The dominant forestry tree species in the catchment is gum tree, occupying 64% of the land use, followed by pine trees (33%), and then wattle.

There are also coal mining activities in the Lower, White, and Black Umfolozi Rivers, and a sugar cane mill is also situated at Mtubatuba.

Ecotourism activities in the area are also dependent on the rivers, specifically in the St Lucia Lake area and the Umfolozi/Hluhluwe game reserve.

4.3.3 W3 Catchment (Main River: Mkuze)

The primary water and land user stats and the production in tons of produce in Catchment W3 are shown in **Table 4.4**.

Table 4.4 W3 Catchment: Main water and land users, and their production

Irrigation Agriculture	Maize	Pineapples	Summer Vegetables	Winter Vegetables	Bananas	Citrus (Grapefruit)	Irrigation Sugar Cane	Cotton	Total
Hectares	222	44	-	941	-	222	7 016	202	**8 645**
Ton/ha	12	40	-	80	-	41	80	3	
Tons	2 663	1 732	-	75 254	-	9 004	561 254	625	**650 532**
Commercial Forestry	**Gum**	**Pine**	**Wattle**						
Hectares	24 000	12 041	2 001						**38 042**
Ton/ha	18	15	10						
Tons	438 122	174 709	19 684						**632 515**

In Catchment W3 the main rivers are the Mkuze and Hluhluwe Rivers. A wide range of crops are directly dependent of the water resources. The irrigated production area is reliant on two water resource areas. The first area is the Hluhluwe River catchment area, where the production of Queen Pineapples and other agricultural crops are cultivated. The second area is the irrigated sugar cane production area in the Pongolo catchment using water transferred from the Pongola Dam into the Mkuze catchment. The Mkuze River is one of the main rivers that feed the St Lucia system.

The sugar cane produce is the largest contributor to the total production of crops in the area, with an estimated yield of 560 000 tons, contributing 86% to the total crop production numbers. Winter Vegetable production represents 75 000 tons with a contribution of 12% to the total crop production in the catchment area.

Gum tree plantations occupy the largest land use area in the catchment, with the highest yield - tonnes per hectare (24 000 ha x 18 ton/ha = 438 122 tons), compared to the other forestry/plantation species in the area.

This catchment is also economically important in terms of ecotourism.

4.3.4 W4 Catchment (Main River: Pongola - excluding Eswatini)

The primary water and land user stats and the production in tons of produce in Catchment W4 are shown in **Table 4.5**.

Table 4.5 W4 Catchment: Main water and land users, and their production

Irrigation Agriculture	Maize	Pineapples	Summer Vegetables	Winter Vegetables	Bananas	Citrus (Grapefruit)	Irrigation Sugar Cane	Cotton	Total
Hectares	5 522	-	793	2 939	-	-	23 782	-	**33 036**
Ton/ha	12	-	22	80	-	-	80	-	
Tons	66 265	-	17 442	235 118	-	-	1 902 546	-	**2 221 371**
Commercial Forestry	**Gum**	**Pine**	**Wattle**						
Hectares	52 722	17 555	5 333						**75 610**
Ton/ha	18	15	10						
Tons	962 444	254 723	52 451						**1 269 619**

The Pongola River is the main irrigation water resource driver for sugar cane, vegetable and maize crop production in Catchment W4. The total yield of the irrigated crop tonnage produced in the area comprises mostly of sugar cane (86% of the yield), followed by a contribution of 11% to the yield from the winter vegetable produce, and the rest of the yield comprises the balance of the total production numbers.

The commercial forestry land use comprises mostly gum trees, with 70% of hectares occupied in the area, with a tonnage output encompassing 76% of the total tons of forestry products produced, followed by pine and wattle.

The sugar cane produce grown in the area is transported to the sugar mill in the town of Pongola.

Subsistence agriculture in the area also benefits from the water resources in the catchment.

4.3.5 W5 Catchment (Main River: Usutu - excluding Eswatini)

The primary water and land user stats and the production in tons of produce in Catchment W5 are shown in **Table 4.6**.

Table 4.6 W5 Catchment: Main water and land users, and their production

Irrigation Agriculture	Maize	Pineapples	Summer Vegetables	Winter Vegetables	Bananas	Citrus (Grapefruit)	Irrigation Sugar Cane	Cotton	Total
Hectares	3 026	-	-	469	-	-	-	-	**3 495**
Ton/ha	12	-	-	80	-	-	-	-	
Tons	36 316	-	-	37 507	-	-	-	-	**73 822**
Commercial Forestry	**Gum**	**Pine**	**Wattle**						
Hectares	157 944	52 591	15 975						**226 510**
Ton/ha	11	15	10						
Tons	1 814 778	763 091	157 132						**2 735 001**

Catchment W5, with the Usutu River as main water resource, provides water in the area for the cultivation of mainly maize (87% of ha's), and winter vegetables (13% of ha's).

With a production of 12 tons per hectare an estimated 36 000 tons of maize are produced annually. Winter vegetables, however, have a much higher contribution to the yield as the winter vegetable crops produce 51% of the total tons produced, compared to the 49% contribution from maize.

Forestry land use statistics:

- Gum trees occupy 70% of forestry land.
- Pine trees occupy 23% of forestry land.
- Wattle trees occupy rest of 7% of forestry land.

Despite a lower yield (ton/ha) of 11 tons per hectare for gum trees, in contrast with the pine tree yield of 15 ton/ha, the most tons of forestry products produced are, however, from gum trees due to a larger land area utilised.

A paper mill at Piet Retief in the secondary sector in this secondary catchment is dependent on forestry production. The activities from agriculture, forestry and the paper mill stimulate trading and other economic services in the catchment.

4.3.6 W7 Catchment (Kosi Estuary and Sibaya Lake)

The primary water and land user stats and the production in tons of produce in Catchment W7 are shown in **Table 4.7**.

Table 4.7 W7 Catchment: Main water and land users, and their production

Irrigation Agriculture	Maize	Pineapples	Summer Vegetables	Winter Vegetables	Bananas	Citrus (Grapefruit)	Irrigation Sugar Cane	Cotton	Total
Hectares	2 196	-	1 088	1 049	-	-	10 712	-	**15 045**
Ton/ha	12	-	22	80	-	-	75	-	
Tons	26 358	-	23 925	83 894	-	-	803 400	-	**937 577**
Commercial Forestry	**Gum**	**Pine**	**Wattle**						**Total**
Hectares	35 403	19 694	2 749						**57 864**
Ton/ha	16	15	10						
Tons	566 449	285 765	27 034						**879 248**

In Catchment W7, no agricultural irrigation is taking place. Gum and pine trees occupy the land in the catchment with 44% and 56% p/ha respectively. Gum tree production, however, shows a higher yield in the area (57% production), compared to a lower yield of Pine trees. Ecotourism contributes to the economic activities in the area, which are dependent on the two water resources in the area namely; the Kosi Estuary and Lake Sibaya.

5 STATUS QUO ASSESSMENT: SURFACE WATER QUALITY

5.1 INTRODUCTION

The Status Quo assessment for water quality of **river systems** provides an overview of water quality across the study area based on a desktop assessment of available information. A similar process is followed for **estuaries**, with the focus being on identifying pollution pressure. Pollution, specifically nutrient enrichment, results in excessive primary production and secondary impacts such as hypoxia and loss of ecosystem services (Adams *et al*., 2020). Eutrophication results in the loss of submerged aquatic vegetation, oxygen depletion, harmful algal blooms, imbalanced food webs, lower biodiversity, altered biogeochemical cycling, and fish kills. Enrichment can change an estuary from a macrophyte-dominated to a phytoplankton- or macroalgae-dominated system. Toxic substances, such as trace metals and Persistent Organic Pollutants (POPs, e.g. herbicides and pesticides) also pose significant ecological and human health risks (Barletta *et al*., 2019), whether they are consistently delivered at low doses or as larger spill events resulting in acute environmental responses.

Note that this step also forms the first data-gathering step which will culminate in the identification of driving water quality issues and physico-chemical variables, for which RQOs will be set. At each step of the process stakeholder input and comment, particularly that of DWS staff operating in the water quality field and other key stakeholders identified during the stakeholder engagement component of the study, will be incorporated.

5.2 APPROACH

5.2.1 Rivers

The approach to the river water quality task is to gather information from a wide range of sources, with the final aim being the identification of water quality priority areas which would feed into the Resource Unit Prioritization Report. These priority areas can be water quality problem areas, or areas requiring protection from a water quality perspective, e.g. resources used as drinking water sources.

The identification of water quality priority areas (shown as tables per secondary catchment; **Section 5.4**) are based on a water quality impact rating (0 - 5) assigned to priority areas, i.e. from 3 (Large) to Critical (5).

Information was gathered from the sources shown below:

- Literature - documents and reports related to water quality across the study area. Specific reference is made to the following sources:
  - The Internal Strategic Perspective (ISP) for the Usutu to Mhlatuze WMA (DWAF, 2004).
  - PES/EIS review of January 2022. The PES/EIS data (DWS, 2014a) were reviewed and updated as required. Water quality priority areas, based on desktop information available at the time, were identified.
  - The Water Quality Specialist Report for the Preliminary Reserve study of 2014 (DWS, 2014b).
  - The 2020 DWS report on the planning level review of water quality in the Pongola to Mtamvuna WMA (WMA 4), prepared by Grobler, Viljoen and Mosoa (DWS, 2020).

Note that this document sets RQOs and Resource Water Quality Objectives (RWQOs) / Water Quality Planning Limits (WQPLs) for each significant resource to describe its quality at the desired level of protection. It will therefore serve as a guiding document throughout the Classification and RQO study.

- DWS's Integrated Regulatory Information System (IRIS), which plots effluent, discharges from Waste Water Treatment Works (WWTW) and Sewage Treatment Works (STW) into South African river systems. Information is provided as at April 2022.
- The water quality chapter of the Usuthu-Lusutfu Ecostatus report (IUCMA, 2020).

- Green Drop Reports for 2021, released 1 April 2022 (Green Drop 2022a, b). The main outputs from the Green Droop 2021 audit cycle relevant to this assessment, are as follows:
  - A Green Drop audit score for each WWTW assessed, which is aggregated into an organisational (overall) score, expressed as a percentage. This score is based on five Key Performance Areas. This score serves as a Performance Indicator of the capacity, compliance and good practice that is attained against the Green Drop Standards. A system that achieves ≥90% Green Drop score is regarded as Excellent; one achieving <31% is considered dysfunctional.
  - A Cumulative Risk Rating (CRR) for each WWTW, expressed as a percentage. This assessment is based on four risk parameters. The CRR% deviation indicates the variance between the baseline CRR and the Maximum CRR value that could be reached if all four risk indicators were in a critical state, e.g. a 95% CRR% deviation means the plant only has 5% remaining before all four risk indicators reach a critical state.
  - Green Drop Certified and Green Drop Contenders. A WWTW that achieves an overall ≥90% Green Drop score and ≥90% for microbiological and chemical effluent qualities, is Green Drop Certified. If the Green Drop Score is met but not the final effluent quality standards, a Green Drop Contender and the Green Drop score is adjusted to 89%.
  - Data is uploaded from the water resource institution to IRIS, for use during Green Drop evaluation.

- Liaison with DWS and the Inkomati-Usuthu Catchment Management Agency (IUCMA) water quality managers working across the study area. Managers were asked to identify any critical water quality issues they may be aware of in their area of operation. The following managers have provided input, which is incorporated in **Section 5.3**.
  - Ms Renelle Pillay, Water Quality Planning, Directorate: Institutional Management, DWS KZN.
  - Ms Halala Mdletshe, Ms Krishnee Naidoo, Ms Lwandle Sibango and Ms Ziyanda Malibiji, DWS, covering the following areas of the KZN Region – refer to map of local and district municipalities in KwaZulu-Natal (KZN) - **Figure 5.1**:
    - City of uMhlathuze Municipality.
    - King Cetshwayo District Municipality.
    - Umkhanyakude District Municipality.
    - A portion of Zululand District Municipality (which covers Nongoma and Ulundi).
  - Ms Caroline Tlowana, Resource Quality Management, IUCMA: Usutu system.

Figure 5.1 District and local municipalities of KZN

5.2.2 Estuaries

To estimate the degree of pressure associated with flow modification, land-use and development, inlet manipulation and pollution, ratings of related indicators in South Africa's Estuarine Health Index (EHI) were applied (Turpie *et al*., 2012, applied in Van Nierkerk *et al*. (2019)). Estuarine health is rated as percentage similarity to natural (rated as 100) with integrated pressure ratings corresponding to: Low ≥75% similar to natural (Categories A - B), Medium = 75 - 60% (Category C), High = 60 – 40% (Category D) and Very High ≤ 40% (Categories E - F). For pollution, a sub-indicator of water quality (scoring similarity in dissolved oxygen, turbidity, nutrients and toxic substances) was applied. Salinity distribution along the length of the estuary is treated separately from the other water quality parameters, as it also informs water exchange patterns.

Estuaries with a High or Very High Pollution Pressure status have been included in water quality priority tables.

5.3 GENERAL STATUS

The study catchments are still largely rural, with the impacts of coal mining (present and past) and mine decant still present in certain areas. Water quality issues appear to be localised due to problems such as non-compliant WWTW and STWs, or industrial complexes, although non-point sources of pollution such as increasing salinity levels are widespread and difficult to manage. The

DWS report of 2020 serves to move the management of water quality from a reactive to proactive state, and identified the steps required for effective water quality management and monitoring. The setting of appropriate water quality objectives for point and diffuse source polluters is stressed in the document. Water quality management strategies were developed for the following catchments in the ISP (DWS, 2004; cited in DWS, 2020):

- W11 and W13: Matikulu and Mtunzini catchments
- Umfolozi catchment
- Mkuze catchment
- Pongola catchment

DWS (2020) provides a set of Management Actions need per catchment, including setting up detailed water quality management strategies.

The drivers of water quality state in aquatic systems in the study area are largely the following:

- Coal mining operations and associated consequences, particularly in the northern and north-western region and particularly where the mines have been closed (DWS, 2020). The Richards Bay Coal Terminal is the centre of operations for SA's aluminium industry, making SA the second-largest exporter of steam coal in the world (source: https://municipalities.co.za/provinces/view/4/kwazulu-natal).
- The growth of the Richards Bay urban/industrial complex; both in terms of water demand and waste discharge (DWS, 2020).
- Irrigation return-flows and rising salinity levels. The sugar cane plantations along the coastal belt are critical to the Gross Domestic Product (GDP) of the area, together with the sub-tropical fruit grown in the area. Farmers inland concentrate on vegetable, dairy and stock farming (source: https://municipalities.co.za/provinces/view/4/kwazulu-natal).
- Areas of poor land management have resulted in high sedimentation levels in river systems.
- Extensive forestry in the areas around Vryheid, Eshowe, Richmond, Harding and Ngome (source: https://municipalities.co.za/provinces/view/4/kwazulu-natal).
- Cholera and other diseases have been reported in some rural areas due to poor sanitation and using run-of-river for domestic use (DWS, 2020).
- Most of the municipal WWTW are only partially functional and therefore contribute to some form of pollution within the river catchments. Some of the challenges observed include, but are not limited to, the following (K Naidoo, DWS KZN, *pers. comm*.):
    - Burst pipes/manhole overflows.
    - Pumpstation failure.
    - Non-functional components of the works.
    - Inadequate disinfection leading to discharge of poor-quality effluent.
    - Nutrient enrichment downstream of WWTW discharge and irrigation schemes. Toxic algal blooms and game fatalities have been reported in the upper reaches of Pongolapoort Dam. Filamentous algal growth has been seen in the Assegaai River downstream of Piet Retief, and algal blooms in the Klipfontein Dam near Vryheid on the upper Umfolozi River (DWS, 2020).

Green Drop (2022a) reports the following for KwaZulu-Natal:

- 14 Water Services Authorities and 147 systems audited.
- 68.7% Technical Site Assessment score.
- 60.3% CRR – medium risk.
- 3 Green Drop certifications.

- 20 Critical State systems – 14 of these fall within the study area, with Zululand District Municipality showing the lowest Green Drop score of 14%.

5.4 DESCRIPTION AND STATUS QUO PER SECONDARY CATCHMENT

5.4.1 W1 Catchment (Main River: Mhlathuze)

Background

A significant activity in the W1 secondary catchment is the Richards Bay Empangeni Industrial hub, including the Richards Bay Minerals (RBM) mining operation. Effluent (industrial and municipal) originating from Richards Bay is discharged to the sea through a marine outfall pipeline.

Amatikulu Sugar Mill is found on the Matigulu River, with impacts in the lower end of the reach (W11A-03612). Extensive agriculture can be seen in the Matigulu Catchment, while extensive overgrazing and sand mining is evident upstream Goedertrouw Dam on the Mhlathuze River. Rural settlements, forestry, dry land cultivation and Melmoth town are located downstream of the dam. Extensive cultivation, forestry and WWTW are found along the Nseleni River, with conditions deteriorating in the lower reaches. Tronox KZN Sands Fairbreeze heavy mineral mine impacts are evident in the lower reaches of the Manzamnyama River (W13B-03774).

Concerns in the catchment are focussed on groundwater quality rather than surface water, emanating from industrial sources (i.e. unlined pollution control dams and effluent storage dams). Eutrophication of the coastal lakes (e.g. Lakes Nsezi and Mzingazi) due to agro-chemicals and sewage which discharges effluent (indirectly) into these lakes, are also a concern (K Naidoo, DWS KZN, *pers. comm*.). Mondi pulp mill also discharge significant volumes of effluent to the marine environment (DWS, 2020).

Status of WWTW and STWs

The following are at High Risk (70 - 90% CRR) or Critical Risk (90 - 100% CRR) and in a Critical State, with Green Drop Scores of < 31% (Green Drop, 2022a).

- Nseleni (or Umseleni) WWTW (Critical Risk).
- Melmoth Ponds (High Risk).
- Mtunzini WWTW (High Risk).
- Nkandla WWTW (High Risk).
- Catherine Booth Hospital (High Risk).
- Gingindlovu Ponds (High Risk).
- King Dinuzulu (High Risk).
- Mpushini Ponds (High Risk) – location to be confirmed.
- Owen Sithole Agricultural College (High Risk).

Water quality priority areas

The following priority areas have been identified (**Table 5.1**). The shaded rows on the table indicate the estuarine zone and riverine SQRs driven by estuarine requirements.

Table 5.1 Catchment W1: Water quality priority areas

SQR	River name	Water quality impact (rating) or category (estuaries)	Water quality issues
W11A-03612	Matigulu	Large (3)	Impacts in lower reaches only: effluents from the Amaticulu Sugar Mill; cultivation; sand-mining.
W12C-03263	Mfulazane	Large (3)	Impact of Melmoth Ponds.
W12E-03475	Mhlatuze	Large (3)	Dryland cultivation; sedimentation and high turbidities.
W12H-03401	Okula	Large (3)	Tronox KZN Sands Fairbreeze mine; extensive dryland cultivation; some pivots.
W12F-03611	Mzingwenya	Large (3)	Urban impacts from Uzimgwenya and Gobandlovu settlements.
W12J-03392	Mpisini	Large (3)	Impacts from RBM smelter close to the small stream.
W12H-03289	Mbabe	Large (3)	Nseleni WWTW in lower reaches.
W12F-03494	Mhlatuze	Large (3)	Tongaat-Hulett Felixton Mill and Mpact, amongst other urban impacts.
Mhlatuze Estuary		E category	Very High pollution pressure; primarily from agriculture.
Richards Bay estuarine lakes		E category	High pollution pressure due to Port-based activities.
Siyaya Estuary		F category	Very High pollution pressure; primarily from agriculture.

5.4.2 W2 Catchment (Main River: Umfolozi)

Background

Commercial forestry/timber plantations are dominant in the upper catchment, resulting in some sand movement in those areas. Poor communal lands management has resulted in high suspended sediments loads in the upper reaches of the Black and White Umfolozi Rivers. Mixed commercial farming is dominant around Vryheid and around Melmoth. Coal mining around Vryheid further impacts the upper reaches of the Black Umfolozi.

In the upper reaches of the White Umfolozi River, the Klipfontein Dam experiences serious water quality issues as a result of return-flows from settlements in the Vryheid area and from a WWTW causing eutrophication of dam water (DWAF, 2004; cited by K Naidoo, DWS KZN, *pers. comm*.). Coal mining in the upper reaches of the catchment, around the town of Vryheid, pollutes surface water and impacts severely on the water quality by decreasing the pH and salinity. Coal mining is also prevalent in the upper reaches of the Black Umfolozi River causing problems with Acid Mine Drainage (AMD). Notable mines include the Somkhele coal mining operation. Resource degradation and high population pressure can be seen in the Ulundi and Nongoma areas.

The recent (2020) spill from the Zululand Anthracite Collieries containment dam on the Mbucwane River, with the active Outcrop shaft and abandoned and unrehabilitated Western shaft, which flow into the Black Umfolozi River, was testament to the impacts that can be caused by mining (Wilson, 2020).

Status of WWTW and STWs

The following are at High Risk (70 - 90% CRR) or Critical Risk (90 - 100% CRR) and in a Critical State, with Green Drop Scores of < 31% (Green Drop, 2022a).

- Vryheid-Klipfontein WWTW (Critical Risk).
- Hlobane WWTW (Critical Risk).

- Bethesda Hospital WWTW (High Risk).
- Emondlo WWTW (Critical Risk).
- Mlokothwa WWTW (Critical Risk).
- St Francis Hospital WWTW (High Risk).

Water quality priority areas

The following priority areas have been identified (**Table 5.2**). The shaded rows on the table indicate the estuarine zone and riverine SQRs driven by estuarine requirements.

Table 5.2 Catchment W2: Water quality priority areas

SQR	River name	Water quality impact (rating) or category (estuaries)	Water quality issues
To be identified and confirmed	***Mbucwane River***	***Priority protection area***	***Perennial spring linked to the Mbucwane River and historically used as a water source (Wilson, 2020).***
W21A-02512	aMagoda	Large (3)	Urban impacts from Vryheid, particularly from Vryheid WWTW on Klipfontein Dam.
W21B-02539	iShoba	Large-Serious (3.5)	Intermittent impacts from Hlobane Mine dumps; extension settlements; grazing and erosion.
W21D-02676	Mvunyane	Large (3)	Dense settlements; erosion; sand-mining; WWTW.
W21D-02788	Vumankala	Large (3)	Extensive bank and gully erosion; overgrazing.
W21D-02832	Jojosi	Large (3)	Extensive bank and gully erosion; overgrazing.
W21D-02848	Jojosi	Large (3)	Extensive bank and gully erosion; overgrazing.
W21E-02963	Nondweni	Large-Serious (3.5)	Extensive bank and gully erosion; overgrazing.
W21E-02912	Nondweni	Large (3)	Extensive erosion; sand-mining.
W21E-02873	Nondweni	Large (3)	Extensive erosion.
W21K-02976	Mbilane	Serious (4)	Urban impacts from Ulundi, including a non-compliant WWTW; pollution from coal mining; erosion.
W22J-02942	Mvalo	Large-Serious (3.5)	Impacts from Zululand Anthracite Collieries.
W23A-03058	Mbukwini	Large (3)	Mining operations.
W23A-03083	Umfolozi	Large (3)	Mining operations.
W23B-03231	Umsinduzi	Serious (4)	Irrigated sugar cane.
W23C-03180	Umsinduzi	Serious (4)	Irrigated sugar cane.
W23D-03108	Umfolozi	Serious (4)	Urban impacts from KwaMsane, including WWTW; irrigated sugar cane; Umfolosi Sugar Mill; Mtubatuba and Mtubatuba Hospital WWTW; extensive cultivation within wetlands and riparian zone.
Umfolozi/Umsinduzi Estuary		E Category	Very High pollution pressure; primarily from agriculture.

5.4.3 W3 Catchment (Main River: Mkuze)

Background

The area is made up of subsistence farming (Ingonyama Trust), commercial farming, and extensive game and nature reserves. Population pressure resulting in resource degradation is evident. High salinity levels are a particular problem in the upper Mkuze catchment, with Lake St Lucia threatened by rising salinity levels during drought cycles. Primary water quality issues in the area are mining activities and irrigation return flows. Water quality management strategies should

therefore focus on managing mine water decant, sources of salinity and sources of sedimentation, so as to ensure adequate quality of water entering Lake St. Lucia (DWS, 2020).

The main water quality issue in W31 (Mkuze) is coal mining, with low pH and high Total Dissolved Solids (TDS/salinity) levels in the upper catchment. Irrigation return flows exacerbate the salinity problems experienced. Sedimentation rates in the Mkuze and Hluhluwe catchments (W32) are high, resulting in increasing siltation levels of Hluhluwe Dam (DWS, 2020).

Status of WWTW and STWs

The following are at High Risk (70 - 90% CRR) or Critical Risk (90 - 100% CRR) and in a Critical State, with Green Drop Scores of < 31% (Green Drop, 2022a).

- St Lucia Ponds (Critical Risk).
- Hluhulwe WWTW (High Risk).
- Mkuze WWTW (High Risk).
- Coronation WWTW (Critical Risk) – location to be confirmed.

Water quality priority areas

The following priority areas have been identified (**Table 5.3**).

Table 5.3 Catchment W3: Water quality priority areas

SQR	River name	Water quality impact (rating)	Water quality issues
W31A-02494	Nkongolwana	Serious (4)	Forestry; extensive coal mining impacts
W31B-02477	Mkuze	Large (3)	Irrigation return flows; over-grazing; upstream impacts.
W31J-02469	Mkuze	Large (3)	Impacts from Mkuze WWTW.
W32C-02749	Mzinene	Large (3)	Impacts from Hluhluwe WWTW in lower reaches.

5.4.4 W4 Catchment (Main River: Pongola - excluding Eswatini)

Background

A mixture of land uses and types of economic activity are evident in Catchment W4, namely Ingonyama Trust land, extensive sugar plantations, commercial and mixed farming, private game reserves and wildlife farms, a large commercial timber plantation around Louwsberg, Penvaan Feedlot on the Pongola River, urban activities around Paulpietersburg, Jozini, Pongola and a number of other dense settlements. Commercial irrigated agriculture is located upstream Pongolapoort Dam (water supplied by the Impala Water User Association (WUA)) and Mjindi Irrigation Scheme using water from the canal system downstream of the dam. The primary industries are the RCL Sugar Mill outside Pongola. There are significant concerns about possible impacts from old and operational mines in the upper Pongola and Paulpietersburg area, with little monitoring taking place (Rossouw *et al*. (2008), cited in DWS (2014b). A study in 1999 showed only local leakage of AMD at the time, with little recorded impact on the Pongola or Bivane rivers.

A trend of increasing salinity and nutrient levels within the Pongolapoort Dam and problems with eutrophication in the dam are emerging. Elevated concentrations of toxins arising from pesticide use in the irrigation area are also likely. Although these return flows occur throughout the year, the water quality is worst in winter when the natural flow in the river is low and dilution capacity is reduced (K Naidoo, DWS KZN, *pers. comm*.).

There are also a number of mines, particularly in the upper catchment:

- Kariboo Colliery on the Soetmelks River which flows into the Bivane and ultimately the Pongola River.
- Brockwell Coal Mine on an unnamed tributary of the Bivane River (possibly an impact in W41E-02359; to be confirmed).
- An old coal mine dump known as Makateskop affecting the Makateskop River.
- Klipwal gold mine outside Ithala Game Reserve but a distance from the Pongola River and along a tributary.

Status of WWTW and STWs

The following are at High Risk (70 - 90% CRR) or Critical Risk (90 - 100% CRR) and in a Critical State, with Green Drop Scores of < 31% (Green Drop, 2022a).

- Ingwavuma Hospital (High Risk)
- A number of other STWs and WWTW are located in the area:
  - The Dumbe WWTW is a partly operational pond system, with an outlet flowing to the Pongola River.
  - Paulpietersburg STW.
  - Jozini STW.
  - Pongola WWTW.

Water quality priority areas

The following priority areas have been identified (**Table 5.4**).

Table 5.4 Catchment W4: Water quality priority areas

SQR	River name	Water quality impact (rating)	Water quality issues
W41B-02434	Soetmelks	Large (3)	Forestry and agriculture; erosion; Kariboo Colliery.
W42D-02327	Gode	Large (3)	Urban and peri-urban area of Paulpietersburg; forestry and irrigation; closed and operational mines.
W43F-02099	Ngwavuma	Large (3)	Irrigated sugar cane; extensive erosion and sedimentation; sand-mining.
W44B-02248	Manzawakho	Large-Serious (3.5)	Extensive irrigated agriculture; erosion and sedimentation; Pongola WWTW; lower half of reach highly impacted.
W44B-02351	Pongola	Serious (4)	Extensive irrigated agriculture; impacts from Pongola town and RCL Sugar Mill; irrigation return flows.
W44C-02338	Pongola	Serious (4)	Extensive irrigated agriculture; irrigation return flows.
W44C-02304	Pongola	Large-Serious (3.5)	Irrigated agriculture; irrigation return flows. Upstream impacts carried down the river.
W45A-02368	Pongola	Serious (4)	Jozini WWTW; extensive irrigated agriculture; dense settlement.
W45B-02105	Pongola	Large (3)	Extensive rural settlements; subsistence farming and erosion on Makatini Flats. High electrical conductivities recorded due to upstream irrigated agriculture – exacerbated during low flows.

5.4.5 W5 Catchment (Main River: Usutu - excluding Eswatini)

Background

The information below is taken from the water quality chapter of the 2019 Usutu Ecostatus report (IUCMA, 2020). The following sites were identified by the IUCMA as requiring a specific water quality assessment.

IUCMA site code / quaternary	River name	Point description	Type of site
U-26 / W51D	Assegai	Assegai River on Road Bridge to Mahamba Border Gate	International Obligations and EWR Site AS1
U-43 / W52C	Hlelo	Hlelo River on R33 Road Bridge to Amsterdam	International Obligations
U-44 / W53E	Ngwempisi	Ngwempisi River on R33 Road Bridge to Amsterdam	International Obligations
U-53 / W54D	Usuthu	Usuthu River @ weir before Nerston Border Gate	International Obligations
U-57 / W55C	Mpuluzi	Mpuluzi River Downstream of Mpuluzi Oxidation Ponds	International Obligations
U-61 / W56A	Lusushwana	Lusushwana River Bridge at Zwalunest Village before Swaziland Borde	International Obligations

Development in the upper Usutu Catchment is generally limited with the only towns of significant size being Piet Retief and Amsterdam. The main land use is forestry with limited commercial and subsistence agriculture in the south-west. General land use practices that pose water quality problems within the study area include the following:

- Non-point source pollution from agriculture (pesticides, fertilizers), although limited in extent.
- Non-point source pollution from residential areas (urban and rural townships) e.g. stormwater run-off, washing in rivers, but again limited in extent as the Upper Usutu is not highly populated.
- Point source pollution from urban infrastructure, e.g. WWTW around Piet Retief and Amsterdam towns in particular.
- Microbiological counts and nutrient concentrations are problematic in some catchments, but appear to be localised issues.
- The presence of alien invasive plants, removal of vegetation and overgrazing within the riparian zone of rivers, which results in erosion and sedimentation.
- The dams and weirs impact on the movement of sediment, and temperature and oxygen levels.
- Mining activities, i.e. Cascade Iron Ore west of Piet Retief in W51C, and coal mining in the following areas: Taaiboschspruit Colliey in W53A, Panbult in W52A, Savmore and Balgarthan collieries in W51B, Kwasa Anthracite Colliery in W51C and Assegai coal mine in W51A. Bauxite Fields Aluminium are located in W51A, Transvaal Supergroup uranium deposits in W53D, and Usushwana Iron Complex in W51F (South African Mine Water Atlas, 2018).

According to Ms Tlowana of the IUCMA (*pers. comm*., March 2022) primary challenges within the Usutu catchment are microbial pollution levels, mainly from WWTW and associated infrastructure within residential areas (urban and rural townships), as follows:

- Partially treated effluent discharge from WWTW,
- spillage of raw sewer manholes and pump stations due to poor maintenance and sanitation servicers, and
- stormwater runoff from rural and urban settlements, including direct disposal of domestic refuse (e.g. disposal of nappies), grey water and seepage from latrines.

Although water quality state at present appears to be Good across the Upper Usutu (IUCMA, 2020), the extent of current and future mining activities poses a threat to water quality. According to the South African Mine Water Atlas (2018) the *Mineral Risk*, i.e. the assessed risk of acid production and/or leaching of constituents of concern into the environment, is High for a number of quaternary catchments in the study area.

Land use as the Usutu River exits Eswatini is mostly Ingonyama Trust land and the Ndumo Game Reserve.

Status of WWTW and STWs

The following are at High Risk (70 - 90% CRR) or Critical Risk (90 - 100% CRR) and in a Critical State, with Green Drop Scores of < 31% (Green Drop, 2022b).

- All five plants (Badplaas, Carolina, Elukwatini, Empuluzi, and Ekulindeni) assessed in Chief Albert Luthuli Local Municipality (Critical Risk), with the 2021 average % CRR being 94.4%. All plants have now been placed under regulatory focus. Relevant to the study is the following:
  - Empuluzi WWTW.
- Piet Retief/Mkhondo WWTW (High Risk).
- All seven plants assessed in Msukaligwa Local Municipality (Critical Risk). Relevant to the study are the following:
  - Chrissiesmeer WWTW.
  - Lothair WWTW.
  - Sheepmoor WWTW.

Water quality priority areas

The following priority areas have been identified (**Table 5.5**).

Table 5.5 Catchment W5: Water quality priority areas

SQR	River name	Water quality impact (rating)	Water quality issues
W51D-02044	Assegaai	Large (3)	Urban impacts from Piet Retief, including WWTW and Mpact.
W51F-01986	Blesbokspruit	Large (3)	Irrigation; impacts from upstream timber processing plants.
W51F-02019	Blesbokspruit	Serious (4)	Tannery effluent draining into the Farroloop and Blesbokspruit; Thuthuka Forestry.
W53C-01679	Thole	Large (3)	Amsterdam WWTW (medium risk).
W55C-01395	Mpuluzi	Large (3)	Lower reach only: Mayflower/Empuluzi WWTW; extensive settlements.

5.4.6 W7 Catchment (Kosi Estuary and Sibaya Lake)

Background

Dense settlements are found along the systems that feed into Kosi Bay and Lake Sibaya. Extensive cultivation and deforestation in the lake catchment area has increased erosion and eutrophication in most of the streams feeding the lake system (K Naidoo, DWS KZN, *pers. comm*.).

Status of WWTW and STWs

The following are at High Risk (70 - 90% CRR) or Critical Risk (90 - 100% CRR) and in a Critical State, with Green Drop Scores of < 31% (Green Drop, 2022a).

- Manguzi WWTW (High Risk)

Water quality priority areas

The following priority areas have been identified (**Table 5.6**).

Table 5.6 Catchment W7: Water quality priority areas

SQR	River name	Water quality impact (rating)	Water quality issues
W70A-02079	Swamanzi	Large (3)	Urban area, so high nutrient levels expected; Manguzi WWTW.
W70A-02301	Unnamed	Large (3)	Extensive settlements so elevated nutrients expected.

6 STATUS QUO ASSESSMENT: ECOLOGICAL GOODS, SERVICES AND ATTRIBUTES (ECOSYSTEM SERVICES)

6.1 INTRODUCTION

The Usutu-Mhlathuze Water Management Area, because of the nature of the communities that it intersects, plays an important role in maintaining important Ecological Goods, Services and Attributes (EGSA) on-site as well as other users. An EGSA is a product that emerges from processes or features within largely natural environments, which enhances human wellbeing and is directly used by people. Natural capital and associated ecosystem services are now becoming scarce and the Millennium Ecosystems Assessment (MEA) partitions ecosystems services into four broad categories:

- Provisioning services are the most familiar category of benefit, often referred to as ecosystem 'goods', such as foods, fuels, fibres, bio-chemicals, medicine, and genetic material, that are in many cases: directly consumed; subject to reasonably well-defined property rights (even in the case of genetic or biochemical material where patent rights protect novel products drawn from ecosystems); and are priced in the market.
- Cultural services are the less familiar services such as religious, spiritual, inspirational and aesthetic well-being derived from ecosystems, recreation, and traditional and scientific knowledge that are: mainly passive or non-use values of ecological resources (non-consumptive uses); that have poorly-developed markets (with the exception of ecotourism); and poorly-defined property rights (most cultural services are regulated by traditional customs, rights and obligations); but are still used directly by people and are therefore open to valuation.
- Regulating services are services, such as water purification, air quality regulation, climate regulation, disease regulation, or natural hazard regulation, that affect the impact of shocks and stresses to socio-ecological systems and are: public goods (globally in the case of disease or climate regulation) meaning that they "offer non-exclusive and non-rival benefits to particular communities" (Perrings, 2006); and are thus frequently undervalued in economic markets; many of these are indirectly used being intermediate in the provision of cultural or provisioning services.
- Supporting services are an additional set of ecosystem services referred to in the MEA, such as nutrient and water cycling, soil formation and primary production, that capture the basic ecosystem functions and processes that underpin all other services and thus: are embedded in those other services (indirectly used); and are not evaluated separately (Mander *et al*., 2007).

An overview of the secondary catchments and their relationship to EGSA is provided in the sections below.

6.2 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 primary tools. These were:

- Geographic Information System (GIS) overlays of quaternary catchments. 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 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.

6.3 DESCRIPTION AND STATUS QUO PER SECONDARY CATCHMENT

6.3.1 W1 catchment (Main River: Mhlathuze)

The Mhlathuze Catchment includes a diverse set of settlement types as well as land and economic uses. The upper catchment includes commercial forestry/timber plantation, notably in the areas around the west of Babanango. This portion also includes land given over to land reform projects, some of which are now part of recent initiatives to develop game parks. Strips of timber plantation areas have also been developed in the more coastal belt of the catchment area. Mixed commercial farming and sugar plantations are found in portions of the catchment. The areas west of Melmoth, as well as Eshowe and Nkawleni valley areas are the most prominent examples.

The Richards Bay Empangeni Industrial hub is the key economic motor and linked to water from Goedertrouw Dam on the Mhlathuze River. There are mining interests in the area, notably the contested Richards Bay Minerals operation. In addition to game farms and nature reserves the coastal areas have elements of tourism appeal. From an ecosystems services perspective the aesthetic appeal of the rivers adds value to the tourism value.

In terms of provisioning aspects of the ecosystem services the rivers and their associated goods are potentially most important to the hinterland areas given over to Ingonyama Trust. Here, for people dependant on these kinds of services for direct utilisation, the river and its attributes are sometime critical for livelihoods. Given that the area is associated with the emergence of the Zulu Kingdom the ritual and historical aspects are also of importance and these are largely, although not exclusively, associated with the Ingonyama area.

6.3.2 W2 catchment (Main River: Umfolozi)

As with the Mhlathuze, the Umfolozi Catchment includes a diverse set of settlement types as well as land and economic uses. The upper catchment includes commercial forestry/timber plantation, notably in the areas around Gelukstadt, east of Bananango and Vryheid. Strips of timber plantation areas have also been developed in the more coastal belt of the catchment area, particularly around KwaMbonombi. Mixed commercial farming is found in portions of the catchment. Vryheid and areas east of Melmoth are the most prominent examples. There are mining interests in the area, notably the Somekele operation.

The Hluhluwe- iMfolozi Park is of considerable importance as a nature reserve. The river and its integrity are crucial to the functioning of the Park. In addition to game farms and nature reserves the coastal areas have elements of tourism appeal. From an ecosystems services perspective the aesthetic appeal of the rivers adds value to the tourism value. The river and its functioning are also linked to the greater iSimanagalso Wetland Park that's that is Heritage Site.

In terms of provisioning aspects of the ecosystem services the rivers and their associated goods are potentially most important to the hinterland areas given over to Ingonyama Trust. The Ulundi and Nongoma areas are of particular interest in this regard, although it should be noted that the high population pressure is associated with resource degradation that is notable in many parts of the central catchment area. Despite the degraded nature of the area, for people dependant on these kinds of services for direct utilisation, the river and its attributes are sometime critical for livelihoods. Given that the area is associated with the central Zulu Kingdom the ritual and historical aspects are also of importance and these are largely, although not exclusively, associated with the Ingonyama area.

6.3.3 W3 catchment (Main River: Mkuze)

The area is made up of subsistence farming (Ingonyama Trust) commercial farming, extensive game and nature reserves including state on private concerns. State concerns include the approaches to Lake St Lucia and parts of the Hluhluwe- iMfolozi Park. The area south of Mkuze is given over to up market private nature reserves that border on the iDimagalsio Wetland as well as Mkuze Reserve. Aesthetic issues associated with the rivers are of key concern in these areas.

Again, in terms of provisioning aspects of the ecosystem services the rivers and their associated goods are potentially most important to the hinterland areas given over to Ingonyama Trust. The area proximate to Hluhluwe, as well the town Mkuze, are of particular interest in this regard. In these areas it should also be noted that the high population pressure is associated with resource degradation. The areas are noted as significantly underdeveloped and despite the degraded nature of the area, the river and its attributes are sometimes critical for livelihoods. The DukuDuku area is prominent with respect to the importance of provisioning services.

Given that the area is associated with the northern Zulu Kingdom, the ritual and historical aspects are also of importance and these are largely, although not exclusively, associated with the Ingonyama area.

6.3.4 W4 Catchment (Main River: Pongola - excluding Eswatini)

This is the Pongola River with its most prominent tributary being the Bivane. Again there is a mixture of land use and types of economic activity. The Bivane River upstream of Paris Dam is extensive commercial farming, including timber in the Paulpietersberg area with some nature lodges and reserves. This is a popular fishing area. The close settlement area of Obivane includes closer settlement areas that are on Ingonyama Trust lands and subsistence farming is critical. The area downstream of Paris Dam is mostly given over to Ingonyama Trust areas.

The Pongolo River Luneneburg area is mostly timber and commercial farming but includes the Paaedeplaats nature reserve. There is some tribal trust land associated with the area specific to the Ntombe tributary. The Pongolo River upstream of Frischgewaagd is commercial and timber farming, while downstream the area is largely Tribal trust. The area around Louwsberg is largely commercial timber plantation although the Ithala Game Reserve also features. The Mozana River environments include some commercial farming and Tribal Trust areas. There is dense settlement lower in the part of this sub-catchment.

The main stem of the Pongolo upstream of Jozini Dam includes extensive sugar plantations with some mixed farming and private Game Reserves and Wildlife Farms. Downstream of Jozini Dam the area is given over to Tribal Trust land that includes the Makhathini Flats. People in this area

are closely reliant on provisioning services provided by the river and its floodplains. The area east of the Ndumo Game reserve is also noteworthy in this lower section adjacent to the Mozambique Border.

6.3.5 W5 Catchment (Main River: Usutu - excluding Eswatini)

This area includes a series of catchments west of Eswatini. The Assegai River and tributaries upstream of Driefontein are mostly given over to commercial farming. There are extensive mixed commercial farming and timber plantations in the areas associated with the Blesbokspruit and Upper Usutu. The areas around the Ngwempisi and Hlelo River tend to have a more mixed profile with some of the area occupied by dense closer settlement associated with Tribal Trust. The Usutu as it exits Eswatini is mostly Ngonyama Trust and the Ndumo Game Reserve.

6.3.6 W7 Catchment (Kosi Estuary and Sibaya Lake)

This secondary catchment includes systems that feed into Kosi Bay as well as Lake Sibaya. Both areas are similar in nature being made up of dense rural/closer settlement areas that feed water bodies. The water bodies function as key providers of provisioning services for subsistence communities. Kosi Bay is a popular tourist destination.

7 RU DELINEATION

7.1 INTRODUCTION

Resource Units (RUs) are the delineation of a river/s used for an Ecological Water Requirement (EWR) determination and for the setting of Resource Quality Objectives (RQOs). The RUs represent homogeneous sections of a river/s. These are each significantly different to warrant their own specification of the Reserve and the determination of RQOs, and the geographic boundaries of each must be clearly delineated (DWAF, 1999, Volume 3).

Resource Units are required as it may not be appropriate to set the same numerical Reserve for the headwaters of a river as for the lowland reaches. These sections of a river frequently have different natural flow patterns, react differently to stress according to their sensitivity, and require individual specifications of the Reserve appropriate for that reach.

7.2 APPROACH

There are different approaches for delineating RUs based on the detail and scale of assessment. Dealing with a Classification study which usually consists of a large study area, the appropriate RU delineation approach at a broad scale will be used. The guiding principle is that if the hydrology, geomorphic characteristics, physico-chemical attributes and river size are relatively similar, a RU can be demarcated (DWAF, 2008a).

The following aspects were used to delineate the W Primary Catchment into river RUs:

- Land cover: Land cover data was provided as part of the PES/EI/ES spreadsheets available for the study area (DWS, 2014a), which were reviewed and updated in January 2022.
- Management requirements (DWAF, 1999, Volume 3). The overriding aspects in terms of identifying RUs are land cover (a surrogate for land use) and the closely related management and operation of the water resources within the study area.
- The PES in terms of Ecological Categories are available for each SQR and it also includes a description of the types of impacts and whether they are flow related, non-flow related and/or whether there are water quality impacts.
- This information is considered, and expert judgement and local knowledge are used for the final delineation of the catchment into RUs.

The starting point for RU delineation is therefore the SQRs (which represents a single stretch of river defined by inflows of tributaries. The status of each SQR is known, as well as land cover, and water resource management and operation. SQRs are therefore nested within RUs and using available information, were grouped into RUs (Tables within **Appendix B**). The RUs are also presented in the figures in **Chapters 8 and 12**.

8 STATUS QUO ASSESSMENT: RIVER ECOLOGICAL STATE

8.1 INTRODUCTION

Determination of the Present Ecological State (PES), which 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 to increasing complexity and intensity of work from the Level I (Desktop) to Level IV. An additional level, also Desktop, was developed by Dr Kleynhans (DWS, 2014a) 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 PESEIS project, and this data was used as the baseline for the status quo assessment.

8.2 APPROACH

8.2.1 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, 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 from A to F (where A is natural, and F is critically modified) (**Table 8.1**). 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 totality 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 8.1 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.
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 A→F scale represents a continuum, and that the boundaries between categories are notional, artificially-defined points along the continuum. Therefore there may be cases where there is uncertainty as to which category a particular entity belongs. 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 8.1**.

Figure 8.1 Illustration of the distribution of Ecological Categories on a continuum

The Desktop level EcoClassification was modified for use in the PESEIS project to deal with numerous sub-quaternary river reaches and the relationship between the Desktop Level EcoClassification and the modified desktop level used within the PESEIS project is illustrated in **Figure 8.2**.

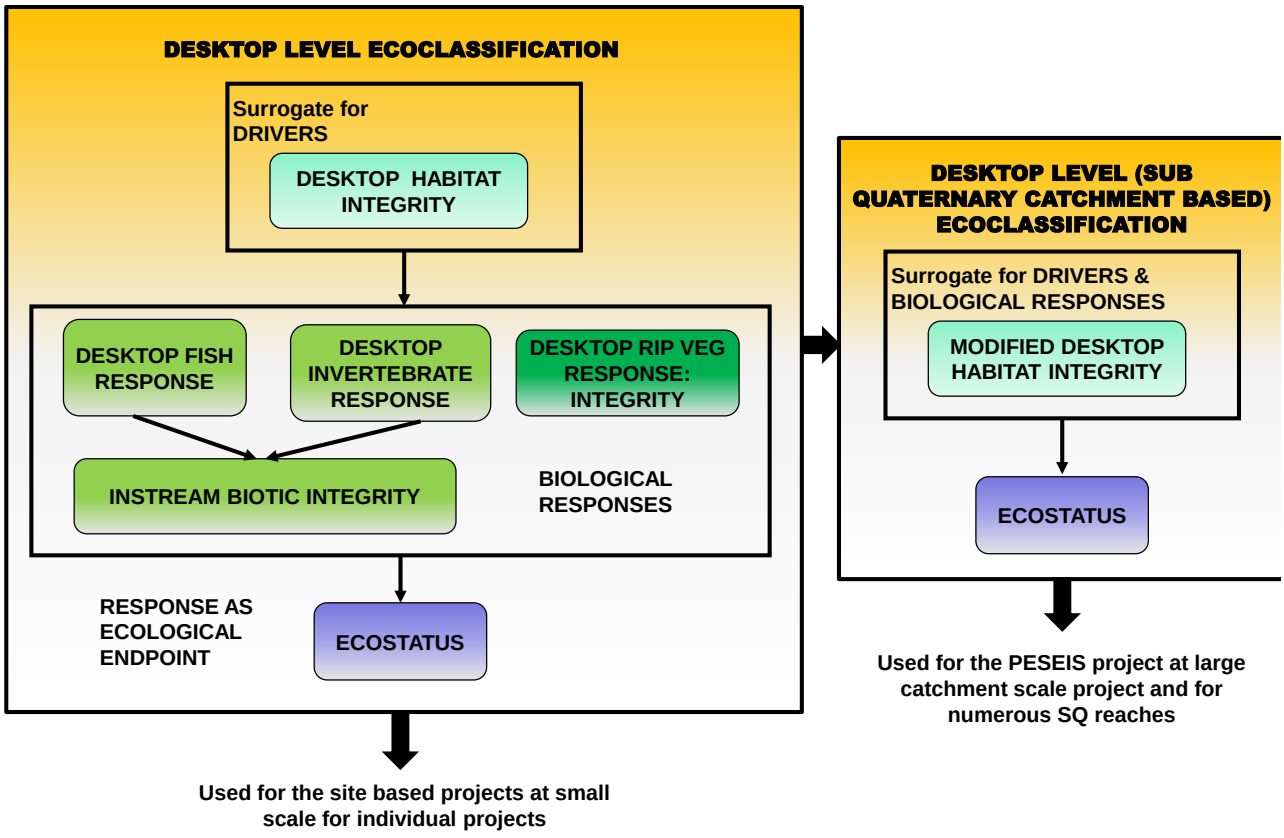


Figure 8.2 Relationship between the Desktop Level EcoClassification and the PESEIS approach to determine the PES

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 8.2** (DWA, 2013). Each metric is scored from zero to five.

Table 8.2 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. *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. 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, crustaceans and molluscs) 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 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, urbanisation, 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. *Indicators:* Derived likelihood that flow and flood regimes have changed. Assessment based on land cover/land use information (urban areas, interbasin 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. *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.

8.2.2 PES supporting information

Comments summarising the activities that result in the PES were provided for each SQR. Additionally, water resource information on use and existing infrastructure was used to determine where possible impacts are and whether they are flow or non-flow (including water quality) related. This study team also viewed each SQR using Google Earth™ to provide the flow and non-flow impact assessment and to identify the key PES drivers.

8.2.3 Database for PES information in an Excel spreadsheet

The relevant six secondary catchments which represent the W primary catchment consist of 336 SQRs (**Table 8.3**). These exclude the SQRs in Eswatini as well as estuary and related SQRs. The final modelled information in the front-end model for each secondary is available from DWS (https://www.dwa.gov.za/iwqs/rhp/eco/peseismodel.aspx). Information was extracted in a master spreadsheet that incorporates all the PESEIS results, modifications to the PES results, as well as the additional information required for this project. The spreadsheets will be available on the final data flash drive for this project and the columns of the PES sheet (called PES) is described below.

The SQRs were grouped into Resource Units (RUs) based on similarity of state, land use and impacts (refer to **Chapter 7**) for details. The number of RUs per secondary catchment is provided in **Table 8.3**. The PES and all further assessments will be provided at the scale of Resource Units which will be further grouped into Integrated Units of Analysis (refer to **Chapter 11**).

Table 8.3 Number of SQRs and RUs per Secondary Catchment

	SQR	RU
W1	46	15
W2	91	16
W3	61	13
W4	75	11
W5	57	13
W7	3	3
Total	**333**	**71**

A description of the columns is provided below:

- Column A: **RU number:** Individual code created for the RU represented by a number of SQRs.
- Column B: **SQR number:** Individual code provided for each SQR by DWS and based on the codes used in the NFEPA (Nel *et al*., 2011) assessment.
- Column C: **River Name**: River name where available.
- Column D: **Node:** Biophysical node per RU with node number or name
- Column E: **Length km:** River length of SQR.
- Column F - K: A zero to five rating for impacts for metrics as provided from the PESEIS study. Numbers adjusted during the review show a red font. There are also notes attached to the cell providing reasoning if necessary.
- Column L: **Comments:** Comments copied from the front-end model providing a valuable summary of activities in the SQR. Where the font is in red, the comment has been adjusted or added to by the reviewers.
- Column M: **Water quality hotspots**: An evaluation undertaken to identify problem (ecology and user) water quality areas. Only hotspots which represent a 3, 4 or 5 rating have been completed. Note, this information has been undertaken for THIS study and does not form part of the original PESEIS assessment.
- Column N: **Water quality comments:** Provides an indication of what the reasons are for the water quality hotspots. General water quality comments also included. Note, this information has been undertaken for THIS study and does not form part of the original PESEIS assessment.
- Column O: **River PES (Value):** PES value generated using the median of the ratings for metrics as provided in column F to K.
- Column P: **River PES (EC):** PES category based on median of PES metrics.
- Column Q: **Flow:** The word flow is included in the cell if column F or J is > 1.
- Column R: **WQ:** The abbreviation WQ (water quality) is included in the cell if column K is >1.
- Column S: **Non-Flow:** The term Non-Flow (Non-Flow related impacts) is included in the cell if column G or I is >1.
- Column T: **Impact Summary:** Concatenates the information in columns AJ, AK and AL.

- 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: **Total RU Length:** Total of the SQR lengths (column D) which comprises the RU.
- Column W: **% of dominant EC:** Percentage provided represents the percentage of river length of the dominant EC within the RU.
- Column X: **PES RU value**: The EC value is provided and it represents an average if there is more than one SQR within the RU with the same EC. Note that a specific configuration of the ECs within the RU can result in a decision to override the calculated (based on dominant EC) EC.
- Column Y: **PES RU EC**. The EC value for the RU is translated to an EC.

8.3 DESCRIPTION AND STATUS QUO PER SECONDARY CATCHMENT

The status quo assessment consists of a table and short summary for each secondary catchment. No key PES drivers are provided for rivers in a B or higher PES as the changes from natural are minor. Maps for each secondary catchment are provided showing the RUs and the PES.

8.3.1 W1 Catchment (Main River: Mhlathuze)

The PES results per RU are provided in **Table 8.4**. An indication of whether the source of the primary impact drivers is flow, non-flow related and/or water quality impacts is also provided in the last column.

a) W11 Tertiary Catchment (Matigulu River)

The W11 tertiary catchment (Matigulu River) is largely in a C and C/D EC, i.e. moderately modified (RU W11-2, W11-3). These impacts are due to mostly non-flow related activities such as the presence of roads, extensive agriculture, vegetation clearing and alien vegetation. Flow related activities are related to small dams in the main stream and tributaries as well as some forestry. A small section in the Entumeni Nature Reserve is possibly in a B EC. The upstream reaches of the Matigulu River is largely in a B EC, i.e. largely natural (RU W11-1).

b) W12 Tertiary Catchment upstream of Goedertrouw Dam (Mhlathuze River)

The W12 tertiary catchment upstream of Goedertrouw Dam (Mhlathuze River and tributaries) is largely in a C EC, i.e. moderately modified ((RU W12-1, W12-3 andW12-4). These impacts are due to flow and non-flow related activities such as the presence of roads, extensive overgrazing and sand mining, alien vegetation, forestry, small dams and intermittent transfers from the Thukela River. The Mavungwini tributary and downstream and upstream Mhlathuze Rivers are in a B (largely natural) EC as parts of it occurs in the Nkhandla Forest Reserve and the Vungwini Nature Reserve (RU W12-2).

c) Mhlathuze Tributaries downstream of Goudertrouw Dam in the W12 Tertiary Catchment

The Mfule catchment (RU W12-5) is a mixture of a C and B ECs. Impacts are flow and non-flow related with rural settlements, forestry, dry land cultivation, dams in tributaries and the town of Melmoth. The Mhlatuzana catchment (RU W12-7) is in a B EC with minor non-flow related activities related to settlements, grazing and farming in the riparian zone. The Nseleni Catchment (RU W12-8) is in a C EC and deteriorates to a D (largely modified) EC in the lower reaches. The impacts are related to extensive cultivation, forestry, alien vegetation, dams in tributaries, WWTW and back flooding from Lake Nsezi due to a raised weir.

d) W12 Tertiary Catchment: Mhlathuze River downstream of Goedertrouw Dam

The Mhlathuze River downstream of Goedertrouw Dam (RU W12-6) is highly modified due to the release patterns from Goedertrouw Dam, the extensive irrigated cultivation, presence of alien vegetation and sand mining. This section of the Mhlathuze River was measured against a pool-riffle baseline due to the river changing from alluvial system to a pool-riffle system, caused by downstream scouring from Goedertrouw. Measuring against natural would therefore yield an E EC because of this alluvial-pool riffle change. The lowest reaches of the Mhlathuze River is not included in the assessment. This stretch of river is significantly modified, and sections have been canalised (historically from a papyrus swamp). The function of this section of the river is as a conduit to the estuary and estuary requirements will be used to determine the flow and quality which should pass through this highly modified section of the Mhlathuze River.

e) W12 Tertiary Catchment: Short coastal rivers

The RU W12-9 consists of various short rivers (shorter than 12 km) mostly associated with Lake Mzingazi and Lake Nhlabane. The rivers are largely in a C EC and this is due to extensive forestry, roads, stormwater runoff, the RMB smelter, historical mine and water quality issues from seepage and urban areas.

f) W13 Tertiary Catchment (Mlalazi River)

The catchment is largely in a C EC (RU W13-1) and this is due to extensive formal agriculture, WWTW, tributary dams, emerging and subsistence farming and localised forestry. The Manzamnyama River (RU W13-2) is in a marginally better condition (B/C EC) as it is associated with Umlalazi Nature Reserve in the lower reaches. Impacts are mostly due to forestry outside of the Reserve.

Table 8.4 PES for W1 Secondary Catchment

RU number	Main river name	PES RU value	PES RU EC	Primary driver
W11-1	Matigulu	1.00	B	Non-flow
W11-2	Matigulu	2.00	C	Flow, WQ, Non-flow.
W11-3	Nyoni	2.50	C/D	Non-flow
W12-1	Mhlathuze	2.00	C	Flow, Non-flow.
W12-2	Mhlathuze	1.00	B	Flow, Non-flow.
W12-3	Mhlatuze	2.00	C	Flow, WQ, Non-flow.
W12-4	KwaMazula	2.00	C	Flow, Non-flow.
W12-5	Mfule	1.92	C	Flow, Non-flow.
W12-6	Mhlatuze	2.00	C	Flow, WQ, Non-flow.
W12-7	Mhlatuzana	1.00	B	Non-flow
W12-8	Nseleni	1.94	C	Flow, WQ, Non-flow.
W12-9	Kondweni	2.00	C	Flow, WQ, Non-flow.
W12-10	Lake Msingaze	2.00	C	Flow, WQ, Non-flow.
W13-1	Mlalazi	2.00	C	Flow, WQ, Non-flow.
W13-2	Manzamnyama	1.50	B/C	Flow, Non-flow.

8.3.2 W2 Catchment (Main River: Umfolozi)

The PES results per RU are provided in **Table 8.5**. An indication of whether the source of the primary impact drivers is flow, non-flow related and/or water quality impacts is also provided in the last column.

a) W21 Tertiary Catchment (White Umfolozi River)

The upper White Umfolozi (RU W21-1, W21-2, and W21-3) is largely in a C EC with a short section of the White Umfolozi in a B EC. The impacts are associated with forestry, dams in tributaries and main rivers, agriculture, the Hlobane mine dumps, extensive rural developments, irrigation, erosion and sedimentation.

The Nondweni Catchment is in a D category (RU W21-4) with one section even dropping to an E EC. The impacts are dominated by overgrazing, erosion and sedimentation. Other contributing impacts are water quality impacts from urban areas and a WWTW.

The rest of the White Umfolozi Tertiary Catchment consist in a B/C EC (RU W21-5, W21-6, and W21-7) with the most downstream RU W21-8 in a B category as it falls into the Hluhluwe iMfolozi Game Reserve. Impacts are largely due to subsistence farming, overgrazing, erosion, sedimentation, instream weirs (abstraction for Ulundi), water quality issues related to a non-compliant WWTW (Ulundi) and pollution from coal mining.

b) W22 Tertiary Catchment (Black Umfolozi River)

The Black Umfolozi upstream of the Hluhluwe iMfolozi Game Reserve (RU W22-1and W22-2) is in a B/C EC. These impacts are due to formal and subsistence farming, forestry, erosion, water quality impacts from coal mining and rural areas. There are numerous instream and tributary dams which result in changes in flow playing a major role in this area. The Sikwebezi Tributary and associated Black Umfolozi River (RU W22-3 and W22-4) are largely in a C EC. The impacts are similar to the upstream Black Umfolozi Tertiary Catchment.

The lower Black Umfolozi and tributaries (RU W22-5) are largely in a B EC with the lower reaches falling either into or bordering the Hluhluwe iMfolozi Game Reserve. Impacts outside of the Reserve are associated with overgrazing, fallow land, rural development and erosion.

c) W23 Tertiary Catchment (Umfolozi River)

The Umfolozi River in and immediately downstream of the Hluhluwe iMfolozi Game Reserve is in a B EC (RU W23-1 and W23-2). This is in direct contrast with the most downstream section of the Umfolozi River and the Msunduzi Tributary. This is due to extensive forestry, irrigated sugar cane and the canalisation of the Umfolozi River for irrigated sugar cane and changing the connection of the Umfolozi River with the St Lucia Estuary.

Table 8.5 PES for W2 Secondary Catchment

RU number	Main river name	PES RU value	PES RU EC	Primary driver
W21-1	White Mfolozi	1.94	C	Flow, WQ, Non-flow.
W21-2	White Mfolozi	1.13	B	Flow, WQ
W21-3	White Mfolozi	2.00	C	Flow, WQ, Non-flow.
W21-4	Nondweni	3.00	D	WQ, Non-flow.
W21-5	White Mfolozi	1.50	B/C	Flow, Non-flow.
W21-6	White Mfolozi	1.44	B/C	Flow, Non-flow.
W21-7	White Mfolozi	1.50	B/C	Flow
W21-8	White Mfolozi	1.00	B	Flow, WQ
W22-1	Black Mfolozi	1.50	B/C	Flow
W22-2	Black Mfolozi	1.50	B/C	Flow, WQ (main river)
W22-3	Sikwebezi	2.00	C	Non-flow
W22-4	Black Mfolozi	2.00	C	Flow, WQ, Non-flow.

RU number	Main river name	PES RU value	PES RU EC	Primary driver
W22-5	Black Mfolozi	1.25	B	Flow Non-flow
W23-1	Mfolozi	1.13	B	Flow, WQ, Non-flow.
W23-2	Msunduzi	1.00	B	Flow, WQ, Non-flow.
W23-3	Mfolozi	4.00	E	Flow, WQ, Non-flow.

8.3.3 W3 Catchment (Main River: Mkuze)

The PES results per RU are provided in **Table 8-6**. An indication of whether the source of the primary impact drivers is flow, non-flow related and/or water quality impacts is also provided in the last column.

a) W31 Tertiary Catchment (Mkuze River)

The upper Mkuze Tertiary Catchment (RU W31-1, W31-2, and W31-2) varies from a C (moderately modified) and downstream to a B (largely natural) and further downstream to a B/C EC. These impacts range from forestry, coal mining, instream dams, rural areas, irrigated crops, alien vegetation, instream dams, erosion and sedimentation.

The lower Mkuze Tertiary Catchment (RU W31-4 and W31-6) is in an improved condition with large sections falling within or bordering the uMkhuze Game Reserve. Outside of the protected areas impacts are associated with Mkuze town, irrigation, subsistence farming and erosion. RU W31-5 consists of tributaries of the Mkuze River and a section of the Mkuze River and is in a C condition. Impacts are associated with irrigation from a canal (Pongolapoort Dam), subsistence farming, old lands and vegetation removal.

b) W32 Tertiary Catchment (Hluhluwe River)

RU W32-1 consists of the lower section of the Mkuze River before it flows into St Lucia and is in a B/C condition. The impacts are associated with subsistence farming, road crossings, and irrigated sugar cane farming.

The Hluhluwe Catchment consists of three RUs in a B EC (RU W32-2, W32-3, and W32-6). The upstream RU is mostly within the Hlhluwe Mfolozi Game Reserve. Tributaries of the Hluhluwe River (RUW32-4 and W32-5) are mostly in a C condition due to overgrazing, sand mining, subsistence farming, erosion, sand mining, sugar cane farming, urban (Hlhluwe) and associated WWTW, instream dams and levees).

Table 8.6 PES for W3 Secondary Catchment

RU number	Main river name	PES RU value	PES RU EC	Primary driver
W31-1	Mkuze	2.00	C	Flow, WQ, Non-flow
W31-2	Mkuze	1.00	B	Flow, WQ
W31-3	Mkuze	1.50	B/C	Flow, WQ, Non-flow
W31-4	Mkuze	1.08	B	Flow, WQ, Non-flow
W31-5	Mkuze	2.17	C	Flow, WQ, Non-flow
W31-6	Msunduzi	1.00	B	Flow
W32_1	Mkuze	1.25	B/C	Flow, Non-flow
W32-2	Hluhluwe	1.00	B	Non-flow
W32-3	Nyalazi	1.00	B	Non-flow
W32-4	Nyalazi	2.00	C	Flow, WQ, Non-flow
W32-5	Mzinene	1.94	C	Flow, WQ, Non-flow
W32-6	Munywana	1.13	B	Flow

8.3.4 W4 Catchment (Main River: Pongola - excluding Eswatini)

The PES results per RU are provided in **Table 8.7**. An indication of whether the source of the primary impact drivers is flow, non-flow related and/or water quality impacts is also provided in the last column.

a) W41 Tertiary Catchment (Bivane River)

The upper Bivane River (RU W41-1 is in a C (moderately modified) condition. The impacts upstream of the Bivane Dam are dominated by non-flow regulated impacts such as extensive forestry and agriculture. The Bivane River downstream of Bivane Dam (W41-2) is also in a C condition but that is due to the flow changes downstream of the dam. The downstream section of this RU borders the Ithala Game Reserve and the riparian section is therefore protected. The RU W41-2 consisting of the Manzana Tributaries is in a B condition.

b) W42 Tertiary Catchment (Pongola River)

The Pongola River and tributaries upstream from the Bivane confluence (W42-1 and W42-2) is in a C condition. Impacts are largely flow and non-flow related consisting of extensive forestry, irrigated and dryland agriculture, dams in tributaries and urban areas such Paul Pietersburg. There is also some water quality impacts especially associated with the urban area of Paul Pietersburg.

Downstream of the Bivane Confluence, the Pongola River and the Mozana Tributaries (W42-3 and W42-4) are in a B condition. This is largely due to the fact that the Pongola River borders Ithala Game Reserve, some tributaries such as the Ithalu lies largely within the Game Reserve and that the nature of the river valley provides some protection. The Mozana Tributaries (W42-4) are in a C and B condition (RU in a B). Impacts are associated with instream dams, forestry, agriculture and alien vegetation. RU W42-5 consists of the Spekboom tributaries (impacted by overgrazing, erosion, sand mining and subsistence farming) and the Pongola River (B EC) bordering Ithala Game Reserve for the first half of this RU.

c) W44 Tertiary Catchment (Pongola River)

This section of the Pongola River and its tributaries (W44-1) are in a D (largely modified) EC. The impacts in the main river and some of the tributaries are all associated with the Impala Irrigation Board canal system and Grootdraai Weir and the resulting flow abstractions and a change in flow patterns. Combined with these flow changes, there are the extensive impacts associated with sugar cane farming, and some subsistence farming (in tributaries). The RU ends at the inflow of the Pongola River in Pongolapoort Dam.

d) W45 Tertiary Catchment (Pongola River)

This RU (W45-1) consists of the Pongola River and tributaries downstream of the Pongolo Dam to the confluence with the Usutu River excluding the Ngavuma Tributaries. The RU is in a C condition and is characterised by the Pongola Floodplain (Makatini Flats) and pans. The river is characterised by the significant changes in flow regime – specifically associated with the change in the flooding regime which is important for the floodplain. The lower Pongola River falls within the Ndumo Game Reserve. However, encroachment of people to the Pongola River within the Game Reserve has resulted in a decrease of the surface area of the Ndumo Game Reserve.

e) W43 Tertiary Catchment (Ngavuma River)

This RU (W43-1) is in a C condition and dominated by non-flow related impacts. These impacts are subsistence farming, overgrazing, some forestry and sedimentation. In the Msunduzi Tributary,

there has been total alteration of the seasonal drainage lines by agricultural activities resulting in this part of the RU being in a D/E condition.

Table 8.7 PES for W4 Secondary Catchment

RU	River Name	PES RU value	PES RU EC	Primary PES Driver
W41-1	Bivane	2.00	C	Non-flow, flow
W41-2	Manzana	1.05	B	Non-flow
W41-3	Bivane	2.00	C	Flow
W42-1	Phongolo	2.07	C	Flow, WQ, Non-flow
W42-2	Phongolo	1.92	C	Flow, WQ, Non-flow
W42-3	Phongolo	1.00	B	Flow, WQ, Non-flow
W42-4	Mozana	1.00	B	Flow, WQ, Non-flow
W42-5	Phongolo	1.00	B	Flow, Non-flow
W43-1	Ngwavuma	1.89	C	Flow, WQ, Non-flow
W44-1	Phongolo	2.95	D	Flow, WQ, Non-flow
W45-1	Phongolo	1.81	C	Flow, WQ, Non-flow

8.3.5 W5 Catchment (Main River: Usutu - excluding Eswatini)

The PES results per RU are provided in **Table 8.8**. An indication of whether the source of the primary impact drivers is flow, non-flow related and/or water quality impacts is also provided in the last column.

a) W51 Tertiary Catchment (Assegaai River)

The Assegaai River upstream of Heyshope Dam (W51-1) is in a C/D EC due to forestry, irrigation and some decanting of coal mines. Downstream of Heyshope Dam (W51C) the river is in a C EC (although an E immediately downstream of the dam) largely due to flow changes, extensive forestry, alien vegetation, and irrigation. The river improves further downstream (W51-3) to a B/C with similar impacts as the upstream RU. The RU 51-4 (Blesbokspruit tributary to the Assegaai River) is in a C condition. The impacts are flow and non-flow related with extensive forestry, instream dams, sand mining and a wood treatment plant.

b) W52 Tertiary Catchment (Hlelo River)

This tertiary catchment consists of one RU (RU W52-1). The status is in a B/C condition with non-flow and flow related impacts such as forestry, mining, grazing and instream dams dominating.

c) W53 Tertiary Catchment (Ngwempisi River)

RU W53-1, upstream of Morgenstond Dam, is in a D condition due to instream dams, extensive forestry, and the draining of large wetlands. The Mpama tributary upstream from Jericho Dan (RU W53-2) is in a B/C condition due to instream dams, forestry, wetland draining and channel straightening. The RU downstream of the dams (RU W53-3) is in a C condition due mostly to flow related impacts. The impacts are from the upstream dams and then some non-flow related impacts due to forestry, alien vegetation and wetland drainage.

d) W54 Tertiary Catchment (Usutu River)

The RU upstream of Westoe Dam (RU 54-1) is in a varied condition but dominated by a long stretch of the Usutu River which is in a B condition. Impacts are mostly forestry small dams, and impacts on wetlands. Below Westoe Dam (RU 54-2) the condition is in a C EC with impacts associated with the changes in the flow regime from Westoe Dam, forestry, dams in tributaries, and urban areas (Lothair).

e) W55 Tertiary Catchment (Mpuluzi River)

The RU W55-1 (Mpuluzi River and tributaries) is in a B/C condition with impacts largely being flow related due to small dams and forestry. RU 55-2 (Lusushwana River) is in a C condition mostly due to non-flow related impacts such as forestry. There are also instream dams, cattle grazing, sedimentation and erosion due to subsistence farming.

f) W57 Tertiary Catchment (lower Usutu River)

The lower Usutu River (W57-1) forms the border of South Africa with Eswatini and Mozambique. Large section of this RU forms the border of the Ndumo Game Reserve. Due to the impacts on the left bank in the neighbouring countries, as well as the significant impacts in changes in the flow regime upstream of this RU, the RU is in a B/C condition.

Table 8.8 PES for W5 Secondary Catchment

RU number	River Name	PES RU value	PES RU EC	Primary driver
W51-1	Assegaai	2.30	C/D	Flow, Non-flow, WQ
W51-2	Assegaai	2.00	C	Flow, Non-flow
W51-3	Assegaai	1.50	B/C	Flow, Non-flow, WQ
W51-4	Blesbokspruit	1.92	C	Flow, Non-flow
W52-1	Hlelo	1.50	B/C	Non-flow, Flow
W53-1	Ngwempisi	3.00	D	Flow, Non-flow
W53-2	Mpama	1.50	B/C	Flow, Non-flow
W53-3	Ngwempisi	1.83	C	Flow, Non-flow, WQ
W54-1	uSuthu	1.25	B	Flow, Non-flow, WQ
W54-2	uSuthu	1.88	C	Flow
W55-1	Mpuluzi	1.50	B/C	Flow, WQ, Non-flow
W55-2	Lusushwana	2.13	C	Non-flow, WQ, Flow
W57-1	uSuthu	1.50	B/C	Flow

8.3.6 W7 Catchment (Kosi Estuary and Sibaya Lake)

The PES results per RU are provided in **Table 8.9**. An indication of whether the source of the primary impact drivers is flow, non-flow related and/or water quality impacts is also provided in the last column.

a) Sibaya Lake

This short river feeding into Sibaya Lake is in a D condition associated with water quality issues from the townships and hospital with other non-flow related impacts.

b) Kosi Bay Lakes

Two rivers feed into the lakes forming part of two RUs. RU 70-1 is in a B condition as it is largely within the iSimangaliso wetland Park. RU 70-2 is in a C condition due the presence of urban areas, a WWTW that is not functioning and small forestry areas.

Table 8.9 PES for W7 Secondary Catchment

RU	River Name	PES RU value	PES RU EC	Primary Driver
W70-1	Swamanzi	3.0	D	Non-flow, WQ
W70-2	Malangeni	1.3	B	Flow, Non-flow
W70-3	?	3.0	D	Non-flow, WQ

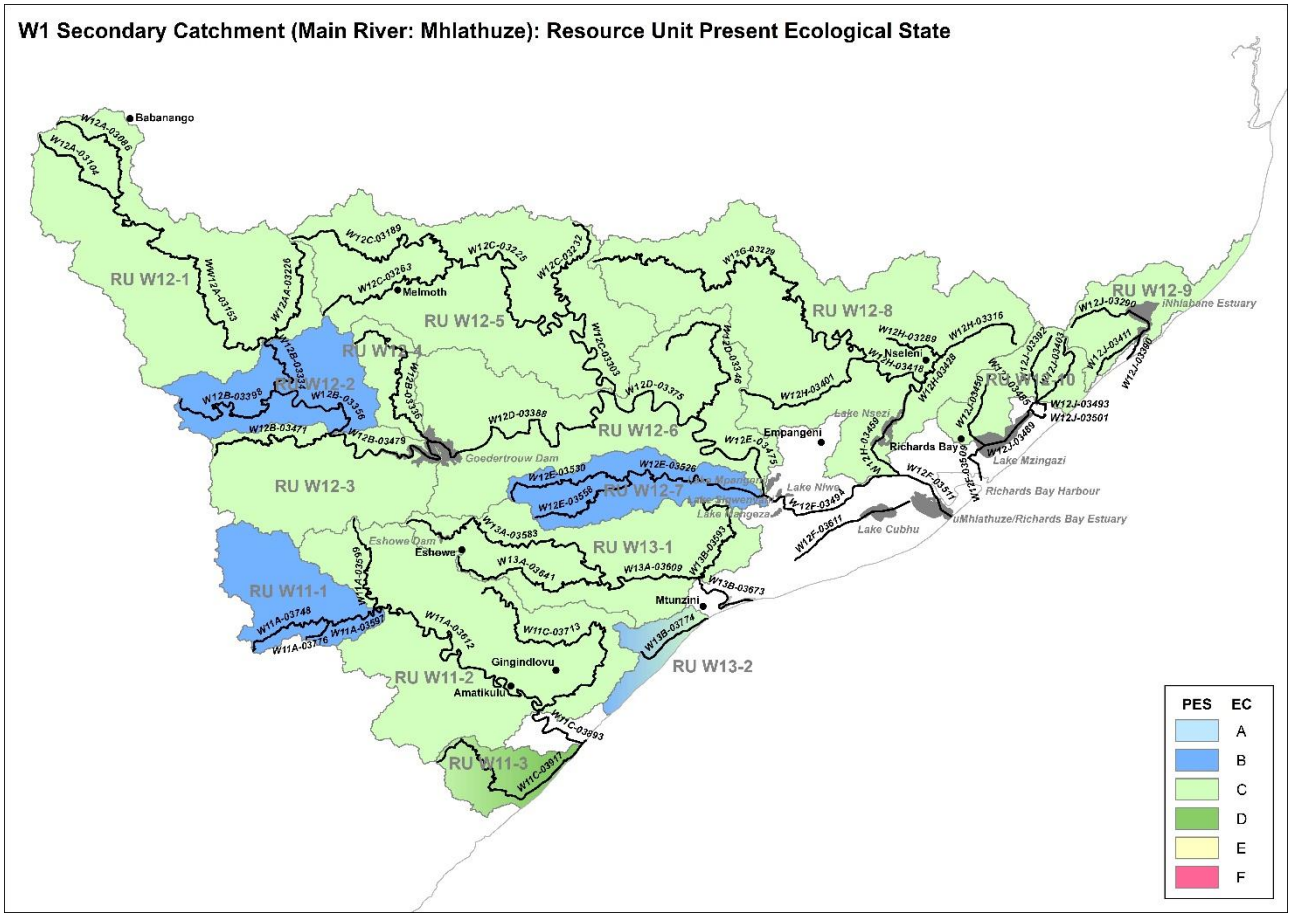


Figure 8.3 W1 RUs illustrating PES

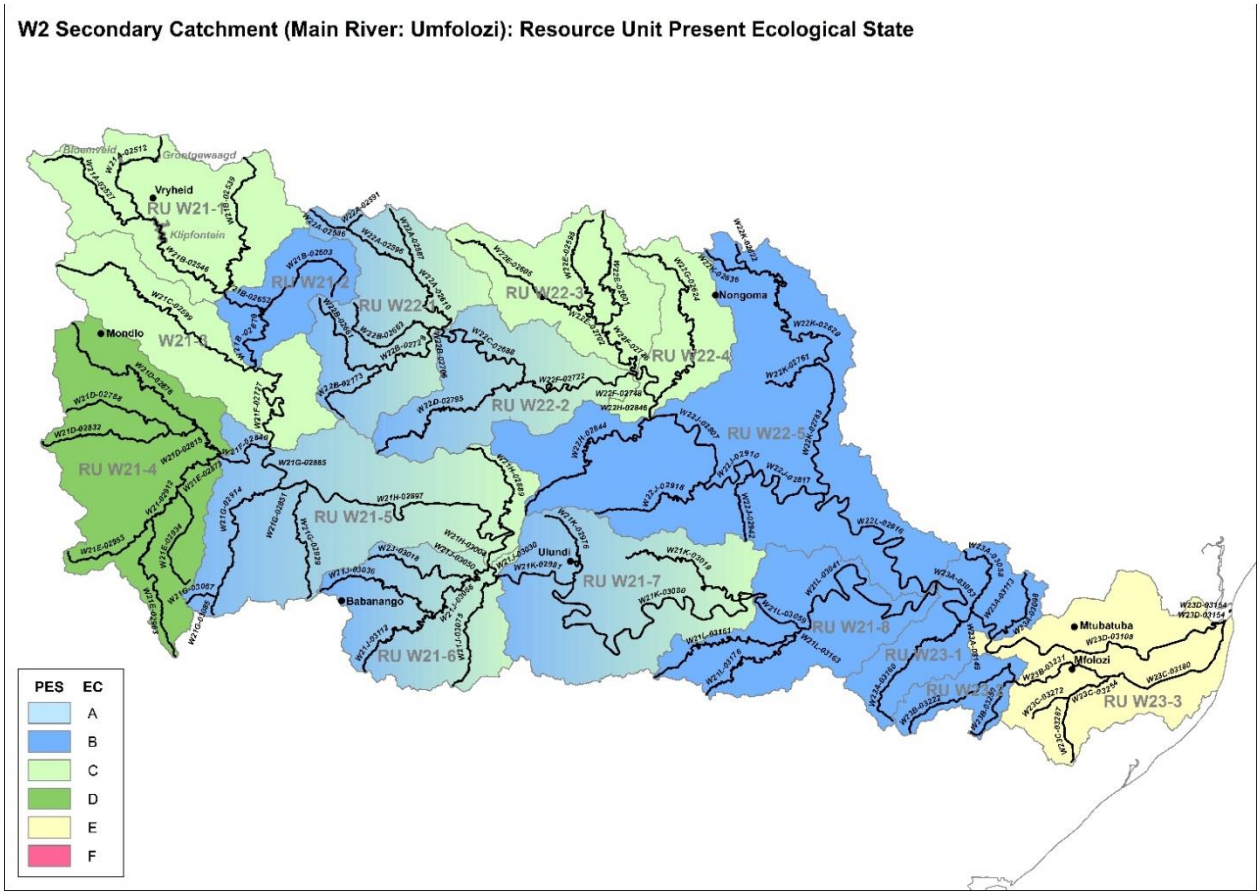


Figure 8.4 W2 RUs illustrating PES

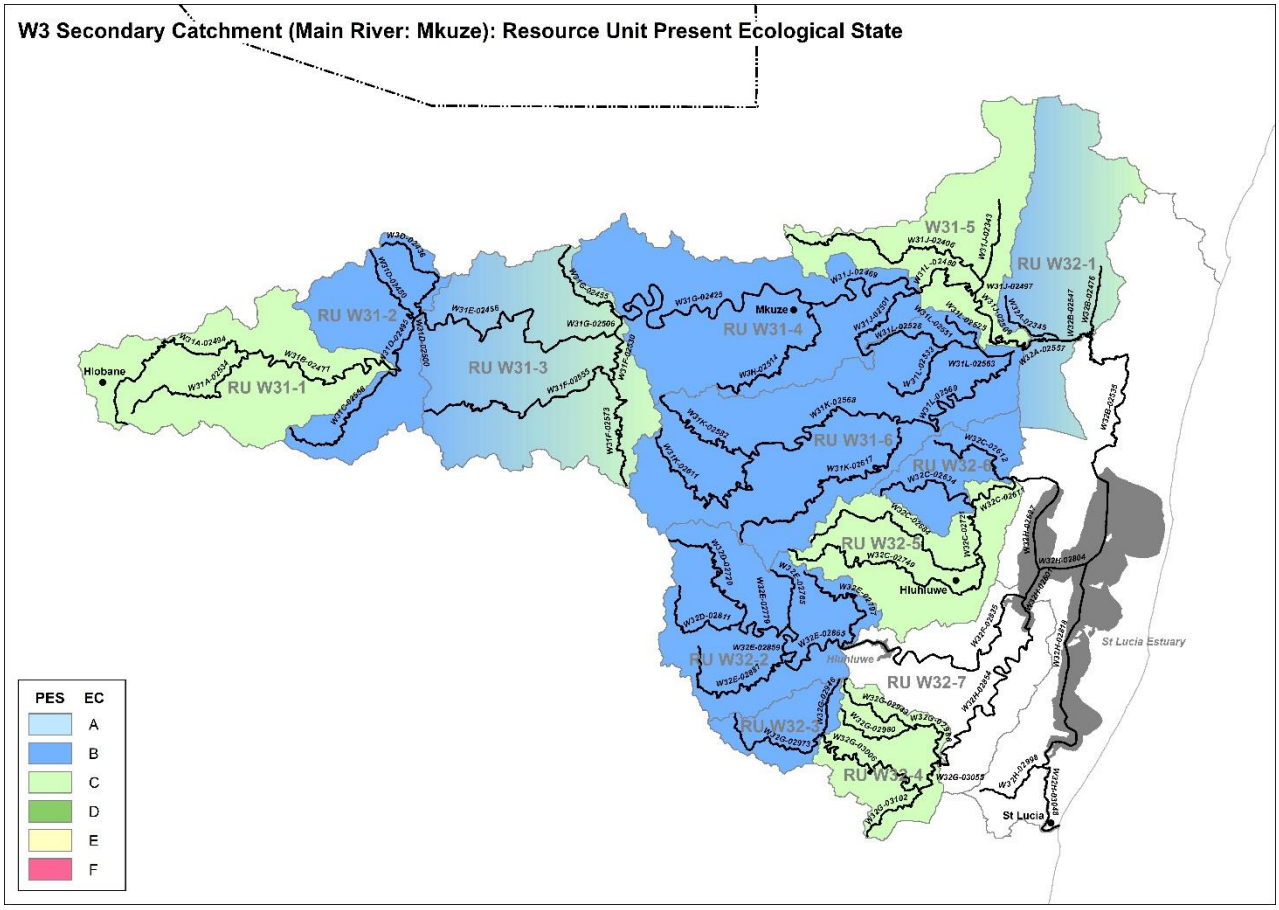


Figure 8.5 W3 RUs illustrating PES

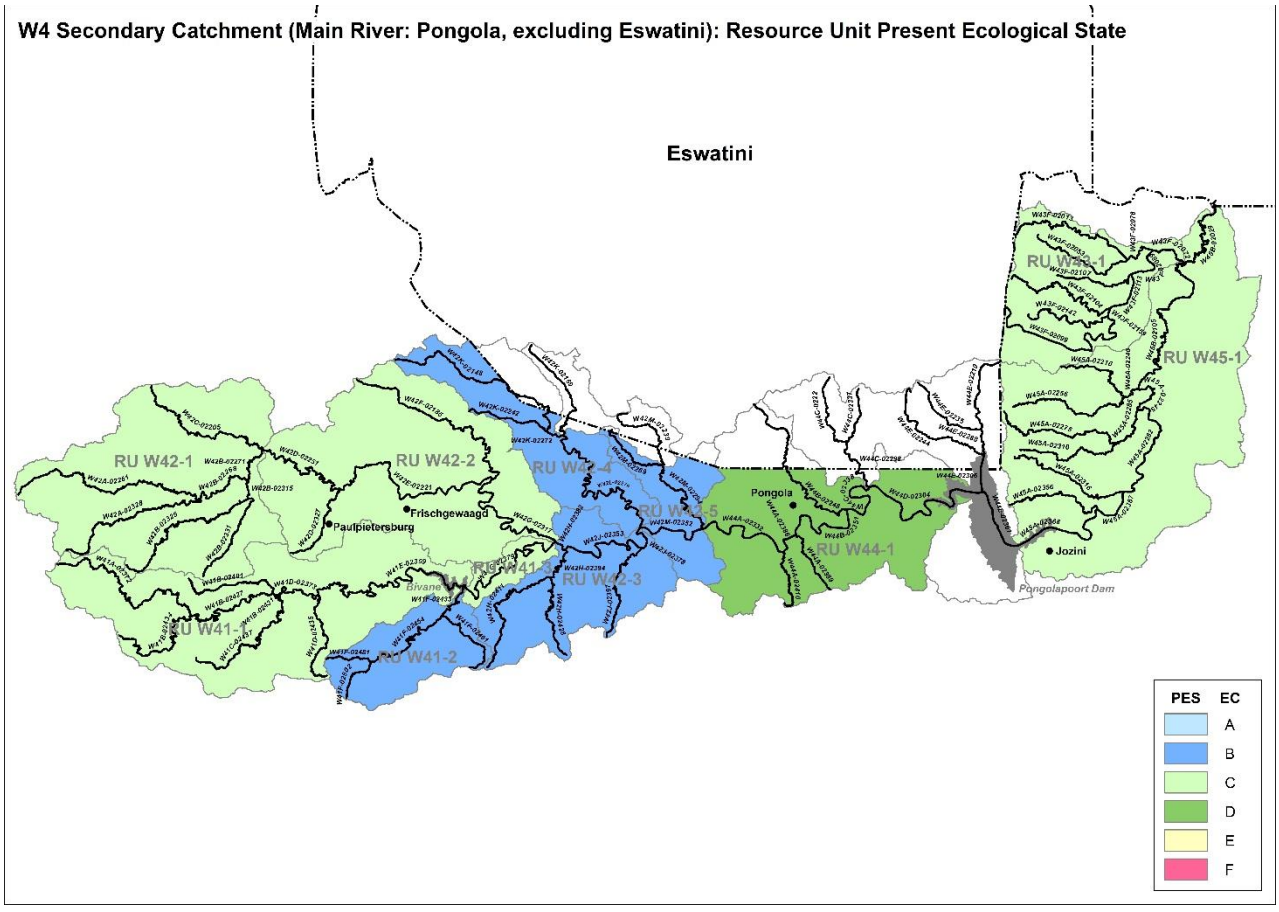


Figure 8.6 W4 RUs illustrating PES

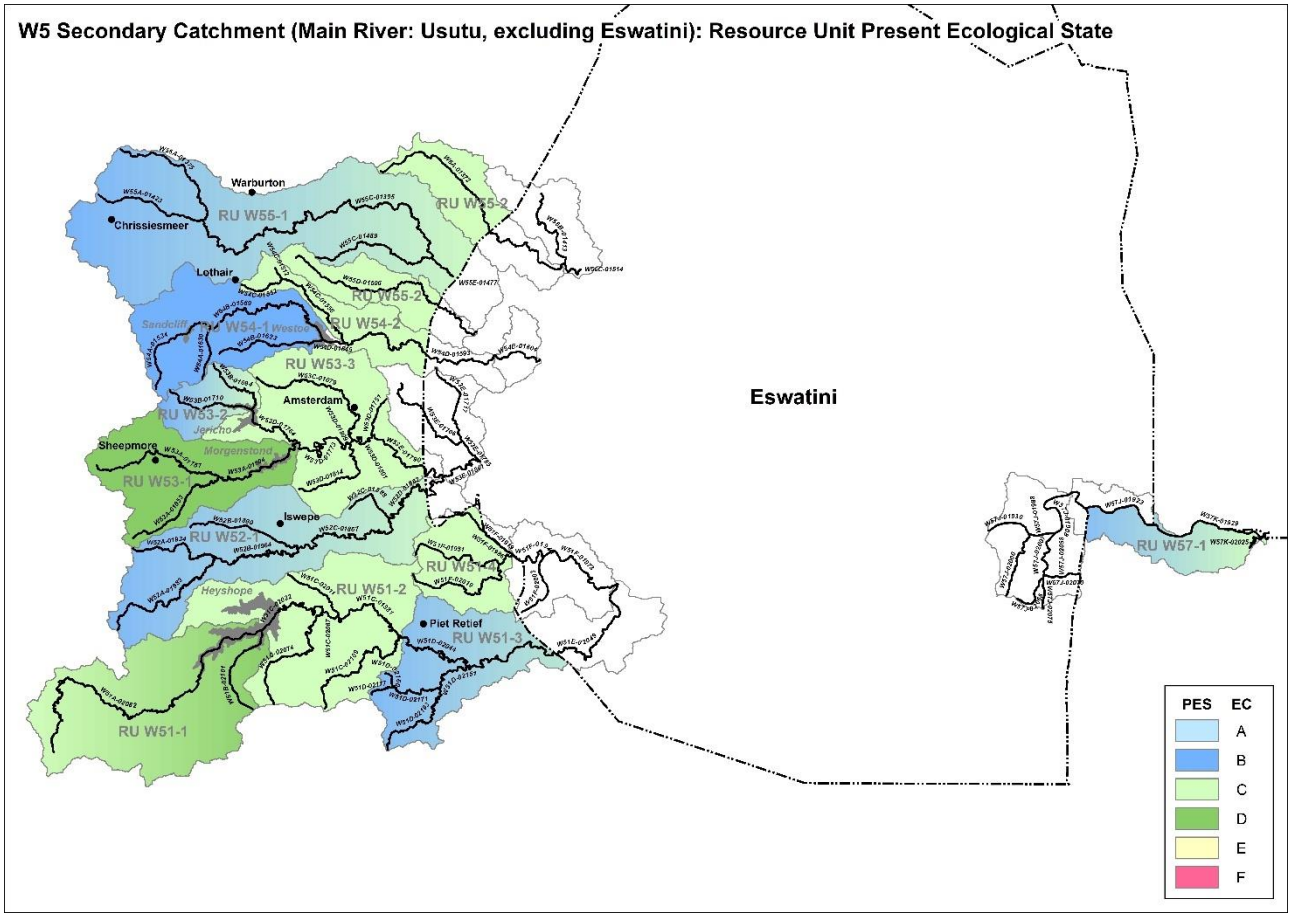


Figure 8.7 W5 RUs illustrating PES

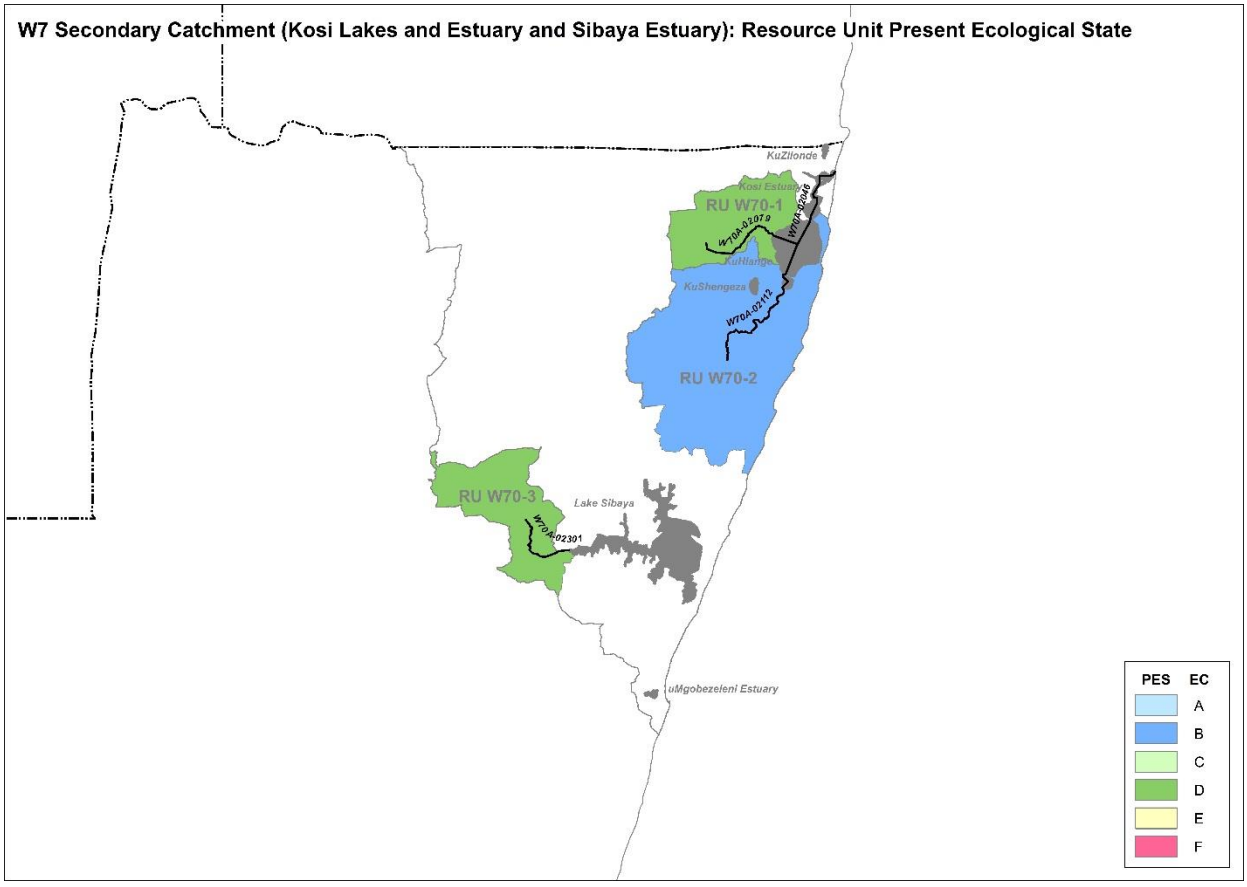


Figure 8.8 W7 RUs illustrating PES

9 STATUS QUO ASSESSMENT: WETLAND ECOLOGICAL STATE

9.1 INTRODUCTION AND APPROACH

The objective of this chapter is to provide a description of the status quo of wetlands within the study area, including wetland distribution and general condition of wetlands and wetland types. The status quo description provides information at a broad scale to inform the delineation and prioritisation of IUAs and RUs. Specific actions included:

- Identifying the spatial distribution of wetlands: The identification was primarily based on wetland data from the National Biodiversity Assessment in 2018 (van Deventer *et al.*, 2018), the National Freshwater Ecosystem Priority Area (NFEPA) spatial and metadata (Nel *et al.*, 2011), and the National Spatial Biodiversity Assessment (NSBA; Driver *et al.*, 2005).
- Typing of wetlands from level 4 wetland classification (Ollis *et al.*, 2013) into Hydrogeomorphic (HGM) units derived from the new wetland map (van Deventer *et al.*, 2018).
- Identifying the spatial distribution of wetland Freshwater Ecosystem Priority Areas (FEPAs) and NFEPA wetland clusters (derived from metadata within the NFEPA wetland map (Nel *et al.*, 2011).
- Outlining an overview of wetland extent (expressed as Hectares of delineated wetlands) within different catchments (wetland area data were extracted from the new wetland map: van Deventer *et al.*, 2018).
- Applying the riparian and wetland metrics from the DWS PES/EI/ES project (DWS, 2014a) to the quinary catchments within this study area, as a surrogate of wetland integrity / condition within catchments.
- Identifying the spatial distribution of named wetlands, oxbows, springs and thermal springs within the study area. Data were extracted from the NSBA database housed by the South African Inventory of Inland Aquatic Ecosystems (SAIIAE) that informs the new national wetland map (Driver *et al.*, 2005).

9.2 GENERAL OVERVIEW

South Africa's wetlands were defined into 26 different wetland regions by Cowan (1995). The basis of the distinction between types is topography, hydrology and nutrient regimes. Based on geomorphology and climate the 26 different wetland regions can broadly be classified into the following four groups:

- Plateau wetlands
- Mountain wetlands
- Coastal slopes and rimland wetlands and
- Coastal plains.

Within each of these groups are various subdivisions based on differences in geology. Each wetland group has characteristic wetland types. A total of five Ecoregions within two of the main groupings (Coastal slopes and Coastal Plain) fall within the study area (**Table 9-1**).

Table 9.1 Wetland regions described by Cowan (1995), typical wetlands found in the regions and well known wetlands in some of the regions (from DWA, 2014a)

Region	Typical wetlands	Examples within the Study Area
Coastal slopes and rimland		
East coastal slope, Drakensberg region	Grass and restio marshes and reed swamps.	Stilwater Vlei (Vryheid).
East coast, subtropical region	Lagoons, reeds marshes, swamp forest and mangrove swamps.	Umfolozi floodplain.
Northern Escarpment Lowveld region	Diverse, pans and grassland Vleis.	Lake Chrissie (Mpumalanga Province).
Lowveld., Lowveld region	Rivers with distinctive riparian communities.	Usutu floodplain just before Pongola floodplain confluence.
Coastal Plain		
Coastal plain, subtropical	Floodplains, swam forest, coastal lakes and coral reefs.	Lake St. Lucia, Lake Sibaya and Kosi system.

According to the latest national wetland map (National Biodiversity Assessment; van Deventer *et al.*, 2018) there are almost 1.5 million Ha of wetlands in the study area if estuaries are included in the analysis and 371 603 Ha if they are excluded. The distribution of different wetland types (HGMs – hydro-geomorphic units, Level 4 classification from Ollis *et al.*, 2013) is shown in **Figure 9.1**. This includes five RAMSAR sites, the St Lucia System, Lake Sibaya, Kosi Bay, Ndumo Game Reserve and the Turtle Beaches / Coral Reefs of Tongaland. A more detailed breakdown of wetland distribution and extent within each of the secondary catchments is shown in **Table 9.1**. It is clear the Mkuze (W3) secondary catchment has the highest extent of wetlands (67% of wetland hectarage in the study area) but that this is dominated by estuarine ecosystems. If estuaries are eliminated from the analysis then the Pongola (W4) secondary catchment is the highest representing 30% of wetland hectarage (**Table 9.2**), and the (W1) and Mkuzu (W3) the lowest. The study area is also diverse in terms of wetland types and while riverine wetlands dominate with 104038 Ha (excluding estuaries), all other HGMs are well represented (**Table 9.3**).

The NBA focused on the terrestrial, freshwater and marine components of biodiversity and its aim was to assess where our important biodiversity is, how much we should conserve, and whether the current system of protected areas in the country is adequate. The freshwater assessment identified diversity of river systems in the country amongst other outcomes and also identified and named notable wetlands, the details of which are shown in **Appendix C**, and the distribution of springs, thermal springs, oxbows and waterfalls. Within the study area is shown in **Figure 9.2** and the details pertaining to thermal springs in **Table 9.4**. There is also a notable peatland pan called Vazi Pan in Maputaland near the town of Manguzi which was assessed by Grundling *et al.* (2017). This study also assessed several other peatland wetlands (not within this study area) but importantly found that peatlands in South Africa are mostly groundwater-dependent ecosystems with isotope analysis and water flow measurement results supporting the fact that groundwater is the main driver.

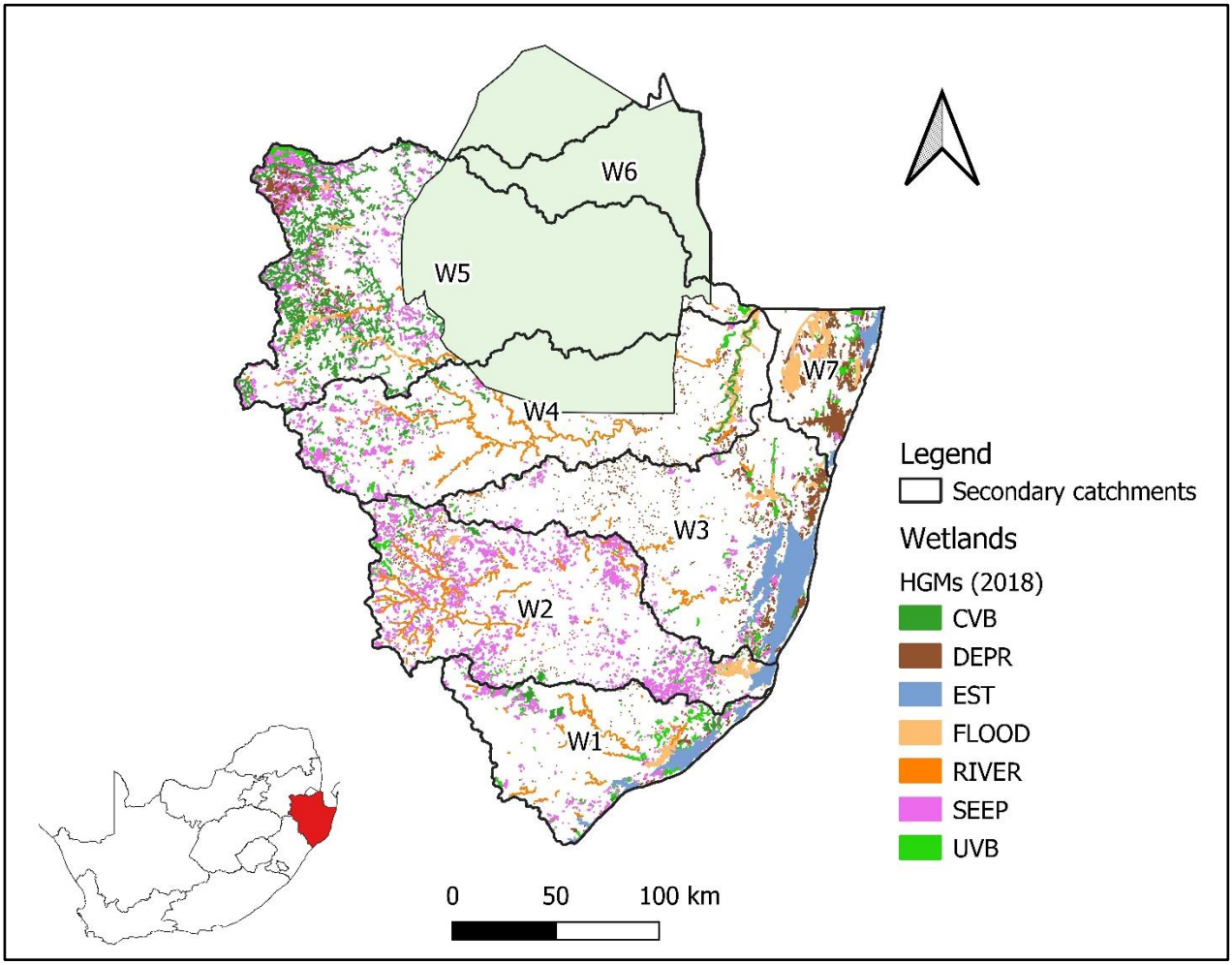


Figure 9.1 Wetlands within the study area showing distribution of different HGMs (2018 updated wetland map 5; van Deventer *et al.*, 2018) and secondary catchments

Table 9.2 HGM wetland area (Ha) within each secondary catchment (analysis from NWM5, 2018 data), including estuaries

Secondary Catchment	Main River	Channeled Valley Bottom	Unchanneled Valley Bottom	Depression	Floodplain	Riverine	Seep	Estuarine	Total (Ha)	Total (% of Wetlands in the Study Area
W1	Mhlathuze	851	3078	949	6705	3882	4490	103972	123926	8
W2	Umfolozi	1399	1764	672	3897	32299	26072	23635	89738	6
W3	Mkuze	706	2722	9484	11844	3501	4689	976435	1009382	67
W4	Pongola	20759	3842	433	17660	61752	8626		113072	8
W5	Usutu	33081	3404	11266	12934	2605	16814		80104	5
W7	Sibaya and Kosi	184	2878	33191	21991		1181	22799	82224	5
Total		**56980**	**17688**	**55995**	**75030**	**104038**	**61873**	**1126842**	**1498445**	**100**

Table 9.3 HGM wetland area (Ha) within each secondary catchment excluding estuaries (analysis from NWM5, 2018 data)

Secondary Catchment	Main River	Channeled Valley Bottom	Unchanneled Valley Bottom	Depression	Floodplain	Riverine	Seep	Total (Ha)	Total (% of Wetlands in the Study Area
W1	Mhlathuze	851	3078	949	6705	3882	4490	19953	5
W2	Umfolozi	1399	1764	672	3897	32299	26072	66103	18
W3	Mkuze	706	2722	9484	11844	3501	4689	32947	9
W4	Pongola	20759	3842	433	17660	61752	8626	113072	30
W5	Usutu	33081	3404	11266	12934	2605	16814	80104	22
W7	Sibaya and Kosi	184	2878	33191	21991		1181	59425	16
Total		**56980**	**17688**	**55995**	**75030**	**104038**	**61873**	**371603**	**100**

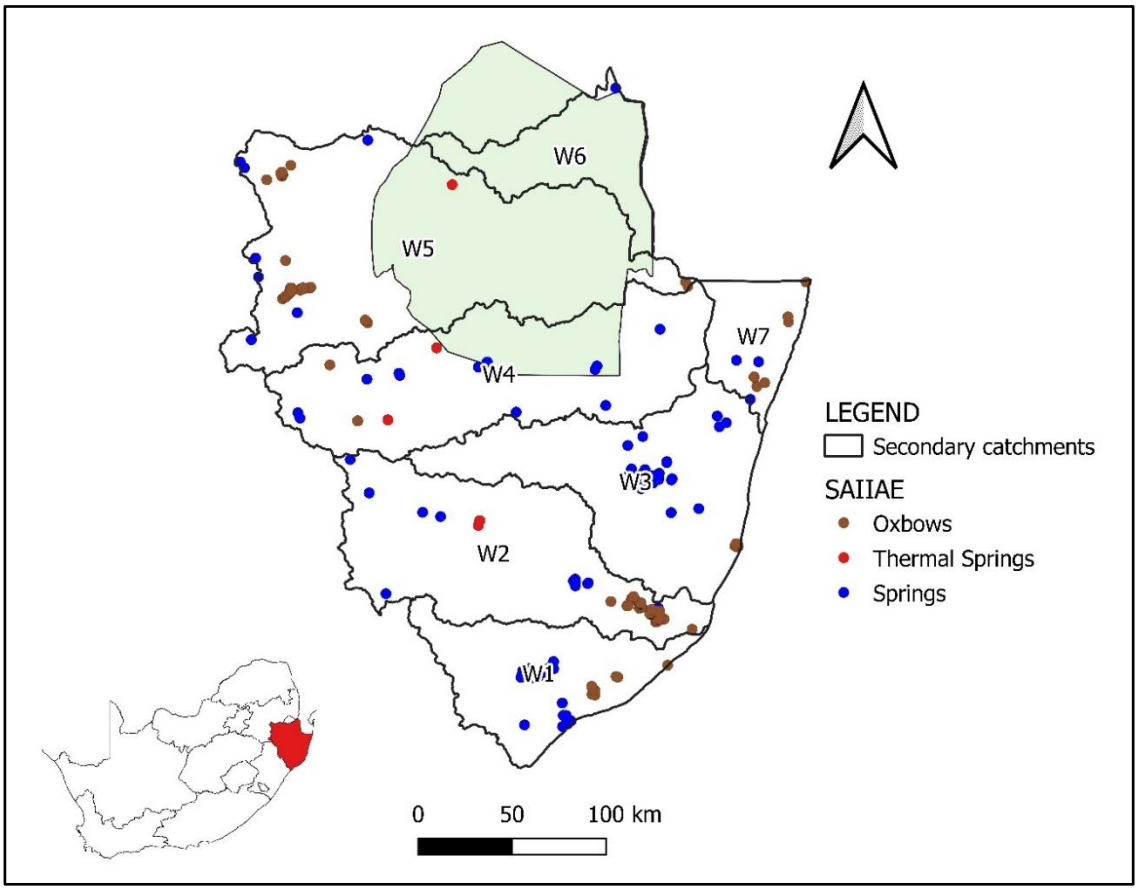


Figure 9.2 The spatial distribution of spring, oxbows and thermal springs in the study area (data from the NSBA, Driver *et al.*, 2005)

Table 9.4 Details of thermal spring in the study area (data from the NSBA, Driver *et al.*, 2005)

SQR	Secondary	Thermal Spring Name	Year	Latitude	Longitude
W41-1	Pongola (W4)	Natal Spa	2008	-27.529	30.867
W42-4	Pongola (W4)	Swaelfontein (Sulpher Spring)	1949	-27.183	31.100
W22-2	Umfolozi (W2)	Swart Umfolozi open	1949	-28.033	31.300
Eswatini	Usutu (W5)	Swazi Spa	2008	-26.402	31.175
W22-2	Umfolozi (W2)	Thangami (enclosed) Black Umfolosi	2008	-28.011	31.308

SQR	Secondary	Thermal Spring Name	Year	Latitude	Longitude
W22-2	Umfolozi (W2)	Thangami (open)	2008	-28.010	31.307

The NFEPA Project was finalised in 2011, and was a multi-partner project between CSIR, South African National Biodiversity Institute (SANBI), Water Research Commission (WRC), Department of Water Affairs (DWA), Department of Environmental Affairs (DEA), Worldwide Fund for Nature (WWF), South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). The NFEPA project's aims were to:

1. Identify FEPAs to meet national biodiversity goals for freshwater ecosystems; and
2. Develop a basis for enabling effective implementation of measures to protect FEPAs, including free-flowing rivers.

As such, a number of Wetland FEPAs were delineated within the current study area (**Figure 9.3**). Wetland FEPAs are defined priority areas that do not overlap with river FEPAs and their associated sub-quaternary catchments, the final selection of which was reviewed at a NFEPA National Stakeholder Review Workshop, July 2010.

The wetland FEPAs shown in **Figure 9.3** can be broadly summarised into several main areas:

- The Indian Ocean coastal plain area known as Maputaland from the lower Umfolozi River wetlands (Mfolozi swamp) extending through north-eastern KwaZulu-Natal including St Lucia estuary, Mkuzu floodplain and swamp system, Lake Sibaya, the Vazi Pan peatlands (deep peats) and Kosi Bay and the surrounding Muzi swamps. The ecological diversity, pristine beauty and conservation value of this area is encapsulated in the UNESCO World Heritage Site status of the iSimangaliso (Greater St Lucia) Wetland Park and adjacent coastal plain.
- The Pongolo floodplain downstream of Jozini Dam including several pans and the wetlands within and surrounding the Ndumo Game Reserve, a designated Ramsar site with international recognition and importance.
- The dense network of depressional and seep wetlands and channelled valley bottoms around the vicinity of Chrissiesmeer town.
- Drainage catchment wetlands upstream of Heyshope Dam.
- The dense network of seepage wetlands in the greater Vryheid vicinity.

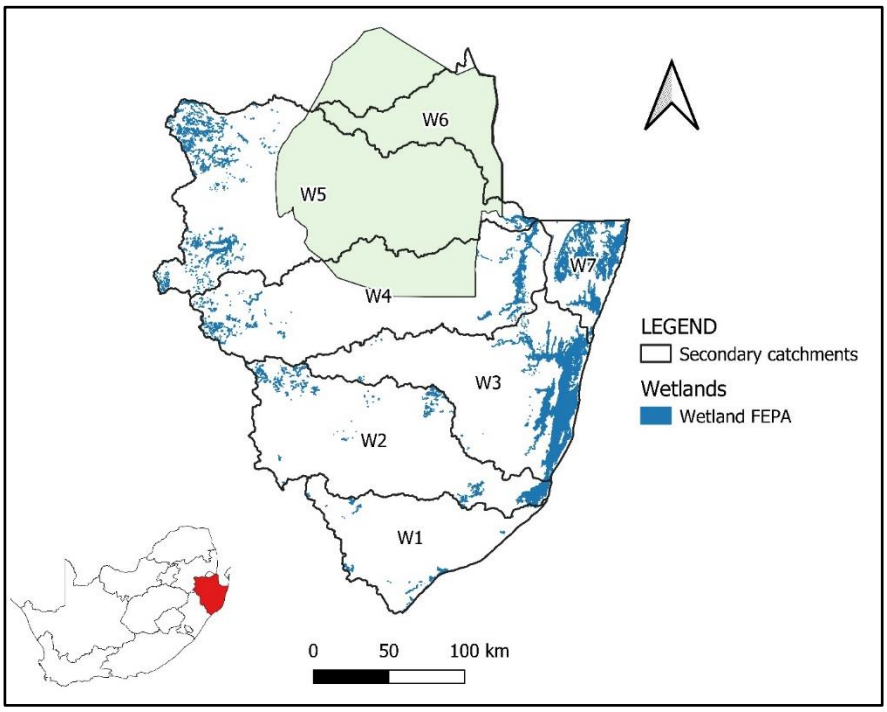


Figure 9.3 The spatial distribution of Wetland FEPAs in the study area (data from NFEPA, Nel *et al.*, 2011).

The NFEPA project also identified and delineated NFEPA wetland clusters, a number of which occur within the current study area (**Figure 9.4**Figure 9.3). NFEPA clusters are groups of wetlands within 1 km of each other and embedded in a relatively natural landscape. The purpose of their delineation was to derive significant clusters of wetlands embedded in a relatively natural landscape matrix through which dispersal between wetlands can occur (e.g. amphibians and invertebrates). This allows for important ecological processes such as migration of birds, amphibians and insects between wetlands. A goal of NFEPA is to ensure that at least 20% of the wetland cluster area identified for each wetland vegetation group is managed in a way that supports dispersal between wetlands within the cluster, ideally a natural or near-natural condition. Wetland clusters focus on maintaining lateral connections in the landscape matrix. As such, only non-riverine wetlands were used to identify wetland clusters (channelled valley-bottom wetlands, floodplain wetlands and valleyhead seeps were excluded in the cluster identification process). Unchannelled valley-bottom wetlands were treated as non-riverine wetlands. The distribution of NFEPA wetland clusters in the study area coincides well with that of the wetland FEPAs but is more limited in extent (**Figure 9.4**).

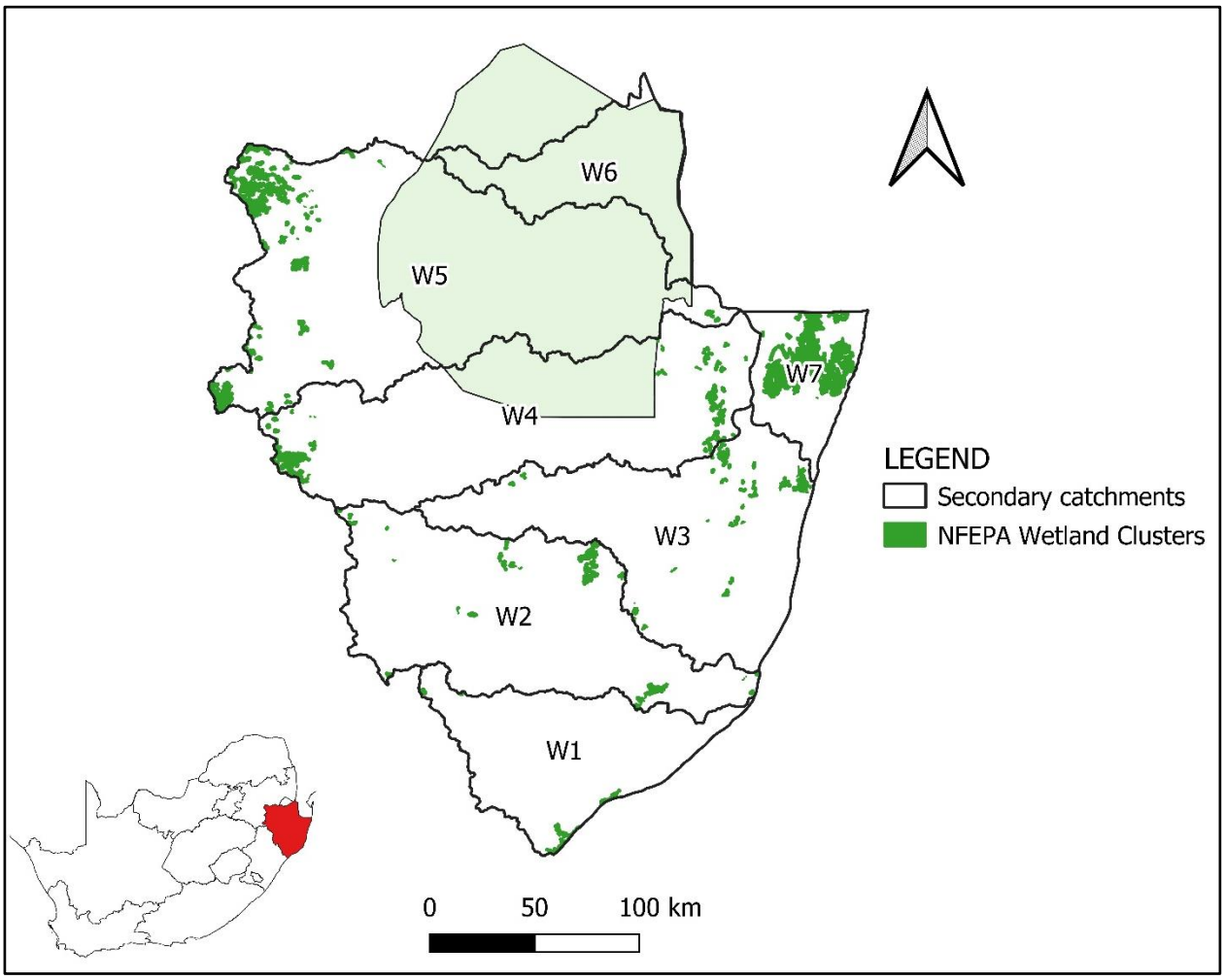


Figure 9.4 The spatial distribution of NFEPA Wetland Clusters in the study area (data from NFEPA, Nel *et al.*, 2011)

Both the NFEPA project and the National Biodiversity Assessment produced an estimation of wetland condition and the final ecological condition of inland wetlands modelled from ancillary data (using mainly land use within variously defined buffer zones around wetlands) is shown in **Figure 9.5** using the updated 2018 metadata (van Deventer *et al.*, 2018), where the dominant condition (A/B, C or D/E/F) is indicated. The majority of the wetlands within the study area have a condition status of D/E/F. Together with wetland condition, the Ecosystem Threat Status (ETS) was also calculated and similarly an overwhelming proportion of wetlands in the study area have a threat status of CR (Critically Endangered) or EN (Endangered; **Figure 9.6**).

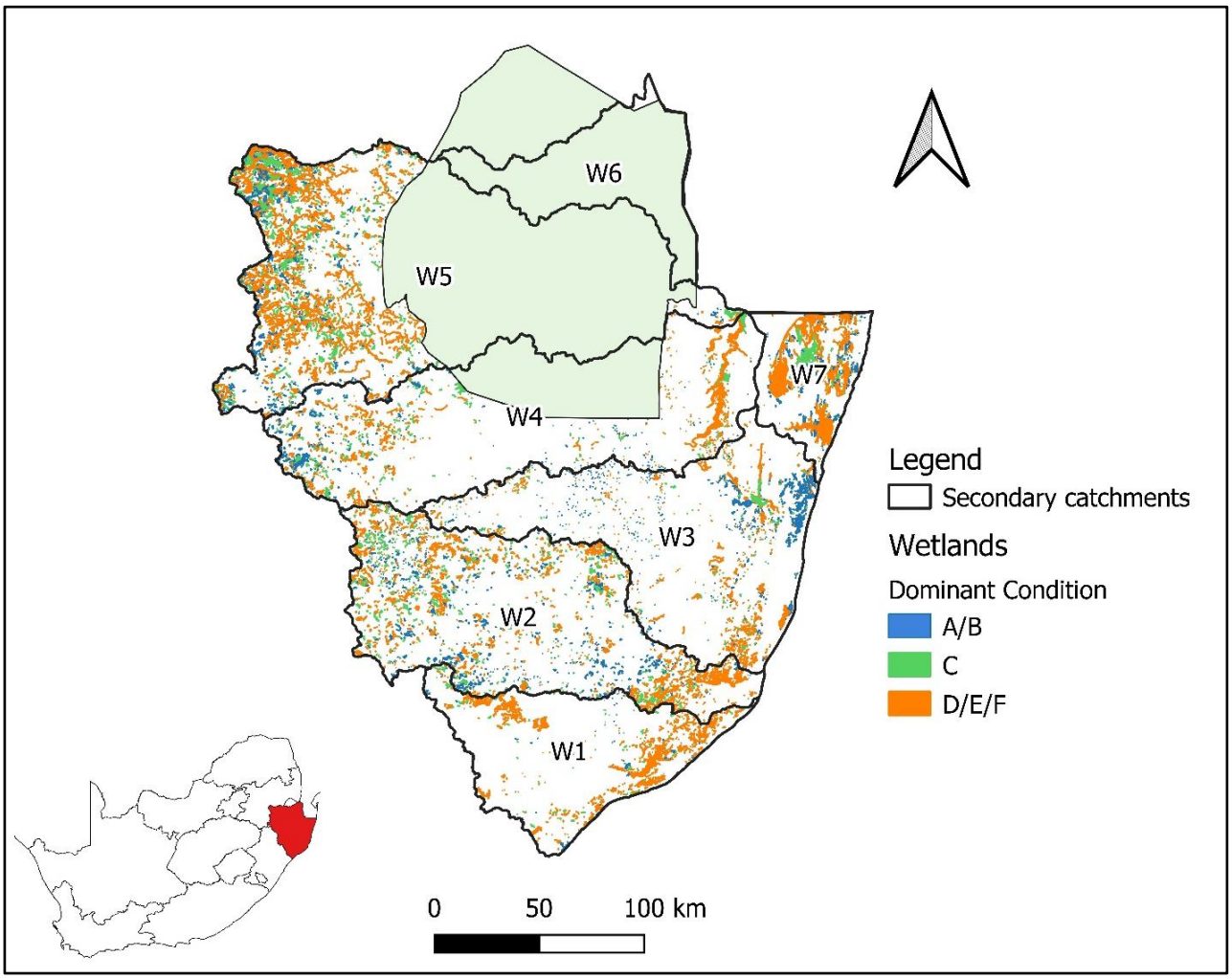


Figure 9.5 Dominant wetland condition within the study area (2018 updated wetland map 5; van Deventer *et al.*, 2018)

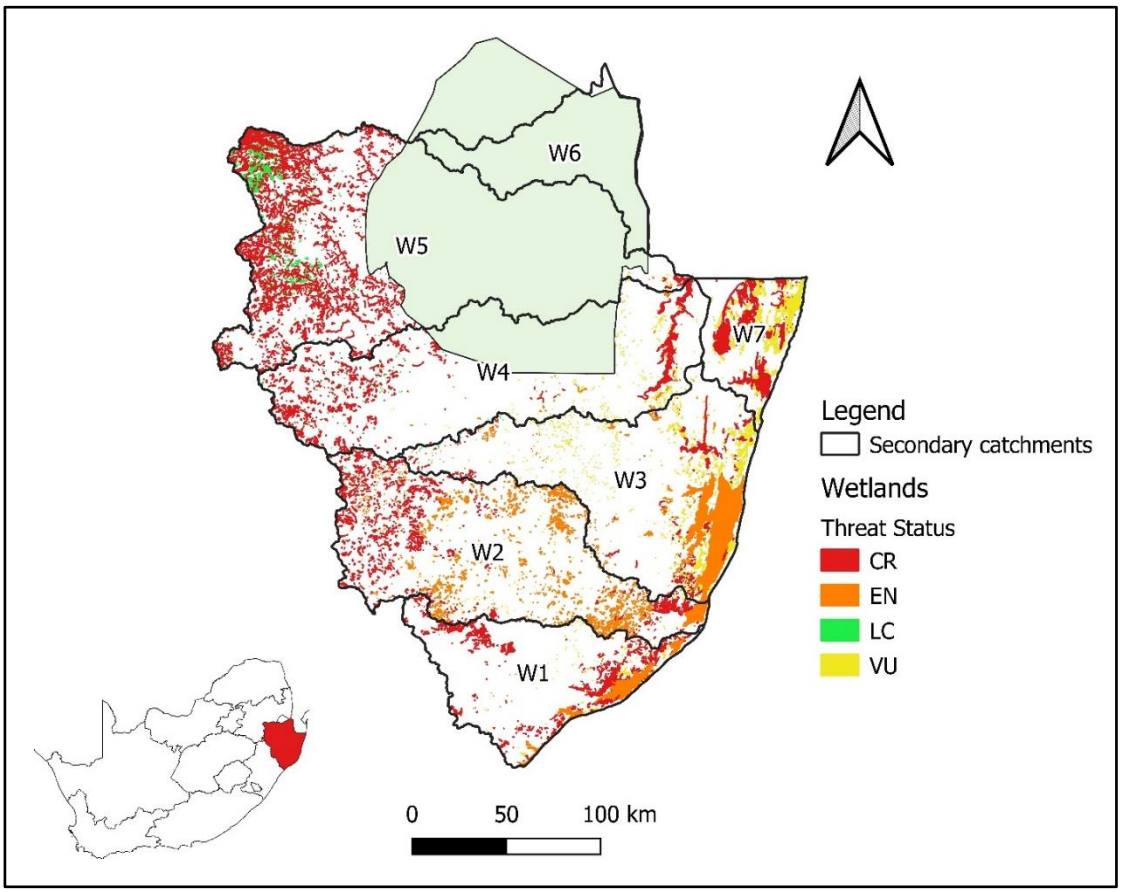


Figure 9.6 Dominant threat status of wetlands within the study area (2018 updated wetland map 5; van Deventer *et al.*, 2018)

Within the PES/EI/ES data (DWS, 2014a) two of the metrics relate to riparian and wetland ecosystems within each respective quinary catchment, the riparian/wetland zone continuity modification and the riparian/wetland zone modification. These metrics were rated on a scale of 0 to 4 (where 0 is natural, akin to a category A, and 4 is poor/compromised, akin to a category F). The summary results for this study area are shown in **Table 9.5** at secondary catchment scale. From these data it appears that most riparian zones / wetlands are moderately modified (C) and that continuity within and between systems is less impacted than internal ecological condition.

Table 9.5 Summary of PES/EI/ES riparian/wetland ratings (DWS, 2014a). Ratings are 0 to 4, where 0 is natural (akin to category A) and 4 is poor (akin to category F)

Riparian / Wetland Zone Continuity Modification										
Secondary Catchment	**Ratings**									**Total**
	0	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	
W1			11	1	27		10			49
W2			38	4	31	1	12		6	92
W3		3	19	7	24	2	6			61
W4			16	1	33	2	17	1	1	72
W5	4		26	5	14	2	5	1		57
W7				1					2	3
Total	**4**	**3**	**110**	**19**	**129**	**7**	**50**	**2**	**9**	**334**
Riparian / Wetland Zone Modification										
W1			11		22		11		5	49
W2			24	7	36	2	16		7	92
W3		3	22	4	19	1	11		1	61
W4			8	5	31	3	20	1	3	72
W5	3		9	9	23	5	8			57
W7					1				2	3
Total	**3**	**3**	**74**	**25**	**132**	**11**	**66**	**1**	**18**	**334**

Ramsar Wetlands within the Study Area

The Convention on Wetlands of International Importance was adopted in the Iranian city of Ramsar in 1971 and is generally known as the Ramsar Convention. It is an intergovernmental treaty that provides a recognised framework for national action and international cooperation in the conservation and wise use of wetlands and the natural resources associated with them (Ramsar 2010). One of the fundamental concepts of the Ramsar convention is Wise Use, which is defined as "the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development". Ramsar sites are therefore designated as high priority wetlands in this study in which five Ramsar sites are present, and include the St Lucia System, Lake Sibaya, Kosi Bay, Ndumo Game Reserve and the Turtle Beaches / Coral Reefs of Tongaland. The St Lucia System and Kosi Bay are designated estuaries and will be dealt with in that chapter, while the Turtle Beaches and Coral Reefs are marine wetlands and will not be dealt with in this project which focusses on freshwater ecosystems. The following are descriptions of the remaining Ramsar sites, extracted from the Ramsar fact-sheets available on the Ramsar website (Ramsar, 2010; https://www.ramsar.org):

Lake Sibaya

Ramsar Site number: 528
Area: 7,750 ha
Designation date: 28-06-1991
Location: Kwazulu-Natal Province, South Africa
Coordinates: 27°20'S 32°40'E
Status/Type: World Heritage Site.
Ramsar information sheet available here.

Description: The largest natural freshwater lake in South Africa, separated from the ocean by forested dunes; includes areas of swamp forest and wet grassland. A large variety of endangered or endemic species of reptiles, fish, birds, mammals and plants occur. The site is important for numerous species of breeding birds and supports the second largest population of hippopotamus in Kwa Zulu Natal. The lake supports a diverse zooplankton fauna, 15 species of aquatic and 43 species of terrestrial molluscs, as well as flora and fauna unique to South Africa. A research station is located within the site. The lake provides water for Mbazwane and Vasi. Human activities consist of livestock grazing and cultivation.

Ndumo Game Reserve

Ramsar Site number: 887
Area: 10,117 ha
Designation date: 21-01-1997
Coordinates: 26°52'S 32°15'E
Location: Kwazulu-Natal Province, South Africa
Status/Type: Nature Reserve.
Ramsar information sheet available here.

Description: Situated at the junction of the Usutu and Pongolo floodplain systems, the site forms the largest floodplain system in South Africa, consisting of five wetland types, from fresh to brackish, permanent to ephemeral lakes, marshes and pools, as well as riparian and gallery forest. Well known for its abundant bird life and diversity of species, internationally important numbers of several species are supported, including many that are rare or vulnerable. Human activities include controlled harvesting of reeds and sedges, low-density tourism, an important fishery, illegal black and white rhinoceros hunting, and collecting river water for sale in nearby communities. A

large agricultural irrigation scheme is operating erratically south of the reserve in the catchment area.

9.3 DESCRIPTION OF STATUS QUO PER SECONDARY CATCHMENT

The status quo descriptions given below for each secondary catchment include:

- The spatial distribution and extent (Ha) of different wetland types (HGMs) and hence a measure of wetland diversity (all data are from the 2018 updated wetland map 5; van Deventer *et al*., 2018).
- NSBA named wetlands (data from the National Spatial Biodiversity Assessment, Driver *et al.*, 2005).
- Dominant wetland PES expressed as proportional extent (Ha) within the secondary catchment (WETCON from 2018 updated wetland map 5; van Deventer *et al*., 2018).
- Wetland threat status expressed as proportional extent (Ha) within the secondary catchment.
- Wetland protection level expressed as proportional extent (Ha) within the secondary catchment.

9.3.1 W1 Catchment (Main River: Mhlathuze)

The Mhlathuze catchment has roughly 124 000 Ha of wetlands including estuaries and nearly 20 000 Ha if estuaries are excluded. **Figure 9.7** shows the spatial distribution of different wetland HGMs within the catchment. Floodplain wetlands dominate the catchment with a combined area of over 6700 Ha, but unchanneled valley bottoms and riverine and seepage wetlands are also notable in extent covering 3078, 3882 and 4490 Ha respectively. Wetlands named in the NSBA within this catchment include the floodplain and swamp system, Umlalazi, Cubhu, Nsezi, Thulazihleka and Mzingazi. Mzingazi was historically part of the Richard's Bay estuary, but a weir was built between the lake and the connection to the ocean which results in the lake being a freshwater system. **Figure 9.8** outlines an overview of proportional wetland extent (Ha), showing wetland types (HGMs), wetland condition (excludes riverine wetlands), wetland threat status, and wetland protection level. Riverine wetlands in the catchment were not assessed for wetland condition but 90% of other wetland types were rated as D/E/F. Of the non-riverine and non-estuarine wetlands 87% have an endangered threat status and 12% are critically endangered. This may be due to the high level of poor protection of wetlands in general, with only 1% and 11% with high or moderate protection respectively and 85% with poor protection.

The following Wetland HGM abbreviations are applicable to maps in this Chapter:

- CVB - Channeled valley bottoms
- DEPR - Depressions
- FLOOD - Floodplains
- RIVER - Riverine
- SEEP - Seeps
- UVB - Unchanneled valley bottoms
- EST - Estuary

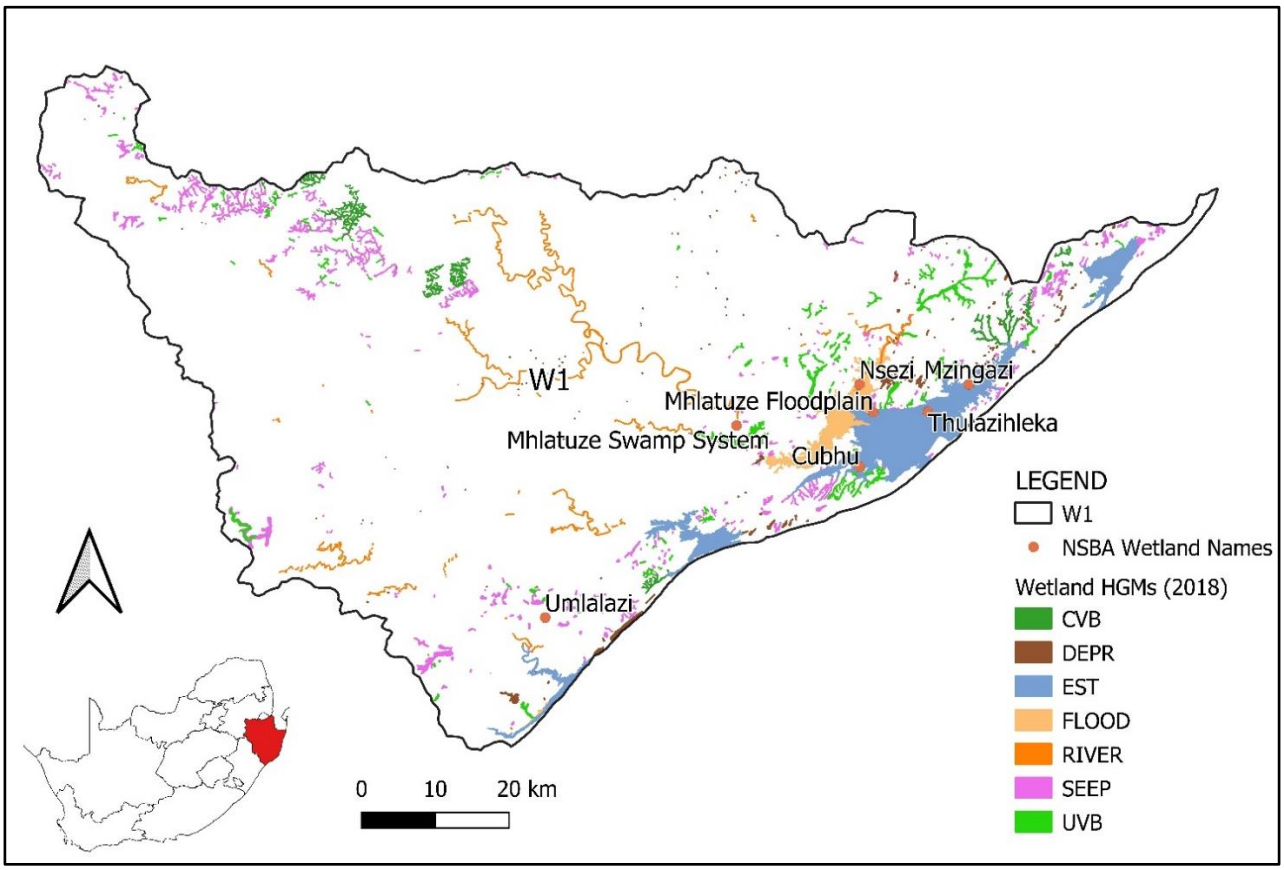


Figure 9.7 **The spatial distribution of different HGMs (2018 updated wetland map 5; van Deventer *et al.*, 2018) in the Mhlathuze Catchment (W1) and NSBA named wetlands (data from the NSBA, Driver *et al.*, 2005)**

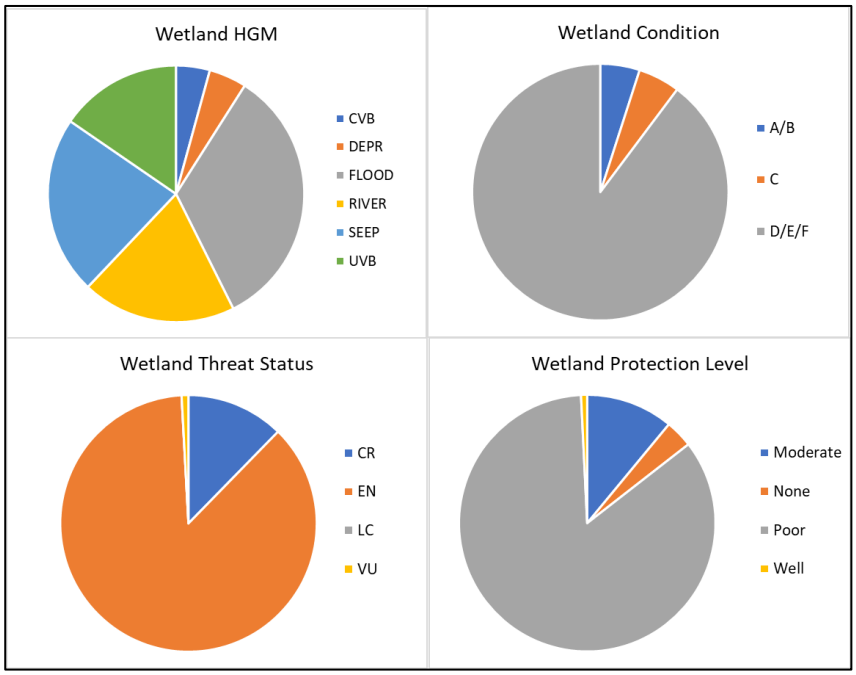


Figure 9.8 **Overview of proportional wetland extent (Ha) in the Mhlathuze Catchment (W1), showing wetland types (HGMs), wetland condition, wetland threat status, and wetland protection level. Estuaries and blank values are not included in the analysis (data from the new national wetland map, 2018; van Deventer *et al.*, 2018)**

9.3.2 W2 Catchment (Main River: Umfolozi)

The Umfolozi catchment has roughly 90 000 Ha of wetlands including estuaries and just over 66 100 Ha if estuaries are excluded. **Figure 9.9** shows the spatial distribution of different wetland HGMs within the catchment. Riverine and seepage wetlands dominate the catchment with a total area each of nearly 32300 Ha and 26072 Ha respectively. Wetlands named in the NSBA within this catchment include the Bloemveld Vlei, Stilwater Vlei, Grootgewaagd Vlei, Lenjani Vlei, Aloeboom Vlei, the Fuyeni Reedbed, Mvamazi Pan, Umfolozi, Lake Teza, Collin's Lake, Mavuya Pan, Mfuthululu and the Umfolozi Swamp. **Figure 9.10** outlines an overview of proportional wetland extent (Ha), showing wetland types (HGMs), wetland condition (excludes riverine wetlands), wetland threat status, and wetland protection level. Riverine wetlands in the catchment were not assessed for wetland condition but 65% of other wetland types were rated as D/E/F, 19% as C and 16% as A/B. Of the non-riverine and non-estuarine wetlands 64% have an endangered threat status and 35% are critically endangered. This may be due to the high level of poor protection of wetlands in general, with only 1% with high protection and 78% with poor protection, while 21% have no protection.

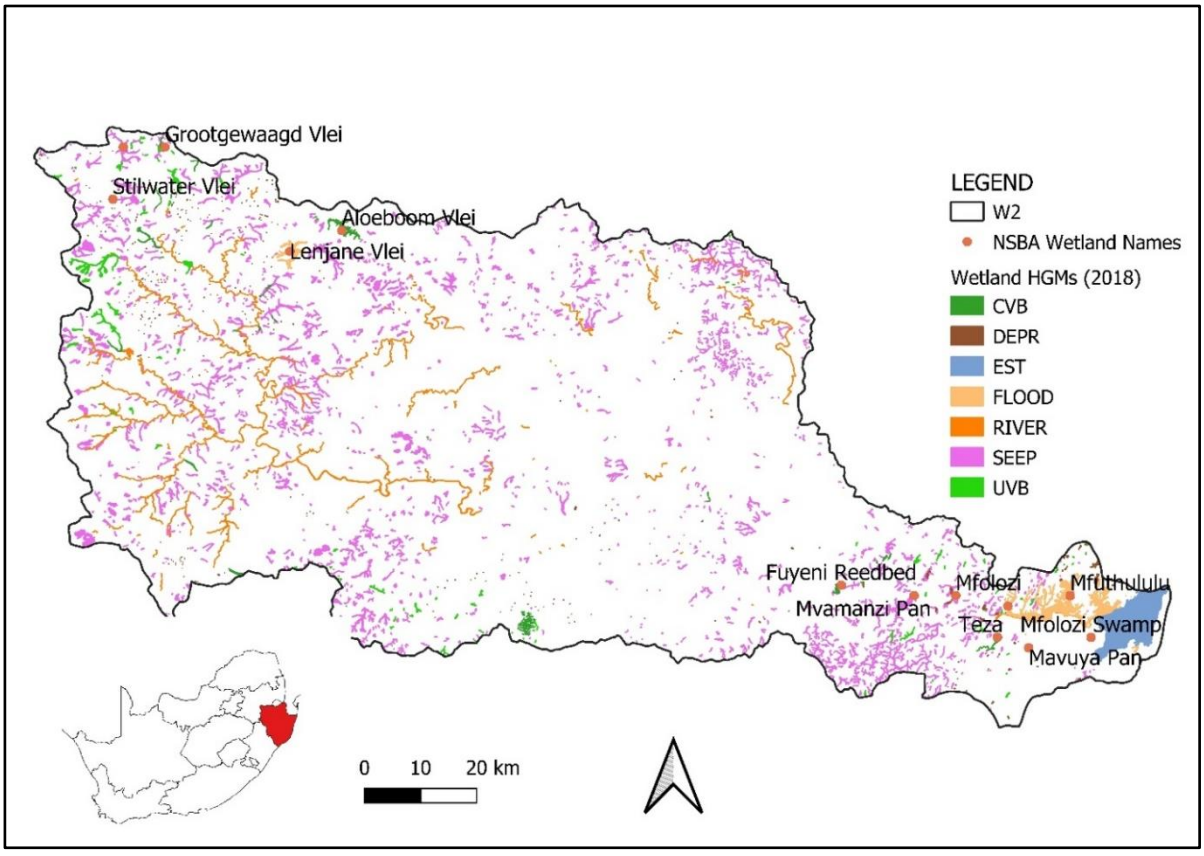


Figure 9.9 The spatial distribution of different HGMs (2018 updated wetland map 5; van Deventer *et al.*, 2018) in the Umfolozi Catchment (W2) and NSBA named wetlands (data from the NSBA, Driver *et al.*, 2005)

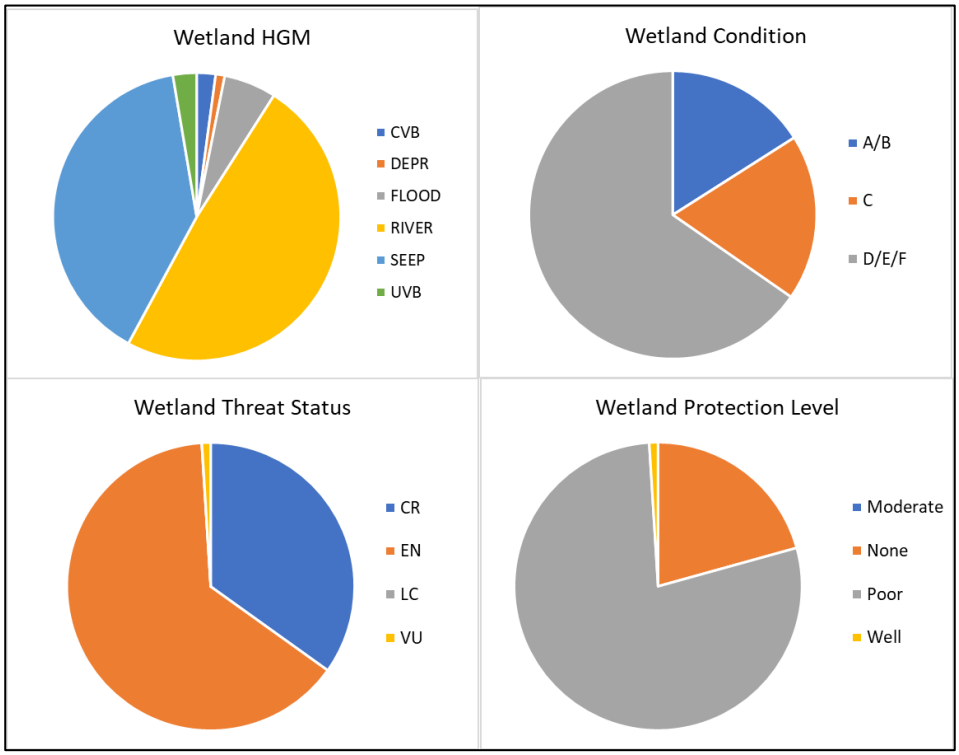


Figure 9.10 Overview of proportional wetland extent (Ha) in the Umfolozi Catchment (W2), showing wetland types (HGMs), wetland condition, wetland threat status, and wetland protection level. Estuaries and blank values are not included in the analysis (data from the new national wetland map, 2018; van Deventer *et al.*, 2018)

9.3.3 W3 Catchment (Main River: Mkuze)

The Mkuze catchment has over 1 000 000 Ha of wetlands including estuaries but almost 33 000 Ha if estuaries are excluded. **Figure 9.11** shows the spatial distribution of different wetland HGMs within the catchment. Floodplains and depressional wetlands dominate the catchment with a total area each of 11844 Ha and 9484 Ha respectively. Wetlands named in the NSBA within this catchment include Enseleni, Nyalazi, the Makhakathana Flats, Hluhluwe River Vlei, Bushlands Pan, the Hluhluwe Floodplain, the Mkuze Floodplain and Swamp System, Ku Ndlebeni, Nhlonhlela Pan, Hlonhlela, Mkuze Airstrip Pans, Nsumo Pan, Neshe, Muzi (South), Tshanetshe, Ntshangwe Lake, Mpanze Pan, Yengweni, Mdlaze Pan, StLucia-Manzibomvu, Mhlazi Pan, St Lucia-Siphudwini, Siphudwini, Mfula Pan and St Lucia-Mbazwana. **Figure 9.12** outlines an overview of proportional wetland extent (Ha), showing wetland types (HGMs), wetland condition (excludes riverine wetlands), wetland threat status, and wetland protection level. Riverine wetlands in the catchment were not assessed for wetland condition but 46% of other wetland types were rated as A/B, 17% as C and 37% as D/E/F. Of the non-riverine and non-estuarine wetlands 97% have an endangered threat status and 2% are critically endangered. This may be due to the high level of poor protection of wetlands in general (excluding estuaries), with only 1% with high protection and 99% with poor protection.

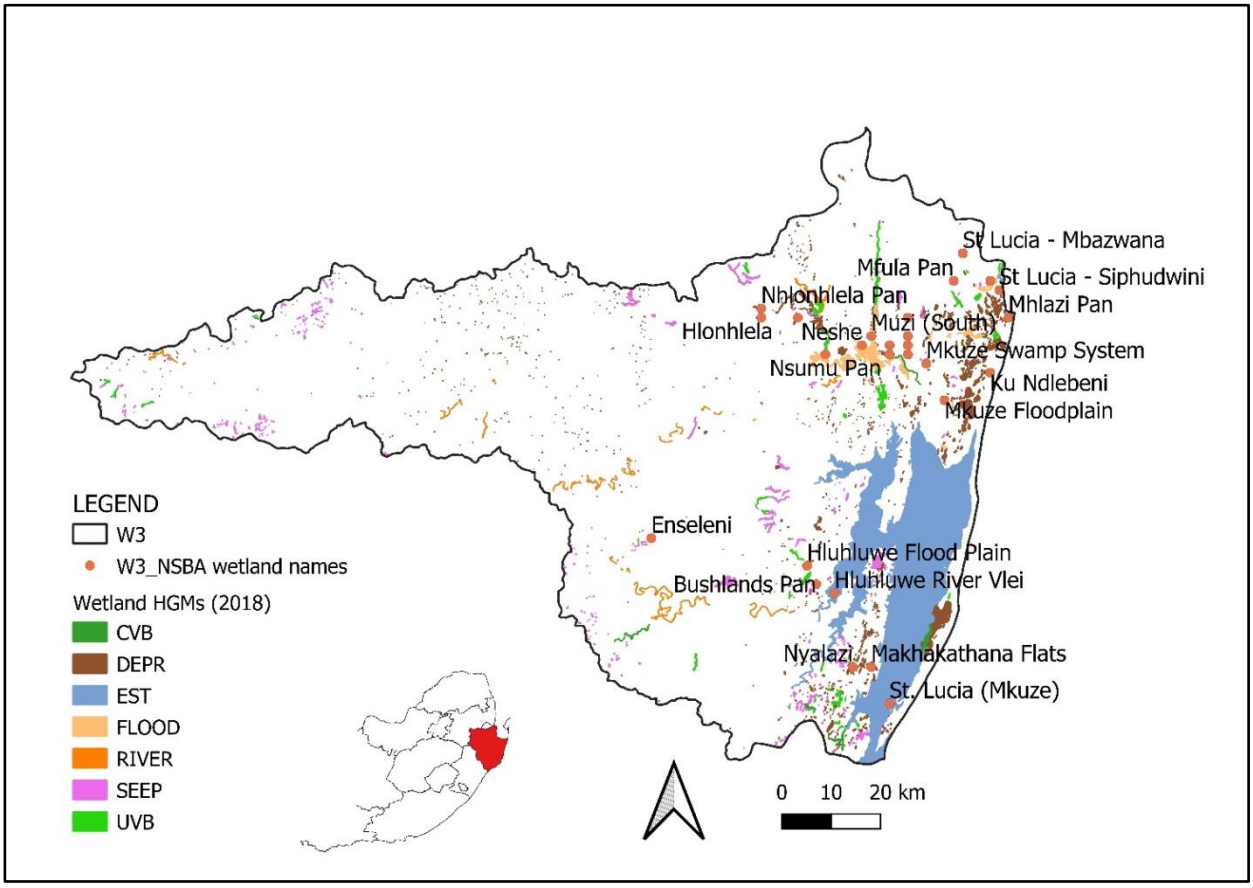


Figure 9.11 **The spatial distribution of different HGMs (2018 updated wetland map 5; van Deventer *et al.*, 2018) in the Mkuze Catchment (W3) and NSBA named wetlands (data from the NSBA, Driver *et al.*, 2005)**

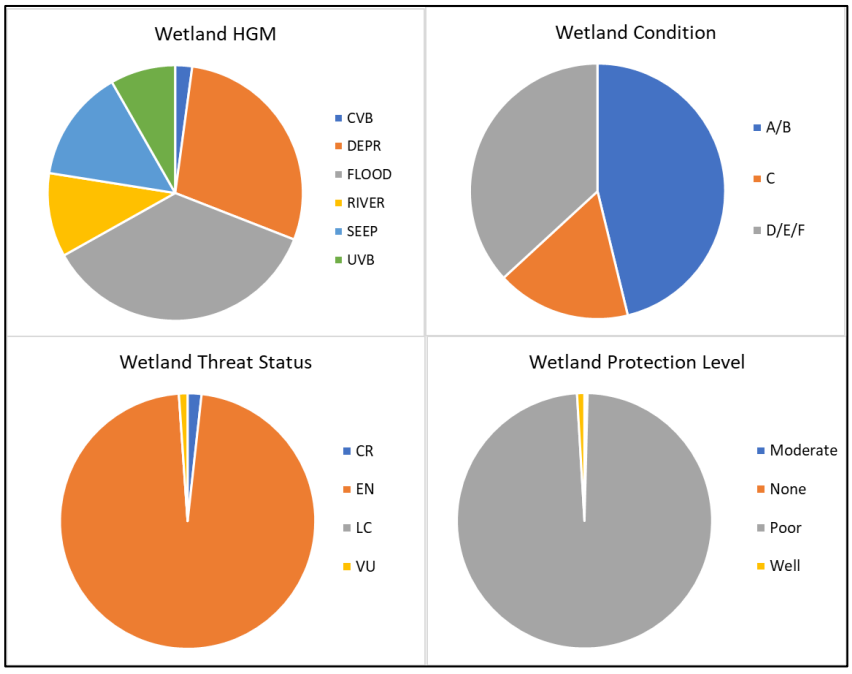


Figure 9.12 **Overview of proportional wetland extent (Ha) in the Mkuze Catchment (W3), showing wetland types (HGMs), wetland condition, wetland threat status, and wetland protection level. Estuaries and blank values are not included in the analysis (data from the new national wetland map, 2018; van Deventer *et al.*, 2018)**

9.3.4 W4 Catchment (Main River: Pongola - excluding Eswatini)

The Pongola catchment has over 113 000 Ha of wetlands. **Figure 9.13** shows the spatial distribution of different wetland HGMs within the catchment. Riverine wetlands dominate the catchment with a total area of 61752 Ha, but channelled valley bottoms and floodplains are also high with 20759 Ha and 17660 Ha respectively. Wetlands named in the NSBA within this catchment include Balamhlanga, the Pongola Floodplain, Msenyeni Pan, Mtoti Pan, Tete Pan, Khanganzeni Pan, Shalala Pans, Nhlole Pan, Bumbe Pan, Mandlankunzi Pan and the Ndumo Game Reserve wetlands (a Ramsar site). The Pongola catchment also contains two thermal springs, Natal Spa and Swaelfontein, a sulphur spring. **Figure 9.14** outlines an overview of proportional wetland extent (Ha), showing wetland types (HGMs), wetland condition (excludes riverine wetlands), wetland threat status, and wetland protection level. Riverine wetlands in the catchment were not assessed for wetland condition but 82% of other wetland types were rated as D/E/F, 12% as C and only 6% as A/B. An overwhelming proportion of wetlands have a critically endangered threat status, 97%, and 2% are endangered. This may be due to the high level of poor protection of wetlands in general (excluding estuaries), with only 1% with high protection and 93% with poor protection and 7% with no protection.

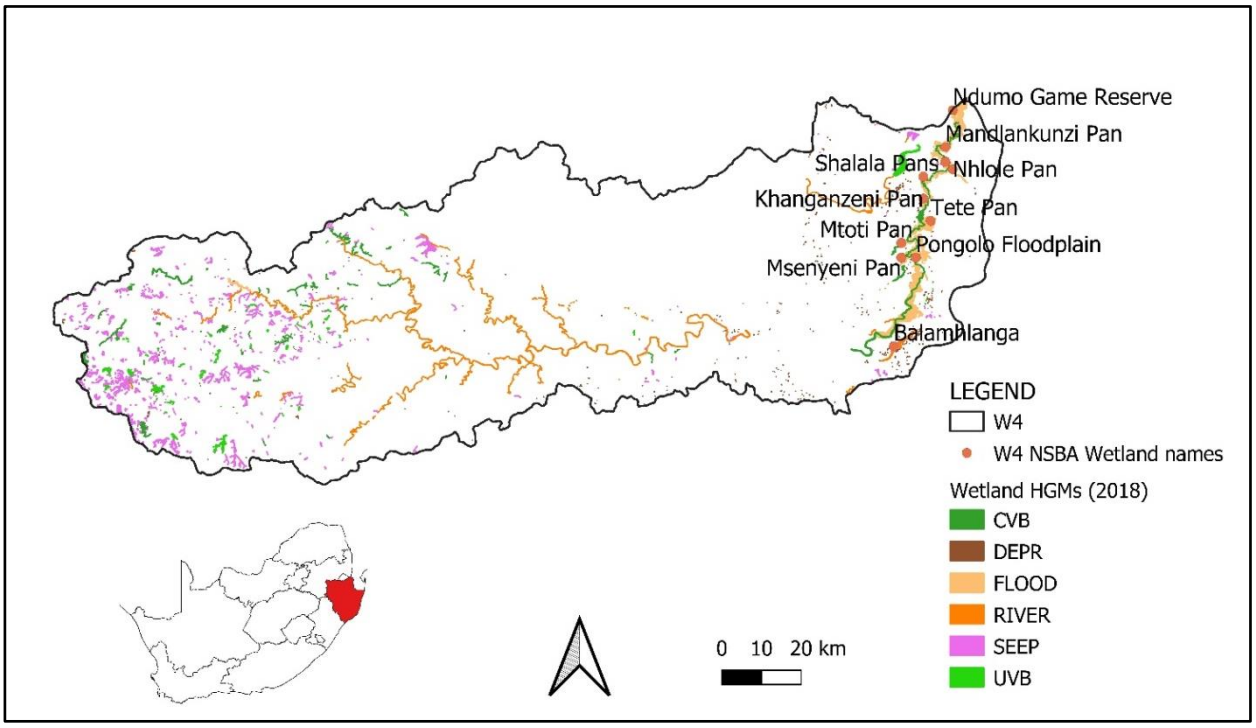


Figure 9.13 The spatial distribution of different HGMs (2018 updated wetland map 5; van Deventer *et al.*, 2018) in the Pongola Catchment (W4) and NSBA named wetlands (data from the NSBA, Driver *et al.*, 2005)

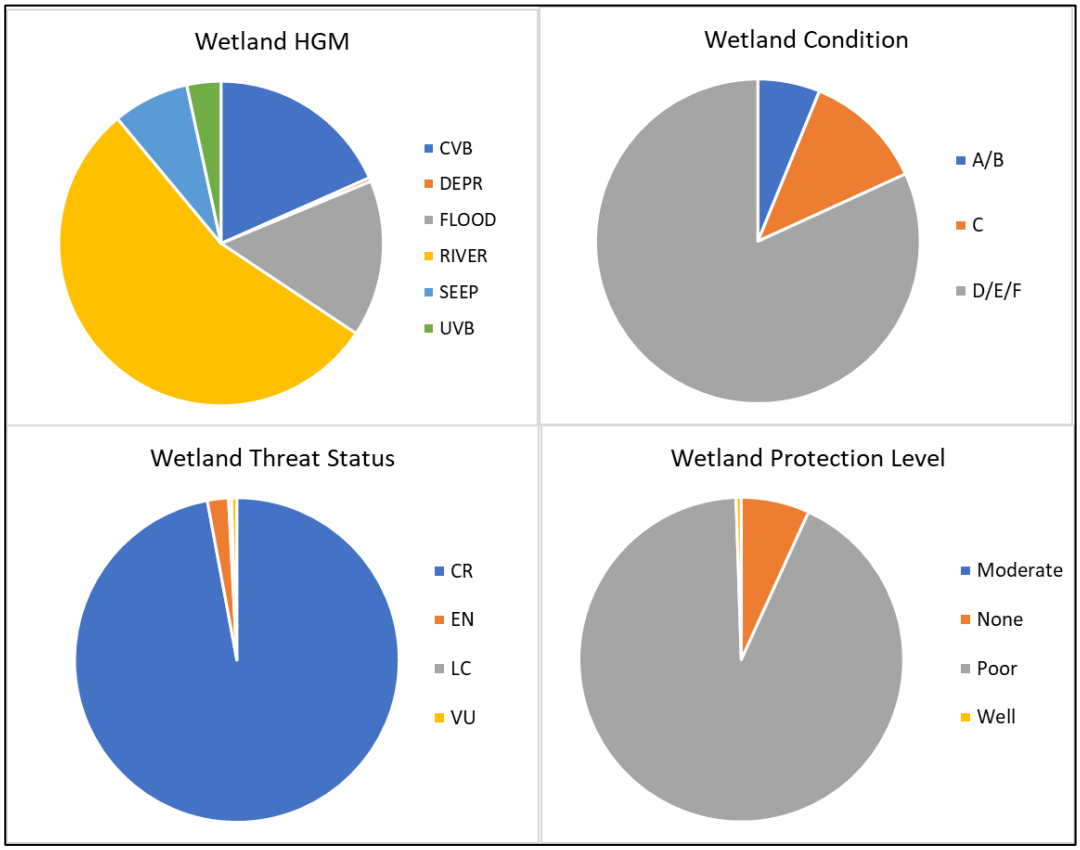


Figure 9.14 Overview of proportional wetland extent (Ha) in the Pongola Catchment (W4), showing wetland types (HGMs), wetland condition, wetland threat status, and wetland protection level. Estuaries and blank values are not included in the analysis (data from the new national wetland map, 2018; van Deventer *et al.*, 2018)

9.3.5 W5 Catchment (Main River: Usutu - excluding Eswatini)

The Usutu catchment has roughly 80 100 Ha of wetlands. **Figure 9.15** shows the spatial distribution of different wetland HGMs within the catchment. Channelled valley bottoms dominate the catchment with a total area of over 33081 Ha, but seepage wetlands, depressions and floodplains are also notable in extent covering 16814, 11266 and 12934 Ha respectively. Wetlands named in the NSBA within this catchment include Banzi Pan, Shokwe Pan, Upper Black Umfolozi, Langfontein Pan 3, Coalbank, Liefgekozen, Lake Chrissie and several other Lake Chrissie pans, Tweelingpan, Wets Tweelingpan, Lake Banagher and several other Lake Banagher pans, Van Aardt Kaalpan, Blinkpan, Hamilton, Neethlingpan, Grasdal, Florence, Blaauwater, Lusthop Pan 18, Tevreden and Tevrede se pan 16. **Figure 9.16** outlines an overview of proportional wetland extent (Ha), showing wetland types (HGMs), wetland condition (excludes riverine wetlands), wetland threat status, and wetland protection level. Riverine wetlands in the catchment were not assessed for wetland condition but 64% of other wetland types were rated as D/E/F, 24% as C and 12% as A/B. Of the non-riverine and non-estuarine wetlands 88% have a critically endangered threat status and 12% are least concern. This may be due to the high level of poor protection of wetlands in general, with 42% that are poorly protected and 58% with no protection.

From a regional perspective, Chrissiesmeer (Mpumalanga Lake District) has been classified as being an irreplaceable Critical Biodiversity Area in the Mpumalanga Biodiversity Sector Plan 2013. The majority of this ecosystem falls within the Chrissiesmeer Panveld Ecosystem which has been listed as Endangered in the National List of Ecosystems that are Threatened and in Need of

Protection (GN1002 of 9 December 2011). In terms of the Mpumalanga Provincial Gazette Extraordinary (Notice 19 of 2014) the Mpumalanga Lake District forms part of the Chrissiesmeer Protected Environment (CPE). This area is unique due to the high density of pans, several of which are permanently saturated (DWA, 2014a). The pans range in size from less than a hectare to over a thousand hectares (Lake Chrissie). According to McCarthy *et al*., 2007, Tevreden Pan, along with other pans in the Mpumalanga Lakes District should be nominated/proposed for Listing as Wetlands of International Importance in terms of the Ramsar Convention, given the uniqueness of the area, which includes its status as an important bird area (Global IBA: SA019 Chrissie Pans of approximately 62500 ha), as well as its geomorphological and hydrological uniqueness.

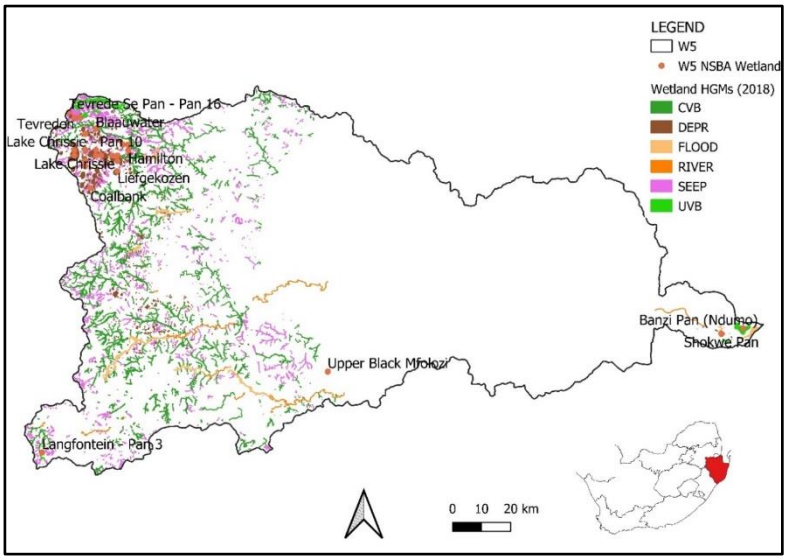


Figure 9.15 The spatial distribution of different HGMs (2018 updated wetland map 5; van Deventer *et al.*, 2018) in the Usutu Catchment (W5) and NSBA named wetlands (data from the NSBA, Driver *et al.*, 2005)

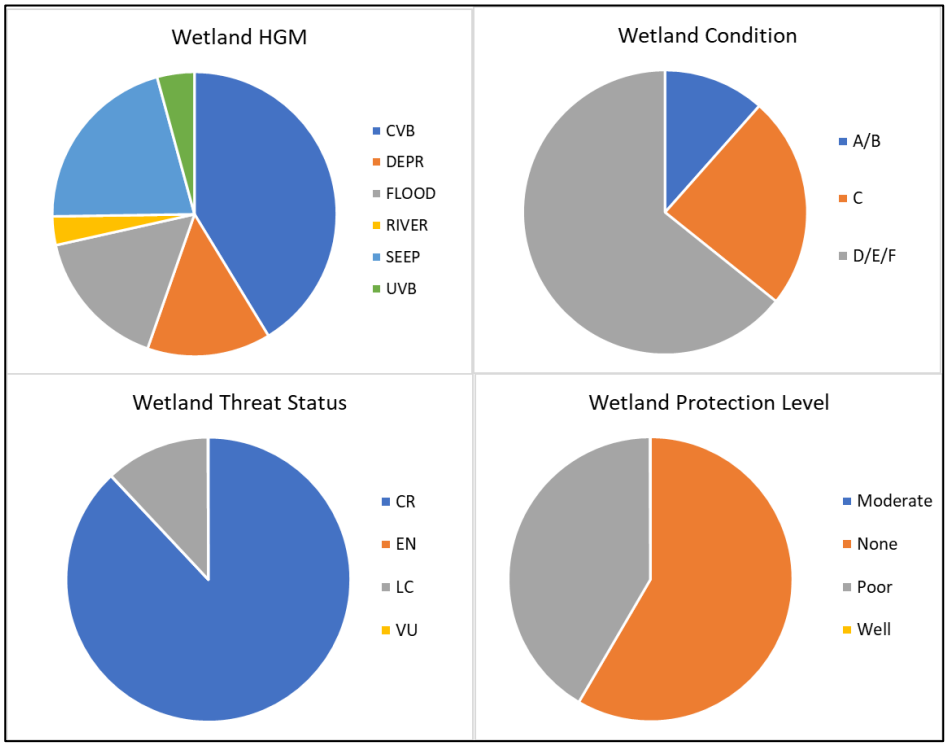


Figure 9.16 Overview of proportional wetland extent (Ha) in the Usutu Catchment (W5), showing wetland types (HGMs), wetland condition, wetland threat status, and wetland protection level. Estuaries and blank values are not included in the analysis (data from the new national wetland map, 2018; van Deventer *et al.*, 2018)

9.3.6 W7 Catchment (Kosi Estuary and Sibaya Lake)

The Lake Sibaya and Kosi catchment has roughly 82 200 Ha of wetlands including estuaries and 59 500 Ha of wetlands excluding estuaries. **Figure 9.17** shows the spatial distribution of different wetland HGMs within the catchment. Depressions and floodplains dominate the catchment with a total area each of 33191 Ha and 21991 Ha respectively. Wetlands named in the National Spatial Biodiversity Assessment within this catchment include Mgobozeleni – Shazibe, KuMzingwane, KuMzinganwane, Siyadla, Mvelabusha, Muzi Swamps, Sileza Vlei, Nlangu mire complex, Kosi – Siyadla, KuShengeza, Kozi – aManzamnyama, Sihadla, Enkathweni, Kosi – Swamanzi, KuNkanini, Matitimane, Apiesdraai, Mtando, Kosi – Ngweve, KuZilonde, Kukalwe, Cele, Nlovu, Gazini and Mloli. The Vazi Pan peatlands near the town of Manguzi is also within this catchment. **Figure 9.18** outlines an overview of proportional wetland extent (Ha), showing wetland types (HGMs), wetland condition (excludes riverine wetlands), wetland threat status, and wetland protection level. Riverine wetlands in the catchment were not assessed for wetland condition but 83% of other wetland types were rated as D/E/F, 13% as C and 5% as A/B. Of the non-riverine and non-estuarine wetlands 62% have a critically endangered threat status and 38% are Vulnerable. This may be due to the high level of poor protection of wetlands in general, with 61% that are poorly protected and 28% with moderate protection, but at least 10% are well protected.

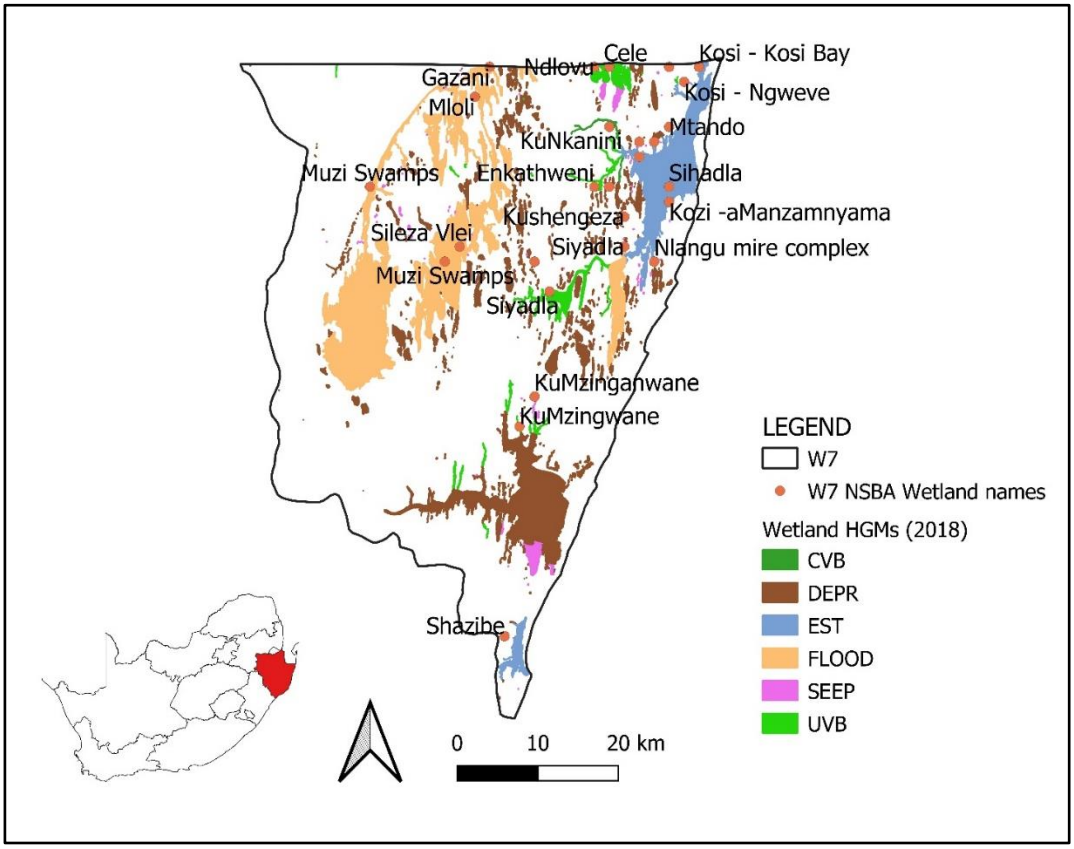


Figure 9.17 **The spatial distribution of different HGMs (2018 updated wetland map 5; van Deventer *et al.*, 2018) in the Lake Sibaya and Kosi Catchment (W7) and NSBA named wetlands (data from the NSBA, Driver *et al.*, 2005)**

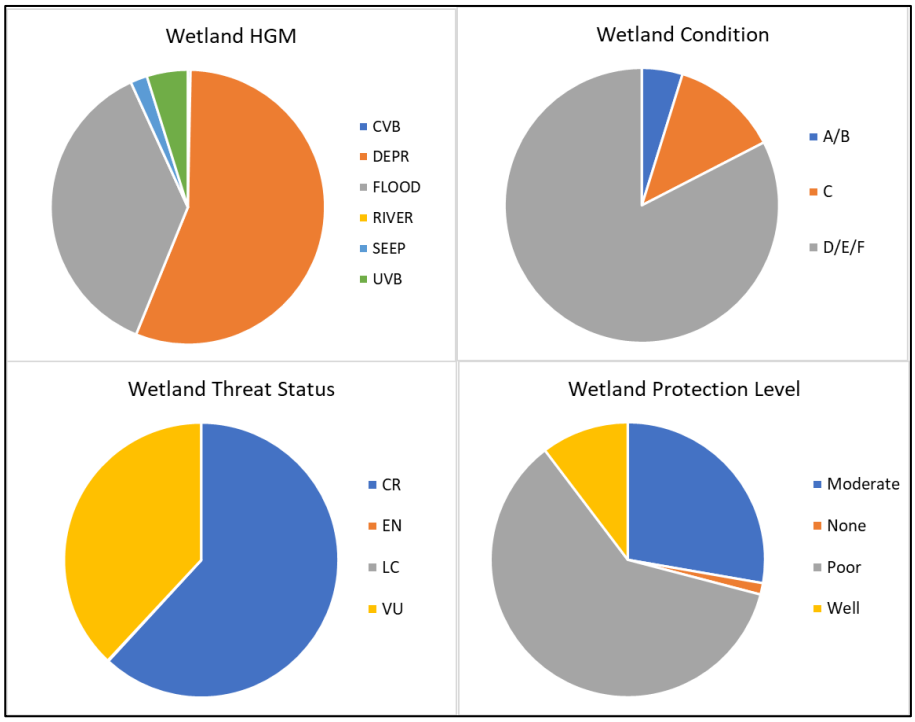


Figure 9.18 **Overview of proportional wetland extent (Ha) in the Lake Sibaya and Kosi Catchment (W7), showing wetland types (HGMs), wetland condition, wetland threat status, and wetland protection level. Estuaries and blank values are not included in the analysis (data from the new national wetland map, 2018; van Deventer *et al.*, 2018)**

9.4 SUMMARY OF SUB QUATERNARY REACH CATCHMENTS

To complete the description of wetland status quo in the study area, existing wetland data from the PES/EI/ES assessment (DWS, 2014a), the NFEPA data (Nel *et al.*, 2011) and the national biodiversity assessment (van Deventer *et al.*, 2018) were summarised at the SQR catchment scale (**Appendix D**). The wetland PES category calculated in **Appendix D** (Wet PES) is a surrogate measure (surr) based on the average of the riparian / wetland zone continuity modification and the riparian / wetland zone modification metrics, and as such only moderately represents wetlands within the respective SQR catchment.

10 STATUS QUO ASSESSMENT: ESTUARY ECOLOGICAL STATE

10.1 INTRODUCTION

10.1.1 What is an estuary

In South Africa an estuary is defined as '*a partially enclosed permanent water body, either continuously or periodically open to the sea on decadal time scales, extending as far as the upper limit of tidal action, salinity penetration or back-flooding under closed mouth conditions. During floods an estuary can become a river mouth with no seawater entering the formerly estuarine area or, when there is little or no fluvial input, an estuary can be isolated from the sea by a sandbar and become fresh or even hypersaline*' (Van Niekerk *et al*., 2019). A defining feature of this definition is that complex estuarine abiotic processes distinguish estuaries from other aquatic ecosystem types i.e. restricted tidal action, mixing of fresh and salt water, increased retention and/or increased water levels under closed mouth conditions.

There are nine estuaries in the study area.

10.1.2 Refined estuary classification

To assist with ecosystem condition and flow requirement assessments the National Biodiversity Assessment 2018 developed a revised national classification system for South Africa's 290 estuaries (Van Niekerk *et al*., 2019; Van Niekerk *et al*., 2020; Dayaram *et al*., 2021), derived from the interplay between **biogeographical regions** and **estuary functional types,** that stems from the country's diverse climatic, oceanographic and geological drivers.

Historically, the biogeographic distribution of South Africa's estuaries comprised three regions, viz. Cool Temperate, Warm Temperate and Subtropical. However, an analysis of species data indicated that there is significant ingress of marine tropical species typical of tropical Mozambique into the estuaries north of Cape Vidal. For this reason, the historical Subtropical region was subdivided to include a Tropical transition zone to the north of Cape Vidal to reflect the tropical character of these systems. This subdivision essentially includes the uMgobezeleni and Kosi estuaries as Tropical and aligns with the current marine biogeographic distribution that includes the Natal-Delagoa tropical region (Van Niekerk *et al*., 2020).

All 'rivers or streams with outlets on the coast' were evaluated and categorised as either 'estuaries' or 'micro-systems', based on an expert panel review of biological information and specialists' observations. The 290 estuarine systems were further categorised into nine functional types, namely Estuarine Lake, Estuarine Bay, Estuarine Lagoon, Predominantly Open, Large and Small Temporarily Closed, Large and Small Fluvially Dominated, and Arid Predominantly Closed.

Estuarine Lagoons are the rarest South African estuary type with only one representative system in the Cool Temperate region, followed by Estuarine Bays with two systems in the Subtropical- and one in the Warm Temperate region. Arid Predominantly Closed estuaries are limited to six systems in the Cool Temperate region. The Large and Small Fluvially Dominated types comprise seven systems each, occurring in three and two biogeographical regions, respectively. Small Temporarily Closed (116), Large Temporarily Closed (94), and Predominantly Open (44) are the most dominant types occurring across the Cool Temperate, Warm Temperate and Subtropical biogeographical regions. Estuarine Lakes occur in all four biogeographical zones. While not numerically dominant, this type of estuary represents the largest surface area of all estuary

functional types, with Lake St Lucia/iMfolozi covering more than half of South Africa's estuarine surface area.

Estuary ecosystem types can serve as surrogates for ecosystem processes and enable predictions of biophysical characteristics. Understanding ecological processes and patterns associated with an estuary type facilitates an assessment of its resilience to anthropogenic pressures. This allows for extrapolation in data-limited environments. The revised classification scheme forms the "blue print" for South Africa's IUCN red listing of estuarine ecosystem types, that allows for the identification of threatened ecosystem types, i.e. "Critically endangered", "Endangered", or "Vulnerable" (Van Niekerk *et al*., 2019). Thus, highlighting ecosystem types in urgent need of management intervention and protection. Determining the condition of estuarine ecosystem types have the added advantage that it can also be used for reporting on United Nations Sustainable Development Goal 14 (Conserve and sustainably use the oceans, seas and marine resources) that specifically highlights coastal ecosystems such as estuaries. Ecosystem types, together with species and habitat targets, are used in setting conservation planning targets to ensure that all life supporting abiotic and biotic processes are captured in a representative protected areas network (Turpie *et al*., 2012). These targets in turn, inform flow allocation processes. Given that the identified estuary types characterise physical and biotic processes, they can also be used as proxies for predicting sensitivity to anthropogenic pressures such as flow reduction and increased nutrient loading in environmental flow assessment in data-poor environments. Aquatic ecosystem typing is one of the fundamental datasets for extrapolating freshwater flow requirements across a region in low confidence assessments (van Niekerk *et al*., 2020).

10.1.3 Estuarine Functional Zone

By nature, estuaries are constantly changing both temporally and spatially, and as a consequence they do not have permanent or static habitat structures. While the total habitat area occupied by various biotic and abiotic habitat types within an estuary tends to remain more or less constant over long time scales, the actual location of these habitats is likely to be highly variable between resetting events (e.g. larger floods on decadal scales). A fundamental constraint associated with the assessment and management of estuaries is defining their spatial extent (i.e. the smallest management unit or boundary) owing to the dynamic nature of estuarine habitats. Biodiversity protection and the wise use of our estuarine resources require not only the protection of estuarine habitat and biota, but also the protection of the physical processes that sustain ecological and evolutionary processes. To do this, it is important to define the 'space' within which estuaries function over long time scales to safeguard the present and future health – the so-called 'estuarine functional zone' (EFZ) (Van Niekerk *et al*., 2019 and 2020).

The Estuary Functional Zone (EFZ) is defined as the area that not only covers the estuary water body, but also areas that support physical and biological processes and habitats necessary for estuarine function and condition. The latter includes areas influenced by long-term estuarine sedimentary processes (i.e. sediment stored or eroded during floods), changes in channel configuration, aeolian transport processes, and changes due to coastal storms. The EFZ also encompasses flood plain ecotones and estuarine vegetation that contribute detritus to the base of the estuarine food chain and provide refuge to estuarine biota during high flow events from strong currents.

The delineation of the EFZ were done in a consistent but cost-effective manner, to be inclusive of all estuarine physical and biological processes so that it can be used to protect estuarine habitats.

South Africa's method for the determination of the EFZ is described in detail in the NBA 2018 (Van Niekerk *et al*., 2019).

The EFZs of the nine estuaries in the study area serves as the boundaries of the RU for the estuaries component of this work.

10.2 APPROACH

10.2.1 Estuary PES assessment

'Ecosystem condition reflects the overall quality of an ecosystem asset in terms of its characteristics'. One of the key challenges in developing estuarine ecosystem integrity indices is the need to reflect the change in dynamic estuarine ecosystems in a data-limited environment, largely framing the selection of representative indicators and the calculation and weightings of indicators in the index to be functional in both data-rich and data-poor systems. Once-off measurements of abiotic or biotic aspects of estuaries should be interpreted in the context of medium to long-term dynamics, able to recognise the difference between dynamic and unidirectional change. Severe degradation of an estuary may involve a shift from dynamic change to dominantly unidirectional change. The loss of dynamic function per se may thus constitute an important measure of degradation in estuarine health.

South Africa has a well-established system for assessing the ecological condition of estuaries using an Estuary Health Index (DWAF, 2008b). The term 'estuary health' is used to describe an estuary's condition - measured as the degree to which the present condition of an estuary deviates from its pristine condition (DWAF 2008b; Turpie *et al*., 2012). The same approach is used to evaluate the change in estuary productivity and condition across a range of government processes, for example in water resource classification and ecological flow requirements under the National Water Act (No. 36 of 1998) and in national biodiversity assessments under the National Environmental Management: Biodiversity Act (No. 10 of 2004) (e.g. Niekerk *et al*., 2019). The index is also widely used in estuarine management planning under the National Environmental Management: Integrated Coastal Management Act (No. 26 of 2008) and estuary conservation planning under the National Environmental Management: Protected Areas Act (No. 57 of 2003).

The Estuary Health Index reflects the overall change in condition relative to a natural condition, assessed separately for each of the selected index variables. The selection of the index variables, as well as their grouping and weighting to reflect 'health' was decided through a series of workshop sessions with estuarine experts where several potential variables were identified, together with reasoning on how they would indicate and vary with a change in ecosystem health, grouped into physical (or abiotic) variables and biotic variables (**Figure 10.1**). The index includes both abiotic and biotic condition indicators (also called components) as the inter-relationships between these indicators are often not well defined, and also because biotic responses often lag abiotic responses - abiotic responses can offer an early warning on condition change (Van Niekerk *et al*., 2013).

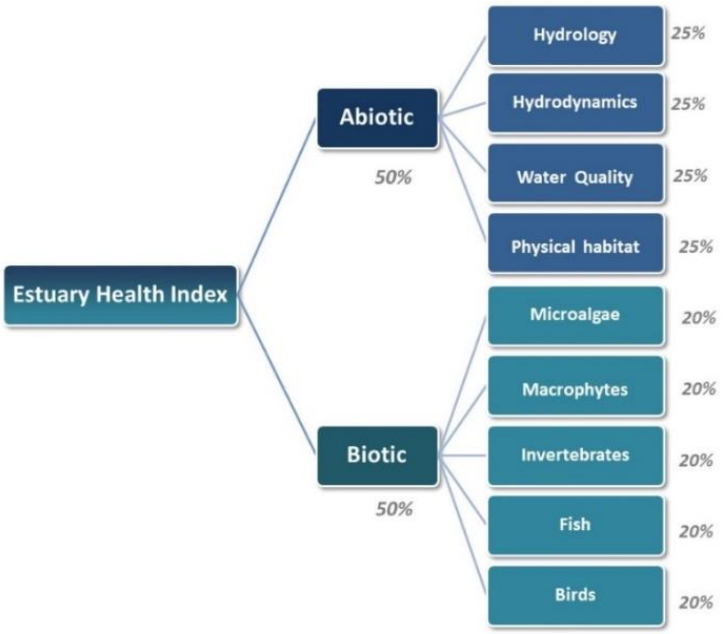


Figure 10.1 Illustration of the structure of the Estuary Health Index (DWAF, 2008b)

The selected variables form the primary input for the **Estuary Health Index** (DWAF, 2008b; Turpie *et al*., 2012). The **abiotic condition** variables or **indicators** comprise:

- **Hydrology:** Assessing the hydrology helps to establish the extent to which modification in river inflow is responsible for the deviation of health from natural. Key elements include changes in wet and dry-season base flows and floods.
- **Hydrodynamics:** Assessing changes in water level, estuarine circulation and mixing processes, with a focus on connectivity to the sea (mouth state) and water level variation (in the case of temporarily open/closed systems).
- **Physical habitat:** Focussing on changes in the sedimentary processes in estuaries such as a change in the size and shape of systems, as well as the sediments structure and composition (e.g. muds, rocks, sands). The size and shape of an estuary determine many of its inherent physical features. Disturbance of the sediment erosion/deposition equilibrium in an estuary can lead to siltation, resulting in the estuary becoming shallower, or it can lead to the erosion of important estuarine habitats.
- **Water quality:** Assessing change in terms salinity and other water quality parameters (dissolved oxygen, suspended solids/turbidity, nutrients and toxic substances). Salinity distribution along the length of the estuary is treated separately from the other water quality parameters, as it also informs water exchange patterns.

The biotic condition variables comprise:

- **Microalgae:** assessing phytoplankton and benthic microalgae which are important food sources for higher taxa.
- **Macrophytes:** assessing primary producers that are both habitat and food for many of the estuarine fauna (e.g. submerged macrophyte beds form important nursery areas for juvenile fish by providing food, shelter and protection from predators). Macrophytes also play an essential role in nutrient trapping and recycling, sediment stabilisation and bank protection.
- **Invertebrates:** assessing zooplankton, nektonic (swimming) invertebrates and benthic (bottom-dwelling) invertebrates that are all important food sources for fish and birds, as well

as being an important resource used by people for food and bait. Invertebrates are also well-known habitat formers in estuaries and provide additional niches for other organisms thereby increasing the diversity and carrying capacity of estuarine systems.

- **Fish:** serving as an important food source for one another and birds, as well as being an important resource used by people for food. Fish are also highly mobile and thus respond rapidly to changes estuary condition.
- **Birds:** making an important contribution to the recreational and aesthetic value of estuaries, as well as contributing to the maintenance of estuarine processes through predation and nutrient inputs. Many birds are good indicators of estuarine conditions such as water quality, habitats and fish abundance.

The Estuarine Health Index reflects change as a percentage similarity (0 – 100%) to a defined natural state (referred to as the 'Reference Condition') which is calculated for both abiotic and biotic variables derived from various data and information sources. Ratings for indicators are weighted (25% for each abiotic and 20% for each biotic component) and aggregated (50:50) to provide an overall percentage deviation from natural (van Niekerk *et al*., 2013). These percentage values are then translated into six ecological condition categories, ranging from natural (A) to critically modified (F) (**Table 10.1**). The categories represent declining functionality in process and pattern, from natural to little remaining.

Table 10.1 The Estuary Health Index translated to ecological condition and categories (modified from Van Niekerk *et al*., 2013)

Condition (% of natural)	≥91%	90-75	75 - 61	60 - 41	40-21	≤20
Ecological condition Category	A Natural	B Largely natural / few changes	C Moderately modified	D Largely modified	E Highly degraded	F Extremely degraded
Ecological State	NATURAL	NEAR NATURAL	MODERATE	HEAVILY	SEVERE/CRITICAL	
Functionality	Retain Process & Pattern (Representation)		Some loss of Process & Pattern	Significant loss of Process & Pattern	Little remaining Process & Pattern	

Category	Description
A	**Unmodified, approximates natural condition.** The natural abiotic processes should not be modified. The characteristics of the resource should be determined by unmodifed natural disturbance regimes. There should be no human induced risks to the abiotic and biotic processes and function.
B	**Near natural with few modifications**. A small change in natural habitats and biota may have taken place, but the ecosystem functions are essentially unchanged.
C	**Moderately modified**. A loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D	**Heavily modified**. A large shift natural processes and ecosystem functions and/or loss of habitat, biota have occurred.
E F	**Severely modified**. The loss of natural habitat, biota and basic ecosystem functions is extensive. **Critically modified**. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural abiotic processes and associated biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

10.3 DESCRIPTION AND STATUS QUO PER SECONDARY CATCHMENT

The status quo assessment consists of a range of tables and short summary for each secondary catchment detailing key aspects relating to the estuaries in the study area.

10.3.1 W1 Catchment (Main River: Mhlathuze)

Five estuaries occur in the W1 secondary catchment.

aMatigulu/iNyoni is a Predominantly Open estuary that is in a B category (**Table 10.2** to **Table 10.4**). It has low levels of pressures on it, except for overfishing. The system is rated as ecologically important (Turpie *et al*., 2002), and of high importance as a fish nursery area by Department of Forestry, Fisheries and the Environment (DFFE) (Van Niekerk *et al*., 2019) (**Table 10.4**). The system forms part of a protected area.

The iSiyaya is a Small Temporarily Closed estuary that is in a highly degraded E category (**Table 10.2** to **Table 10.4**). It is under very high flow modification, habitat degradation, and pollution pressure (mainly agriculture). It is of low to average importance ecologically (Turpie *et al*., 2002), but forms part of a protected area.

The uMlalazi is also a Predominantly Open estuary that is in a B category (**Table 10.2** to **Table 10.4**). It experiences high levels of fishing pressure and medium levels of flow and habitat degradation pressure. There is also some pollution pressure (agriculture and aquaculture) on the system. Its system is rated as ecologically highly important (Turpie *et al*., 2002) and form part of a protected area. The system is also a designated Important Bird Area. It is also high importance as a fish nursery area by DFFE (Van Niekerk *et al*., 2019) (**Table 10.4**). The system is important for blue carbon sequestration and forms part of South Africa's proposed climate change mitigation strategies (DFFE, 2022).

In the 1970s the uMhlathuze estuarine lake system was subdivided to create an estuarine bay (Richards Bay) and a Predominantly Open system (uMhlathuze Sanctuary) to accommodate a port development (**Table 10.4**). This resulted in two degraded estuarine systems that provisionally are estimated as between a D and D/E Category but needs revisiting as part of this study (**Table 10.3** and **Table 10.3**). These systems are rated as ecologically important to highly important, and of high importance as a fish nursery area by DFFE (Van Niekerk *et al*., 2019) (**Table 10.3**). uMhlathuze form part of a protected area and is also a designated Important Bird Area. The systems are important for blue carbon sequestration and forms part of South Africa's proposed climate change mitigation strategies (DFFE, 2022).

Similarly iNhlabane used to function as an estuarine lake, but due to mining and flow modification (weir) very little of that functionality remains, with the system now functioning more like a Small Temporarily Closed estuary type (**Table 10.2** to **Table 10.3**). This system is considered to be in an E Category. It is rated as ecologically important (Turpie *et al*., 2002), and of medium importance as a fish nursery area by DFFE (Van Niekerk *et al*. 2019) (**Table 10.4**).

Table 10.2 Estuary types occurring in W1 Catchment (light grey shade highlight estuaries where functional types changed)

	Estuary Name	Natural Estuary Type	Present Functional Type	Estuary Aliases/Historical names*
W11	aMatigulu/iNyoni	Predominantly Open	Predominantly Open	Matigulu/Nyoni, aMatigulu/iNyoni, Matigulu, Amatikulu, Matikulu, eMatikulu, Inyoni, Nyoni
W13	iSiyaya	Small Temporarily Closed	Small Temporarily Closed	Siyaya, iSiyaya, Siyana, Siyani, Siaya, Siyai, Siyaní
W13	uMlalazi	Predominantly Open	Predominantly Open	Mlalazi, uMlalazi, Umlalazi, Mlalaas
W12	uMhlathuze	Estuarine Lake	Predominantly Open	uMhlathuze, Mhlathuze, Mhlatuze, Umhlatuzi lake, Mhlatuze, Umhlatuze, uMhlatuze
W12	Richards Bay	Estuarine Lake	Estuarine Bay	Richards Bay, Umhlatuze lagoon, Rio dos Peixos, eChwebeni
W12	iNhlabane	Estuarine Lake	Small Temporarily Closed	iNhlabane, Hlobane, Nhlabane

*Alternative estuary names are provided address discrepancies between various maps and GIS layers

Table 10.3 Condition and degree of pressure on estuaries in W1 Catchment

	Estuary Name	PES	Cumulative Pressure Level	Pressure: Flow modification	Pressure: Pollution	Pressure: Habitat loss	Pressure: Fishing Effort 2018 (DFFE)	Pressure: Invasive alien plants	Pressure: Alien Fish	Artificial Breaching	Pollution source: Catchment (diffuse)	Pollution Source: Riparian	Pollution: Stormwater	Mining (Sand, Diamonds, minerals)	Marina/Harbours	Aquaculture
W11	aMatigulu/ iNyoni	B	L	L	L	L	H			L				●		●
W13	iSiyaya	E	VH	VH	VH	VH	M				Agric					
W13	uMlalazi	B	L	M	L	M	H	M	H	L	Agric	Agric		●		
W12	uMhlathuze	D	H	L	VH	VH	VH		H		Agric	Agric		●		
W12	Richards Bay	D/E	H	H	H	VH	VH					Port	●		Port	
W12	iNhlabane	E	VH	M	H	VH	H			?	Urban			●		

Pressure rating: **VH**=Very high, **H**=High, M=Medium, L=Low

10.3.2 W2 Catchment (Main River: Umfolozi)

The Large Fluvially Dominated iMfolozi/uMsunduze estuary forms part of the Greater St Lucia Estuarine Lake Complex (**Table 10.4**). The system is in a D Category, resulting for very high pollution (agriculture), habitat degradation and fishing pressure. There is also significant pressure from invasive alien plants and artificial breaching (**Table 10.5**).

Table 10.4 Estuary types occurring in W2 Catchment

	Estuary Name	Natural Estuary Type	Present Functional Type	Estuary Aliases/Historical names
W2	iMfolozi/ uMsunduze	Large Fluvially Dominated	Large Fluvially Dominated	iMfolozi/uMsunduze, Umfolosi, Mfolozi

Table 10.5 Condition and degree of pressure on estuaries in W2 Catchment

	Estuary Name	PES	Cumulative Pressure Level	Pressure: Flow modification	Pressure: Pollution	Pressure: Habitat loss	Pressure: Fishing Effort 2018 (DFFE)	Pressure: Invasive alien plants	Pressure: Alien Fish	Artificial Breaching	Pollution source: Catchment (diffuse)	Pollution Source: Riparian	Pollution: Stormwater	Mining (Sand, Diamonds, minerals)	Marina/Harbours	Aquaculture
W2	iMfolozi /uMsunduze	D	H	L	VH	VH	VH	H		H	Agric			●		

Pressure rating: **VH**=Very high, **H**=High, **M**=Medium, **L**=Low

10.3.3 W3 Catchment (Main River: Mkuze)

The St Lucia Estuarine Lake form part of the Greater St Lucia Estuarine Lake Complex (**Table 10.6**). The system is in a D to D/E Category, resulting for flow diversion, habitat degradation and very high fishing pressure. Lake St Lucia naturally experiences large changes in physico-chemical characteristics, both temporally and spatially, as a result of flood and drought events. During recent droughts, reductions in freshwater flow have resulted in periods of mouth closure with salinities that have reached over 150 (with sea water 35). These reductions have been seriously exacerbated by human interventions such as the separation of the Mfolozi from St Lucia and flow reduction from the catchments (Cyrus *et al*., 2011). Several ecological 'states', from fresh through estuarine and marine to hypersaline, may occur in the lake system at different times, with the marine-estuarine being the dominant state. There is also significant pressure from mouth/channel manipulation and artificial breaching at this important system (**Table 10.7)**.

Table 10.6 Estuary types occurring in W3 Catchment

	Estuary Name	Natural Estuary Type	Present Functional Type	Estuary Aliases/Historical names
W3	St Lucia	Estuarine Lake	Estuarine Lake	St Lucia, "Cwebeni las entelengeni", "Rio de medaos do Ouro"

Table 10.7 Condition and degree of pressure on estuaries in W3 Catchment

	Estuary Name	PES	Cumulative Pressure Level	Pressure: Flow modification	Pressure: Pollution	Pressure: Habitat loss	Pressure: Fishing Effort 2018 (DFFE)	Pressure: Invasive alien plants	Pressure: Alien Fish	Artificial Breaching	Pollution source: Catchment (diffuse)	Pollution Source: Riparian	Pollution: Stormwater	Mining (Sand, Diamonds, minerals)	Marina/Harbours	Aquaculture
W3	St Lucia	D/E	H	L	M	M	VH	M		VH	Agri					

Pressure rating: **VH**=Very high, **H**=High, **M**=Medium, **L**=Low

10.3.4 W7 Catchment (Kosi Estuary and Sibaya Lake)

Two estuarine lakes occur within W7, namely Kosi and uMgobezeleni (**Table 10.8**). Both of these system are relative pristine and rated as A/B to B categories, with little pressure except for overfishing (**Table 10.9**). At both Kosi and uMgobezeleni overfishing have escalated in the last few decades, leading to severe depletion of fish resources.

Table 10.8 Estuary types occurring in W7 Catchment

	Estuary Name	Natural Estuary Type	Present Functional Type	Estuary Aliases/Historical names
W7	uMgobezeleni	Estuarine Lake	Estuarine Lake	uMgobezeleni, Mgobezeleni, Mgobozeleni, Ngoboseleni, Ngobeseleni, Sodwa, Sodwana, Sordwana Lagoon
W7	Kosi	Estuarine Lake	Estuarine Lake	Kosi Bay, Kosi, Umkosi, Nkovugeni

Table 10.9 Condition and degree of pressure on estuaries in W7 Catchment

	Estuary Name	PES	Cumulative Pressure Level	Pressure: Flow modification	Pressure: Pollution	Pressure: Habitat loss	Pressure: Fishing Effort 2018 (DFFE)	Pressure: Invasive alien plants	Pressure: Alien Fish	Artificial Breaching	Pollution source: Catchment (diffuse)	Pollution Source: Riparian	Pollution: Stormwater	Mining (Sand, Diamonds, minerals)	Marina/Harbours	Aquaculture
W7	uMgobezeleni	B	L	L	L	L	H			M						
W7	Kosi	A/B	L	L	L	L	VH	L								

Pressure rating: **VH**=Very high, **H**=High, **M**=Medium, **L**=Low

11 INTEGRATED UNIT OF ANALYSIS - DELINEATION

11.1 INTRODUCTION

Integrated Units of Analysis (IUAs) are ***homogenous catchments*** or linear river reaches that can be managed as an entity. SQRs are nested within RUs which are nested within an IUA which represents a larger catchment and can include various rivers.

An IUA is therefore a broad scale unit (or catchment area/s) that contains several RUs, each represented by a biophysical node. These nodes define specific attributes that together describe the catchment configuration of the IUA. A Water Resource Class (Class) is subsequently allocated per IUA. These Classes are the result of an investigation of the consequences of operational scenarios and the socio-economic and ecological implications for the IUA and its catchment configuration.

11.2 PROCESS TO DETERMINE INTEGRATED UNIT OF ANALYSIS

Water resource use, economics, ecosystem services and ecological status information has been collated (previous chapters) and all this information are used to identify catchments that are similar in terms of these specific components. Therefore, the IUAs which have similar land use (and resulting impacts), and can be managed as a logical entity, are thus a logical unit for which scenarios can be designed and evaluated.

11.3 INTEGRATED UNIT OF ANALYSIS - DELINEATION

Table 11.1 provides the IUAs per secondary catchment and a description of each IUA is provided below. Maps of the IUAs are provided at the end of the chapter.

Table 11.1 IUA delineation

Secondary Catchment	IUA No	IUA Descriptive Name	RU (& SQRs where relevant)
W1	W11	Matigulu	W11-1, W11-2, W11-3, SQR W11C-03893, Estuary
	W12-a	Upper Mhlathuze	W12-1, W12-2 W12-3, W12-4
	W12-b	Mfule, Mhlatuzane, Nseleni Tributary systems	W12-5, W12-7, W12-8
	W12-c	Lower Mhlathuze	W12-6, W12F-03494, W12F-03511, W12F-03611 (Lake Cubhu) Mhlathuze Estuary
	W12-d	Lake Nhlabane	W12-9, W12J-03390, Lake Nhlabane and Estuary
	W12-e	Lake Msingazi	W12-10, W12J-03501, W12J-03493, W12J-03485,W12F-03509, (Lake Msingazi and Mhlathuze Estuary connection)
	W13	Mlalazi	W13-1, W13-2, SQR W13B-03673, Estuary
W2	W21	Upper and Middle White Umfolozi	W21-1, W21-2, W21-3, W21-4, W21-5, W21-6, W21-7
	W22	Upper Black Umfolozi	W22-1, W22-2, W22-3, W22-4
	W23	Umfolozi-Hluhluwe Game Reserve	Nyalazi and Mzinene Tributaries
W3	W31-a	Upper Mkuze	W31-1, W31-2, W31-2
	W31-b	Lower Mkuze	W31-4, W31-5, W31-6, W32-1
	W32-a	Upper Hluhluwe	W32-2
	W32-b	Nyalazi and Mzinene Tributaries	W32-3, W32-4, W32-5, W32-6
W4	W41	Bivane River	W41-1, W41-2
	W42-a	Upper Pongola	W42-1, W42-2
	W42-b	Middle Pongola (Ithala)	W41-3, W42-3, W42-4, W42-5

Secondary Catchment	IUA No	IUA Descriptive Name	RU (& SQRs where relevant)
	W44	Middle Pongola (Grootdraai)	W44-1
	W45	Lower Pongola (Floodplain)	W43-1, R45-1
W5	W51	W5 Upstream major dams	W51-1, W53-1, W53-2, W54-1
	W52	W5 Downstream major dams & Hlelo River	W51-2, W51-3, W51-4, W52-1, W53-3, W54-2
	W55	Mpuluzi & Lusushwana River systems	W55-1, W55-2
	W57	Lower Usutu River	W57-1
W7	W70-a	Kosi Bay	W70-1, W70-2
	W70-b	Sibaya	W70-3
W2 & W3	IUA St Lucia	St Lucia	W23-3, W32H-02998, W32H-03048, W32H-02854, W32F-02835, W32B-02535

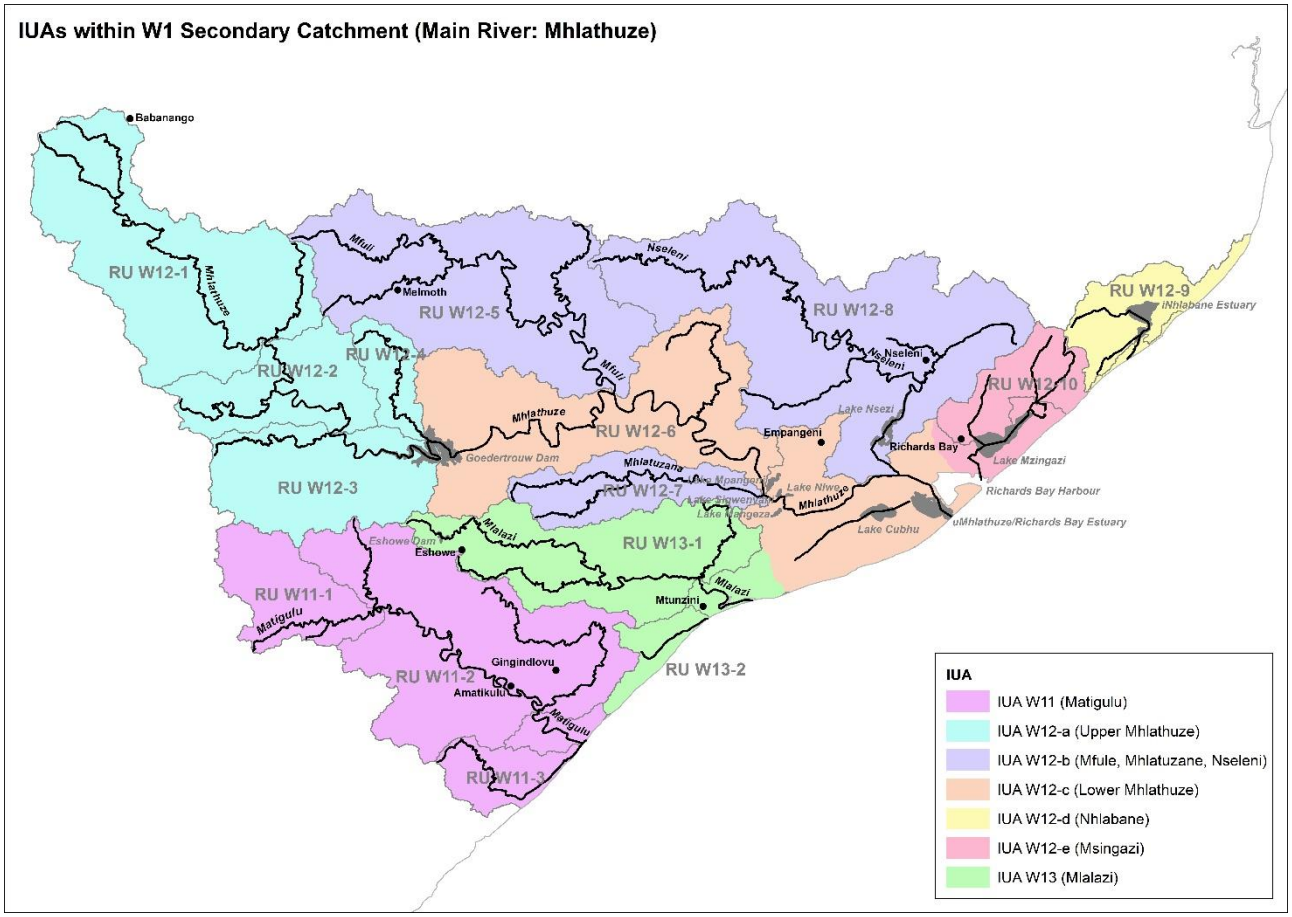


Figure 11.1 IUAs within W1 Secondary Catchment (Main River: Mhlathuze)

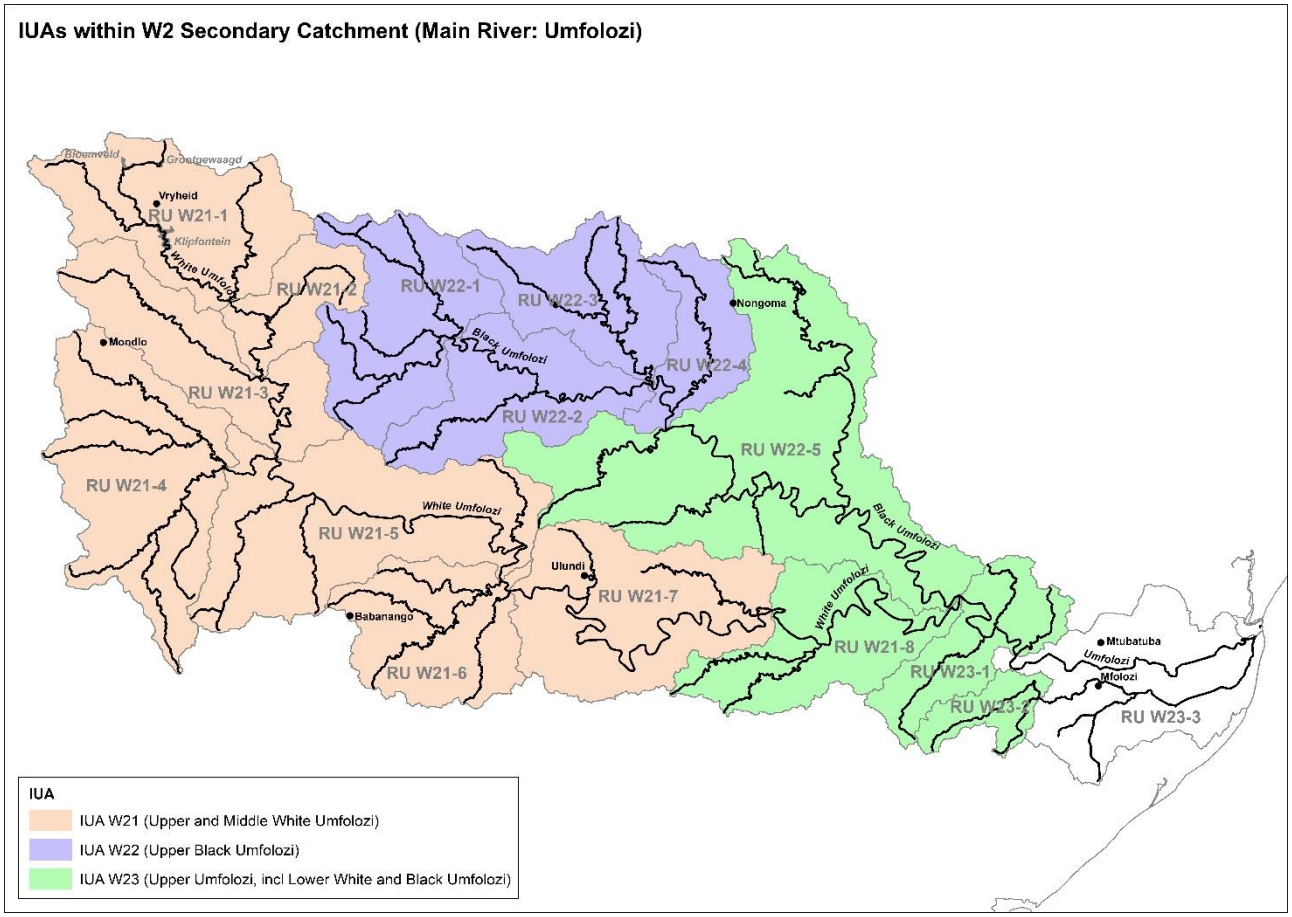


Figure 11.2 IUAs within W2 Secondary Catchment (Main River: Umfolozi)

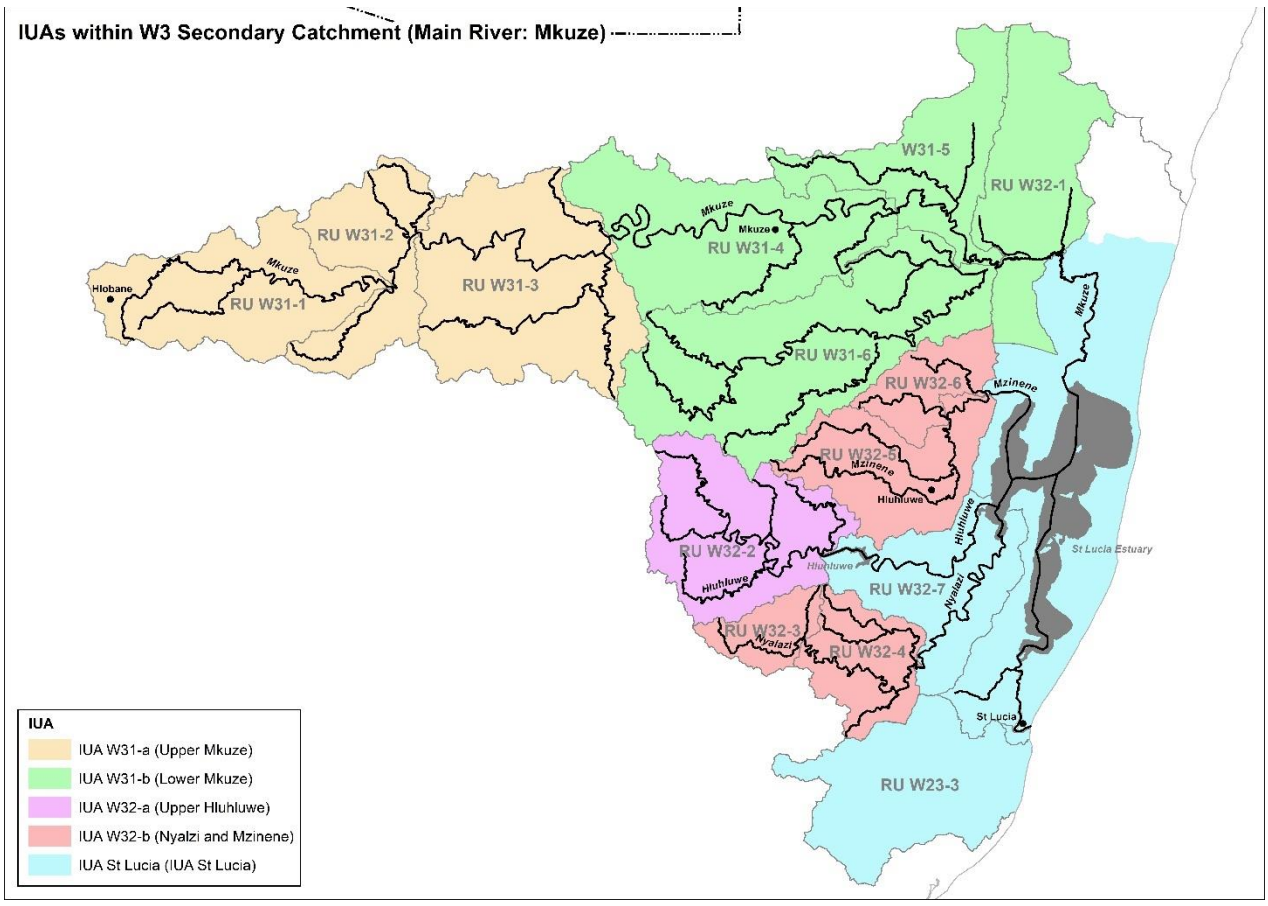


Figure 11.3 IUAs within W3 Secondary Catchment (Main River: Mkuze)

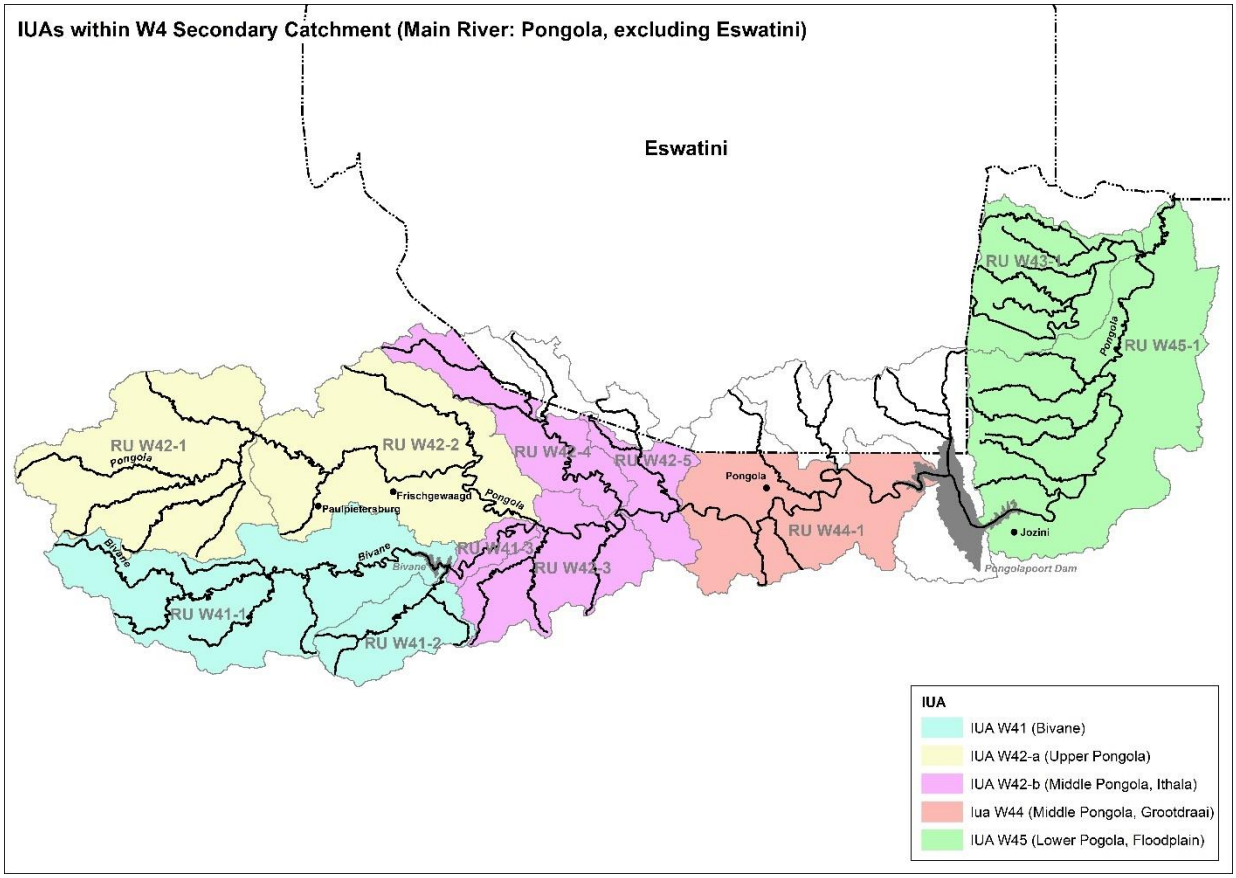


Figure 11.4 IUAs within W4 Secondary Catchment (Main River: Pongola (excluding Eswatini))

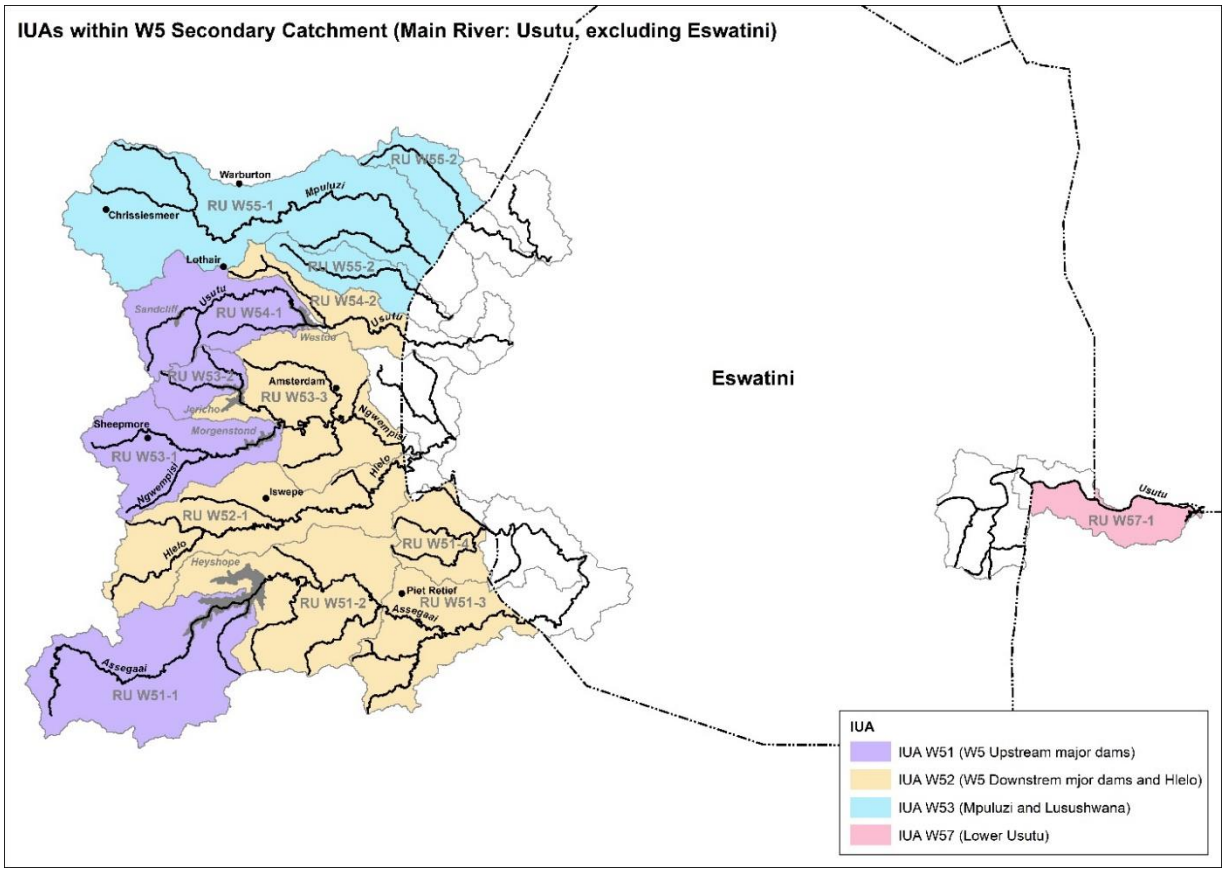


Figure 11.5 IUAs within W5 Secondary Catchment (Main River: Usutu (excluding Eswatini))

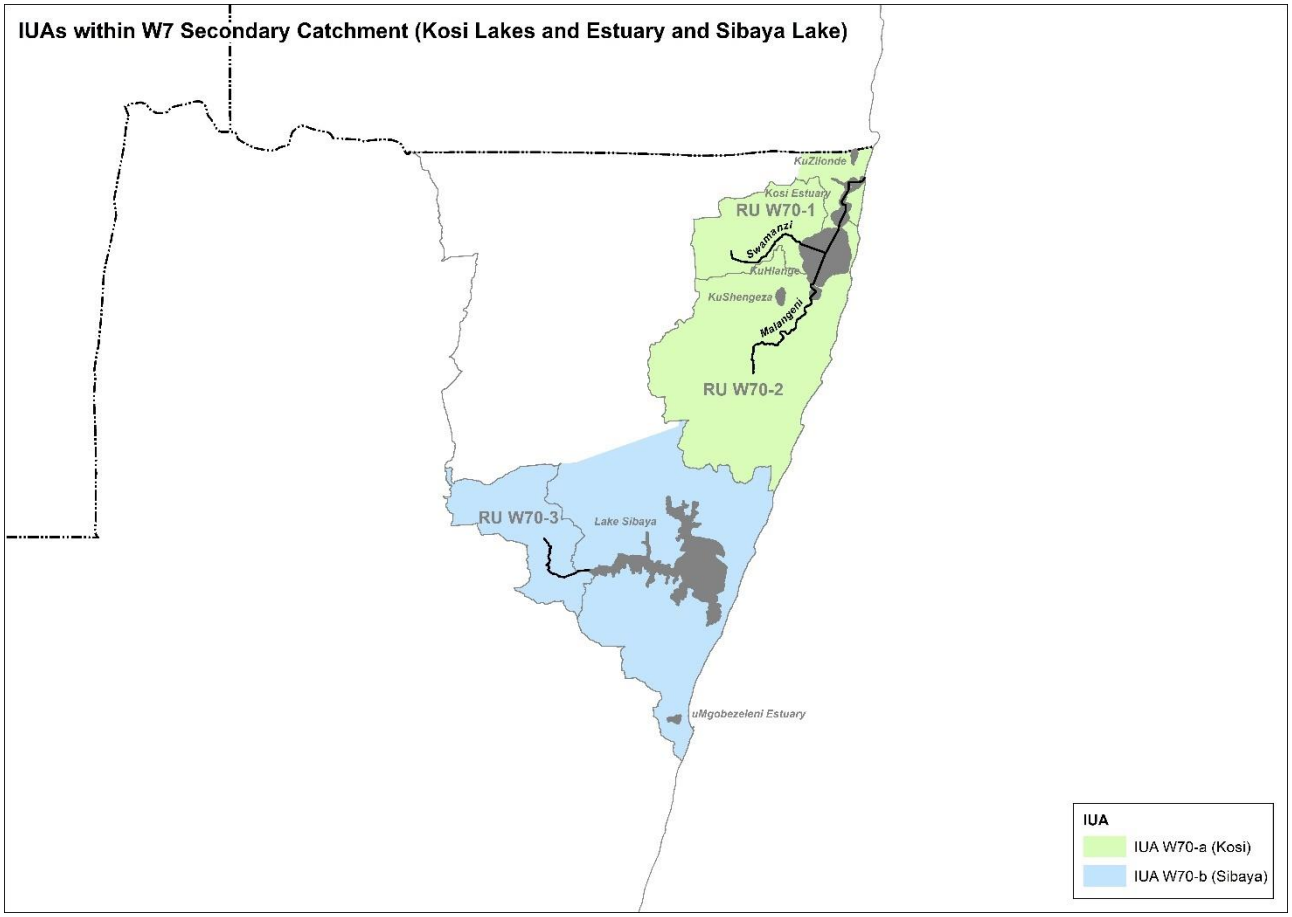


Figure 11.6 IUAs within W7 Secondary Catchment (Main River: Kosi Lakes and Estuary and Lake Sibaya)

12 INTEGRATED UNIT OF ANALYSIS - STATUS QUO ASSESSMENT

The status quo information described in the previous chapters are used to summarise the status quo for each IUA identified and delineated. No new information will be generated for these status quo descriptions.

12.1 W1: STATUS QUO DESCRIPTION OF THE INTEGRATED UNIT OF ANALYSIS

Table 12.1 W1 Catchment: Status quo description of the IUAs

IUA	W11	W12-a	W12-b	W12-c	W12-d	W12-e	W13
Name	Matigulu	Upper Mhlathuze	Mfule, Mhlatuzane, Nseleni Tributary systems	Lower Mhlathuze	Nhlabane	Msingazi	Mlalazi
Surface Water Resources	▪ Farm dams and river runoff only. No major dams.	▪ Farm dams and river runoff. ▪ Goedertrouw Dam at outlet. ▪ Transfers from Thukela catchment enter.	▪ Farm dams and river runoff. ▪ Lake Nsezi supplying Mhlathuze Water situated.	▪ Releases from Goedertrouw Dam to Mhlathuze weir made in this stretch. ▪ Large areas of commercial irrigation. ▪ Lake Cubhu supplying Esikhaweni.	▪ Lake Nhlabane supplying RBM. ▪ Transfer from Umfolozi to the north enters here.	▪ Lake Mzingazi supplying Richards Bay.	▪ Farm dams and river runoff. ▪ Eshowe and Rutledge Dam provide resources to Eshowe Town.
Groundwater Resources	▪ Stress Index: < 0.05. ▪ Potable water quality fraction: 0.2 - 0.95. ▪ Groundbaseflow as % of baselow: 20 - 22.	▪ Stress Index: < 0.05. ▪ Potable water quality fraction: 0.98 - 1. ▪ Groundbaseflow as % of baselow: 28 - 36.	▪ Stress Index: < 0.05. ▪ Potable water quality fraction: 0.28 - 0.94. ▪ Groundbaseflow as % of baselow: 20 - 36.	▪ Stress Index: < 0.05. ▪ Potable water quality fraction: 0.68. ▪ Groundbaseflow as % of baselow: 35.	▪ Stress Index: < 0.0.5 ▪ Potable water quality fraction: 0.91 - 1. ▪ Groundbaseflow as % of baselow: 28 - 30.	▪ Stress Index: < 0.05. ▪ Potable water quality fraction: 0.7. ▪ Groundbaseflow as % of baselow: 20.	▪ Stress Index: < 0.05. ▪ Potable water quality fraction: 0.89 - 1. ▪ Groundbaseflow as % of baselow:10 - 13.
Economics	▪ Large area of subsistence agriculture. ▪ Small area of commercial forestry.	▪ Predominantly subsistence agriculture. ▪ Extensive commercial forestry.	▪ Predominantly tribal subsistence farming.	▪ Extensive irrigated sugar cane production. ▪ Extensive fruit and vegetable production. ▪ Large commercial forestry area. ▪ Industrial including paper mill, shipping and port area of Richards Bay and	▪ Minor tourism activity.	▪ Minor tourism activity.	▪ Some tributary dams, emerging and subsistence agriculture.

IUA	W11	W12-a	W12-b	W12-c	W12-d	W12-e	W13
Name	Matigulu	Upper Mhlathuze	Mfule, Mhlatuzane, Nseleni Tributary systems	Lower Mhlathuze	Nhlabane	Msingazi	Mlalazi
				Empangeni.			
Water quality	▪ Low water quality impact upstream up to the Amaticulu Sugar Mill in the lower end of W11A-03612.	▪ Low-moderate water quality impacts. ▪ No priority areas identified.	▪ An area of high water quality impact with three priority areas identified. ▪ Impacts include WWTW discharges and mining impacts.	▪ Three priority areas identified, including the lower river reach. ▪ Impacts range from high sedimentation and turbidities to extensive settlements and industrial impacts. ▪ Estuarine pollution pressures high.	▪ Moderate water quality impacts. ▪ No priority areas identified.	▪ One water quality priority area, i.e. RBM smelter impacts. ▪ Estuarine pollution pressures high.	▪ Moderate water quality impacts. No priority areas identified. ▪ Estuarine pollution pressures high.
Ecosystem Services	▪ Tribal Trust land and Entumeni Nature Reserve.	▪ Commercial and Forestry in north part of IUA, Tribal Trust in lower part. ▪ Upstream of Goedertrouw, heart of Shaka and Zulu Kingdom.	▪ Upper Section is Melmoth area and Ingonyama Trust. ▪ Lower Section is large area, mixed land use, upper area mostly Ingonymana Trust, then commercial and forestry, Thula Thula game reserve.	▪ Downstream of Goedertrouw Dam - Nkwaleni valley (large scale commercial farms and some land reform) then Ingonyama Trust land and Industrial Areas.	▪ Lake Nhlabane area. Largely coastal forest, highly contested area and heavily populated.	▪ Largely coastal forest but includes the RBM portion, highly contested area and heavily populated. ▪ Headwater of Lake Mzingazi.	▪ Upper portion Eshowe to the N2 largely Ingonyama Trust. ▪ Lower portion Coastal, commercial land use, forest.
River (Ecology)	▪ -Largely in a C and C/D EC. ▪ Mostly non-flow related activities (presence of roads, extensive agriculture, vegetation clearing and alien vegetation). ▪ Flow related activities (small dams in mainstream and tributaries). ▪ Upstream reaches of the Matigulu River is	▪ Largely in a C. ▪ Roads, extensive overgrazing, sand mining, alien vegetation, forestry, small dams, intermittent transfers from the Thukela River.	▪ Mixture of C and B. ▪ Rural settlements, forestry, dry land cultivation, dams in tributaries, Melmoth. ▪ Lower reaches of Nseleni a D due to extensive cultivation, forestry, alien vegetation, dams and WWTW.	▪ Highly modified due to Goedertrouw releases, extensive irrigated cultivation, alien vegetation, sand mining. ▪ Lower section canalised and conduit to estuary.	▪ Largely C due to extensive forestry, roads.	▪ Largely C due to extensive forestry, roads, stormwater runoff, RBM smelter, historical mine and water quality seepage from urban areas.	▪ Largely in a C. ▪ Extensive formal agriculture, WWTW, tributary dams, emerging and subsistence agriculture. ▪ RU W13-2 is in a B/C as associated with Umlalali Nature Reserve in lower reaches.

IUA	W11	W12-a	W12-b	W12-c	W12-d	W12-e	W13
Name	Matigulu	Upper Mhlathuze	Mfule, Mhlatuzane, Nseleni Tributary systems	Lower Mhlathuze	Nhlabane	Msingazi	Mlalazi
	largely in a B EC.						
Wetland (Ecology)	▪ HGM (Ha in IUA): -CVB: 0 -DEPR: 115 -EST: 4942 -FLOOD: 82 -RIVER: 158 -SEEP: 1068 -UVB: 321 **Total**: **6686** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 2.2 -C: 3.1 -D/E/F: 18.5 -N/A: 76.3	▪ HGM (Ha in IUA) -CVB: 7 -DEPR:3 -EST: 0 -FLOOD: 0 -RIVER: 56 -SEEP: 1096 -UVB: 101 **Total**: **1262** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 4.4 -C: 23.4 -D/E/F: 67.8 -N/A: 4.4	▪ HGM (Ha in IUA): -CVB: 336 -DEPR: 211 -EST: 11848 -FLOOD: 2990 -RIVER: 1350 -SEEP: 659 -UVB: 1396 **Total**: **18789** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 0.2 -C: 0.8 -D/E/F: 28.7 -N/A: 70.2 ▪ Notable wetlands: Nsezi.	▪ HGM (Ha in IUA): -CVB: 0 -DEPR: 210 -EST: 29312 -FLOOD: 3633 -RIVER: 2014 -SEEP:399 -UVB: 949 **Total**: **36517** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 1.0 -C: 0.3 -D/E/F: 12.9 -N/A: 85.8 ▪ Notable wetlands: swamp system, floodplain, Cubhu, Thulazihleka.	▪ HGM (Ha in IUA): ▪ -CVB: 421 -DEPR: 170 -EST: 30726 -FLOOD: 0 -RIVER: 0 -SEEP: 622 -UVB: 190 **Total**: **32128** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 0.1 -C: 0.1 -D/E/F: 4.2 -N/A: 95.6 ▪ Notable wetlands: Mzingazi.	▪ HGM (Ha in IUA): -CVB: 4 -DEPR: 9 -EST: 18879 -FLOOD: 0 -RIVER: 0 -SEEP: 22 -UVB: 0 **Total**: **18913** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 0.0 -C: 0.0 -D/E/F: 0.2 -N/A: 99.8	▪ HGM (Ha in IUA): -CVB: 84 -DEPR: 221 -EST: 8265 -FLOOD: 0 -RIVER: 304 -SEEP: 219 -UVB: 88 **Total**: **9180** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 1.7 -C: 0.3 -D/E/F: 4.6 -N/A: 93.3 ▪ Notable wetlands: Umlalazi.
Estuary (Ecology)	▪ B Category. ▪ -Low cumulative pressure, except for overfishing, artificial breaching.			▪ -D/E Category. ▪ -High cumulative pressure, port development/habitat destruction, pollution, overfishing, flow reduction.	▪ E Category. ▪ High cumulative pressure, weir cutting of lake, mining, habitat destruction, pollution, overfishing.		Mlalazi Estuary: ▪ B Category. ▪ Low cumulative pressure, but some flow reduction and high fishing pressure. Siyaya Estuary: ▪ E Category ▪ High cumulative pressure: flow modification, pollution, development/habitat destruction.

12.2 W2: STATUS QUO DESCRIPTION OF THE INTEGRATED UNIT OF ANALYSIS

Table 12.2 W2 Catchment: Status quo description of the IUAs

IUA	W21	W22	W23
Name	Upper and Middle White Umfolozi	Upper Black Umfolozi	Upper Umfolozi (including Lower White and Black Umfolozi)
Surface Water Resources	▪ Klipfontein Dam and other smaller dams supplying Vryheid and Ulundi.	▪ Vuna and Vokwena Dams supplying Nongoma.	▪ Farm dams and river runoff only. ▪ No major dams.
Groundwater Resources	▪ Stress Index: <0.01 - 0.11. ▪ Potable water quality fraction 0.18 - 1. ▪ Groundbaseflow as % of baseflow: 23 - 34.	▪ Stress Index: < 0.01 – 012. ▪ Potable water quality fraction: 0.64 – 1. ▪ Groundbaseflow as % of baseflow: 13 – 48.	▪ Stress Index: < 0.05. ▪ Potable water quality fraction: 0.18 – 3. ▪ Groundbaseflow as % of baseflow: 35 - 46.
Economics	▪ A mixture of extensive commercial and subsistence farming. ▪ Some dryland maize production. ▪ Umfolozi/Hluhluwe game reserve. ▪ Extensive commercial forestry.	▪ Extensive subsistence farming. ▪ Extensive commercial forestry.	▪ Coal mining. ▪ Extensive sugar cane farming. ▪ Sugar cane mill. ▪ Saw Mill (Mtubatuba). ▪ Extensive tourism activities. ▪ Large area of commercial forestry.
Water quality	▪ An area of high water quality impact, with nine priority areas identified. ▪ Impacts range from pollution from coal mines to dysfunctional WWTW and urban impacts, to extensive gully erosion and sedimentation.	▪ Moderate water quality impacts, with one priority area identified due to coal-mining impacts.	▪ An area of moderate-high water quality impact with two priority areas identified due to mining impacts.
Ecosystem Services	▪ Upper area (north-west) includes Vryheid area with commercial farming as well as Gluckstadt, commercial farming area. ▪ South western portion is mostly Ingonyama Trust, high density closer/rural settlement including Nondweni and Nqutu large sub catchment, including closer rural settlement, some bush lodge and park areas, approaches Ulundi.	▪ Northern parts of sub catchment are commercial and forestry, Gluckstadt area, some game farming (Loziba) some scattered rural homesteads - land claim farms are evident. ▪ Lower portion is commercial and game farming as well as closer rural settlement (KwaDuvela) and dense settlement, proximate to Nongoma.	▪ This includes a large area from Nongoma to Hluhluwe Umfolzi Park, incuses closer and dense settlement, as well as National park. ▪ Somekele Mine is included.
River (Ecology)	▪ Upper White Umfolozi largely in a C (Forestry, dams, agriculture, Hlobane mine dumps, extensive rural developments, irrigation, erosion, sedimentation) ▪ Nondweni is in a D with small section in an E (Overgrazing, erosion, sedimentation, urban areas, WWTW). ▪ Middle Umfolozi in a B/C to a B EC within Hluhluwe iMfolozi Game Reserve.	▪ Black Umfolozi upstream of Hluhluwe iMfolozi Park in a B/C (formal and subsistence farming, forestry, erosion, coal mining, rural areas, dams). ▪ Lower sections in a B EC with Umfolozi River either bordering or within the park.	▪ Largely in a B EC as within or bordering the Hluhluwe iMfolozi Game Reserve.
Wetland (Ecology)	▪ HGM (Ha in IUA): -CVB: 419 -DEPR: 130	▪ HGM (Ha in IUA): -CVB: 779 -DEPR: 13	▪ HGM (Ha in IUA): -CVB: 106 -DEPR: 219

IUA	W21	W22	W23
Name	Upper and Middle White Umfolozi	Upper Black Umfolozi	Upper Umfolozi (including Lower White and Black Umfolozi)
	-EST: 0 -FLOOD: 564 -RIVER: 30533 -SEEP: 14026 -UVB: 1532 **Total**: **47204** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 6.7 -C: 7.8 -D/E/F: 20.8 -N/A: 64.7 ▪ Notable wetlands: Stilwater Vlei, Blomveld Vlei, Lenjani Vlei, Grootgewaagd Vlei.	-EST: 0 -FLOOD: 0 -RIVER: 778 -SEEP: 4832 -UVB: 7 **Total**: **6409** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 11.7 -C: 15.0 -D/E/F: 61.2 -N/A: 12.1 ▪ Notable wetlands: Aloeboom Vlei.	-EST: 0 -FLOOD: 0 -RIVER: 829 -SEEP: 6772 -UVB: 176 **Total**: **8102** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 16.3 -C: 16.9 -D/E/F: 56.6 -N/A: 10.2 ▪ Notable wetlands: Fuyeni Reedbed, Mvamazi Pan, Umfolozi riverine floodplain.

12.3 W3: STATUS QUO DESCRIPTION OF THE INTEGRATED UNIT OF ANALYSIS

Table 12.3 W3 Catchment: Status quo description of the IUAs

IUA	W31-a	W31-b	W32-a	W32-b
Name	Upper Mkuze	Lower Mkuze	Upper Hluhluwe	Nyalazi and Mzinene
Surface Water Resources	▪ Vaalbank Dam, Boulder Dam and other smaller dams supplying Hlobane, Corronation and surrounding communities.	▪ Blackie Dam receives water from transfer from Pongolapoort Dam and supplies large commercial irrigation and nearby communities around Mkuze Village.	▪ Hluhluwe Dam at outlet.	▪ Farm dams and river runoff only. ▪ No major dams.
Groundwater Resources	▪ Stress Index: <0.05. ▪ Potable water quality fraction: 0.36 – 1. ▪ Groundbaseflow as % of baseflow: 21 - 64.	▪ Stress Index: <0.05. ▪ Potable water quality fraction: 0.18 - 0.7. ▪ Groundbaseflow as % of baseflow: 67 - 93	▪ Stress Index: <0.05. ▪ Potable water quality fraction 0.73 - 0.81. ▪ Groundbaseflow as % of baseflow: 45 - 46.	▪ Stress Index: <0.01 - 0.11. ▪ Potable water quality fraction: 0.25 - 0.42. ▪ Groundbaseflow as % of baseflow: 45-68.
Economics	▪ Dominated by subsistence agriculture.	▪ Irrigated sugar cane production. ▪ Mostly winter vegetable production. ▪ Irrigated and dryland cotton production. ▪ Some citrus and maize production. ▪ Tourism activities - uMkhuze Game Reserve.	▪ Tourism activities in the Hluhluwe Game Reserve.	▪ Large commercial farming that includes Queen pineapple production. ▪ Some subsistence farming.
Water quality	▪ Low-moderate water quality impacts, with two priority areas identified due to	▪ Variable water quality state across the IUA, with one priority area identified	▪ An area of low water quality impact. ▪ No priority areas identified.	▪ An area of low water quality impact, with one priority area identified due to

IUA	W31-a	W31-b	W32-a	W32-b
Name	Upper Mkuze	Lower Mkuze	Upper Hluhluwe	Nyalazi and Mzinene
	coal-mining impacts and irrigation return flows.	due to a dysfunctional WWTW.		a dysfunctional WWTW.
Ecosystem Services	▪ Nkongolwana largely in commercial farmland and forest. ▪ The Mkuze river flows through both commercial faming land as well as Ingonyama Trust, the other tributaries appear to be largely in commercial farming areas and upper portions of Ithala Game Reserve. ▪ Amakosi private game reserve, and Magudu town, some commercial farming in IUA.	▪ Upper portion of IUA is Commercial farming in and around town of Mkuze, multiple game and nature reserves. Ingonyama Trust area near Sibonokhukle. ▪ Lower portion is extensive area largely given over to up market game and nature reserves. Very lower parts border on Ingonyama Trust. Also includes closer settlement with some areas bordering on private farm and game park, adjacent to iSimangaliso Wetland Park.	▪ Hluhluwe iMfolozi Game Reserve but also denser rural settlement in vicinity of Sangonya.	▪ Southern portion is in Hluhluwe iMfolozi Game Reserve but also denser rural settlement in vicinity of KwaSithole and Ensolweni and dense rural and closer settlement, virtually all within the Ingonyama areas, Shikishela. ▪ Northern portion is combination of land use given over to nature reserves, forestry and intensive farming as well as some Ingonyama Trust.
River (Ecology)	▪ Varies from a C to a B EC. ▪ Impacts range from forestry, coal mining, instream dams, rural areas, irrigated crops, alien vegetation, erosion and sedimentation.	▪ B EC as associated with uMkhuze Game Reserve. ▪ Outside of the Game Reserve largely in a C EC (impacts associated with Mkuze town, irrigation, subsistence farming and erosion, canals, vegetation removal).	▪ Mostly in a B EC as within the Hluhluwe iMfolozi Game Reserve.	▪ Mostly in a C EC. ▪ Impacts are overgrazing, sand mining, subsistence farming, erosion, sand mining, sugarcane farming, urban (Hluhluwe) and associated WWTW, instream dams and levees.
Wetland (Ecology)	▪ HGM (Ha in IUA): -CVB 5 -DEPR 97 -EST 0 -FLOOD 0 -RIVER 116 -SEEP 311 -UVB 40 **Total 570** ▪ Wetland Condition (% of wetlands in IUA): -A/B 23.3 -C 23.6 -D/E/F 32.8 -N/A 20.3	▪ HGM (Ha in IUA): -CVB 58 -DEPR 1313 -EST 67948 -FLOOD 9604 -RIVER 1616 -SEEP 957 -UVB 1235 **Total 82730** ▪ Wetland Condition (% of wetlands in IUA): -A/B 7.8 -C 5.0 -D/E/F 3.2 -N/A 84.1 ▪ Notable wetlands: Nhlonhlela Pan, Hlonhlela, Mkuze Gr Airstrip Pans, Nsumu Pan, Muzi (South), Neshe, Yengweni, St Lucia – Manzibomvu, Mdlaze Pan, Mpanze Pan, Tshanetshe.	▪ HGM (Ha in IUA): -CVB: 80 -DEPR: 4 -EST: 0 -FLOOD: 0 -RIVER: 1482 -SEEP: 422 -UVB: 2 **Total 1990** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 1.3 -C: 4.0 -D/E/F: 20.2 -N/A: 74.5 ▪ Notable wetlands: Enseleni	▪ HGM (Ha in IUA): -CVB : 0 -DEPR: 486 -EST: 135895 -FLOOD: 0 -RIVER: 0 -SEEP: 687 -UVB: 391 **Total: 137461** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 0.1 -C: 0.1 -D/E/F: 0.9 -N/A: 98.9 ▪ Notable wetlands: Hluhluwe Floodplain

12.4 W4: STATUS QUO DESCRIPTION OF THE INTEGRATED UNIT OF ANALYSIS

Table 12.4 W4 Catchment: Status quo description of the IUAs

IUA	W41	W42-a	W42-b	W44	W45
Name	Bivane	Upper	Middle (Ithala)	Middle Pongola (Grootdraai)	Lower Pongola (Floodplain)
Surface Water Resources	▪ Bivane Dam situated at outlet, releases water for downstream commercial irrigation.	▪ Edumbe Dam supplying Paul Pietersburg. ▪ River abstraction for Frischgewaagd communities.	▪ Smaller tributaries supply Simdlangentsha Central communities.	▪ Canal diversion for large commercial irrigation and Pongola Town and surrounding communities supply. ▪ Pongolapoort Dam situated at outlet.	▪ Releases made from Pongolapoort Dam to supply downstream communities including new Shemula WWTW.
Groundwater Resources	▪ Stress Index: <0.05. ▪ Potable water quality fraction: 0.81 - 1. ▪ Groundbaseflow as % of baseflow: 12 - 20.	▪ Stress Index: <0.05. ▪ Potable water quality fraction: 0.85 – 1. ▪ Groundbaseflow as % of baseflow: 11 - 22.	▪ Stress Index: <0.05. ▪ Potable water quality fraction: 0.1. ▪ Groundbaseflow as % of baseflow: 14 - 29.	▪ Stress Index: <0.05. ▪ Potable water quality fraction 0.69 – 1. ▪ Groundbaseflow as % of baseflow: 46 - 68.	▪ Stress Index: <0.05. ▪ Potable water quality fraction 0.31 - 0.54. ▪ Groundbaseflow as % of baseflow: 67.
Economics	▪ Large commercial forestry. ▪ Large commercial farming. ▪ Subsistence farming.	▪ Large commercial forestry.	▪ Large sugar cane production. ▪ Maize and summer vegetable production. ▪ Sugar cane mill.	▪ Sugar cane production. ▪ Some maize production.	▪ Irrigated and dryland cotton production.
Water quality	▪ An area of low water quality impact with one priority area identified due to mining impacts and agriculture.	▪ An area of moderate water quality impact with one priority area identified at Paulpietersburg.	▪ An area of low water quality impact with no priority areas identified.	▪ An area of high water quality impact with four priority areas identified due to extensive irrigated agriculture, dysfunctional WWTW and urban impacts.	▪ An area of moderate-high water quality impact with three priority areas identified due to dysfunctional WWTW, extensive irrigated agriculture and dense settlements.
Ecosystem Services	▪ IUA includes Paris Dam and upstream of dam. ▪ Upstream is extensive commercial farming with some nature lodges and reserves. ▪ Popular fishing area. ▪ Includes Obivane and areas that are on Ingonyama Trust lands. ▪ Southern tributaries into Bivane/Paris Dam are mostly Ingonyama Trust.	▪ Upper Pongola River Luneneburg area. Mostly timber and commercial farming. Paardeplaats Nature Reserve. ▪ Some tribal trust land associated with Ntombe tributary and also Pongola River ▪ Upstream of Frischgewaagd is commercial and timber farming, downstream is largely Tribal trust.	▪ Downstream of Paris dam to Pongola confluence. Mostly Ingonyama Trust then Ithala Game Reserve and Louwsberg Game park as well as some scattered rural settlement in Tribal trust areas. ▪ Lower portion of IUA is Mozana River, some commercial farming and then Tribal Trust areas. ▪ Dense settlement in lower part of the sub-catchment and ultimately some private game	▪ Pongola River and tributaries upstream of Jozini Dam, includes commercial and game farming, extensive sugar cane and private game reserve areas.	▪ Portion of IUA east of Eswatini and bordering on Ndumo Game Reserve. ▪ Pongola River downstream of Jozini Dam, Makhatinhi Flats and floodplains' and east of Ndumo Game Reserve terminating on Mozambique Border.

IUA	W41	W42-a	W42-b	W44	W45
Name	Bivane	Upper	Middle (Ithala)	Middle Pongola (Grootdraai)	Lower Pongola (Floodplain)
			farms.		
River (Ecology)	▪ C EC. ▪ Non-flow related impacts (extensive forestry and agriculture).	▪ C EC. ▪ Non-flow and flow related impacts (extensive forestry, irrigated and dryland agriculture, dams in tributaries, Paulpietersburg water quality issues).	▪ Pongola River and Mozana Tributaries in a B EC (borders and within Ithala Game Reserve). ▪ Some tributaries in a C condition (instream dams, forestry, agriculture and alien vegetation, overgrazing, sand mining, subsistence farming).	▪ D EC. ▪ Impacts mostly associated with Impala Irrigation Board canal system and Grootdraai Weir – extensive flow regulation.	▪ Pongola River and tributaries in RU W45-1 in C EC. (Makatini Flats). ▪ Changes in flow regime (floods), subsistence agriculture. ▪ Lower section within Ndumo. ▪ Ngavuma River and tributaries. Largely C EC (subsistence farming, overgrazing, forestry, sedimentation.
Wetland (Ecology)	▪ HGM (Ha in IUA): -CVB: 434 -DEPR: 63 -EST: 0 -FLOOD: 0 -RIVER: 2912 -SEEP: 3829 -UVB: 655 **Total: 7893** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 17.6 -C: 11.7 -D/E/F: 33.9 -N/A: 36.9	▪ HGM (Ha in IUA): -CVB: 1281 -DEPR: 83 -EST: 0 -FLOOD: 499 -RIVER: 6883 -SEEP: 3224 -UVB: 358 **Total: 12328** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 14.1 -C: 6.3 -D/E/F: 23.8 -N/A: 55.8	▪ HGM (Ha in IUA): -CVB: 148 -DEPR: 9 -EST: 0 -FLOOD: 0 -RIVER: 30923 -SEEP: 645 -UVB: 0 **Total: 31725** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 0.1 -C: 2.2 -D/E/F: 0.3 -N/A: 97.5	▪ HGM (Ha in IUA): -CVB: 18 -DEPR: 24 -EST: 0 -FLOOD: 203 -RIVER: 17732 -SEEP: 147 -UVB: 15 **Total: 18139** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 0.2 -C: 0.8 -D/E/F: 1.2 -N/A: 97.8	▪ HGM (Ha in IUA): -CVB: 18878 -DEPR: 216 -EST: 0 -FLOOD: 16531 -RIVER: 3289 -SEEP: 675 -UVB: 2813 **Total: 42402** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 0.2 -C: 8.5 -D/E/F: 83.5 -N/A: 7.8 ▪ Notable wetlands: Mtoti Pan, Pongola Floodplain, Msenyeni Pan, Balamhlanga, Mandlankunzi Pan, Ndumo Game Reserve, Bumbe Pan, Khanganzeni Pan, Nhlole Pan, Shalala Pans, Tete Pan.

12.5 W5: STATUS QUO DESCRIPTION OF THE INTEGRATED UNIT OF ANALYSIS

Table 12.5 W5 Catchment: Status quo description of the IUAs

IUA	W51	W52	W55	W57
Name	W5 Upstream major dams	W5 Downstream major dams & Hlelo	Mpuluzi & Lusushwana	Lower Usutu
Surface Water Resources	▪ Major Dams of Westoe, Jericho, Morgenstond and Heyshope situated at outlet. ▪ Main transfers from these dams to Vaal and Olifants powerstations.	▪ Farm dams and river runoff only. ▪ No major dams.	▪ Farm dams and river runoff only. ▪ No major dams.	▪ None
Groundwater Resources	▪ Stress Index: 0 - 0.13. ▪ Potable water quality fraction: 1. ▪ Groundbaseflow as % of baseflow: 20 – 30.	▪ Stress Index: <0.05. ▪ Potable water quality fraction: 1. ▪ Groundbaseflow as % of baseflow: 19 - 34.	▪ Stress Index: <0.05. ▪ Potable water quality fraction: 1 ▪ Groundbaseflow as % of baseflow: 27 - 45	▪ Stress Index: <0.05. ▪ Potable water quality fraction: 0.25 ▪ Groundbaseflow as % of baseflow: 31 – 59.
Economics	▪ Maize and winter vegetables. ▪ Commercial forestry.	▪ Commercial agriculture. ▪ Paper Mill (Piet Retief).	▪ Commercial agriculture.	▪ Subsistence agriculture.
Water quality	▪ An area of low water quality impact with no priority areas identified.	▪ Variable water quality state across the IUA, with three priority areas identified due to a dysfunctional WWTW and urban impacts from Piet Retief and surrounds.	▪ Moderate water quality impacts with a priority area in the lower reaches due to a dysfunctional WWTW and extensive settlements.	▪ Low water quality impact with no priority areas identified.
Ecosystem Services	▪ Tributaries upstream od Dams are mostly commercial farming upper area includes some denser settlement but bulk is commercial and forest plantation with very scattered population.	▪ Some scattered rural tribal trust areas in upper part of sub catchment, bulk of middle and lower areas are commercial and timber farming. Some recreational fishing. ▪ Area in South Africa is commercial farming and timber. The Eswatini area is subsistence agriculture.	▪ IUA upper portions in South Africa are timber and commercial farming, then rivers enter dense tribal trust area before crossing border into Eswatini.	▪ IUA is largely Ndumo Game Reserve and Mozambique Border.
River (Ecology)	▪ Mostly C, C/D and D EC. ▪ Non-flow related impacts (extensive forestry, alien vegetation, and agriculture).	▪ Mostly C. ▪ Flow changes due to upstream dams, extensive forestry, alien vegetation, agriculture, and mining.	▪ Mpuluzi B/C EC (small dams, forestry). ▪ Lusushwana C EC (forestry, dams, subsistence farming).	▪ B/C EC. ▪ Borders Ndumo Game Reserve. ▪ Flow changes.
Wetland (Ecology)	▪ HGM (Ha in IUA): -CVB: 12201 -DEPR: 2086 -EST: 0 -FLOOD: 770 -RIVER: 91 -SEEP: 3768 -UVB: 78 **Total: 18994** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 13.8	▪ HGM (Ha in IUA): -CVB: 12249 -DEPR: 1094 -EST: 0 -FLOOD: 7180 -RIVER: 1657 -SEEP: 4086 -UVB: 29 **Total: 26294** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 6.2 -C: 11.1	▪ HGM (Ha in IUA): -CVB: 8540 -DEPR: 7375 -EST: 0 -FLOOD: 461 -RIVER: 0 -SEEP: 7647 -UVB: 1693 **Total: 25716** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 15.2	▪ HGM (Ha in IUA): -CVB: 0 -DEPR: 36 -EST: 0 -FLOOD: 4949 -RIVER: 134 -SEEP: 21 -UVB: 1604 **Total: 6744** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 1.3

IUA	W51	W52	W55	W57
Name	W5 Upstream major dams	W5 Downstream major dams & Hlelo	Mpuluzi & Lusushwana	Lower Usutu
	-C: 14.6 -D/E/F: 71.1 -N/A: 0.5 ▪ Notable wetlands: Langfontein Pan 3, Liefgekozen.	-D/E/F: 76.4 -N/A: 6.3	-C: 25.8 -D/E/F: 59.1 -N/A: 0.0 ▪ Notable wetlands: Lusthof - Pan 18, Tevrede Se Pan - Pan 16, Tevreden, Blaauwater, Florence, Blinkpan, Coalbank, Eilandsmeer, Goedehoop - Pan 18, Grasdal, Hamilton, Lake Banagher, Lake Banagher - Pan 31, Lake Banagher - Pan 36, Lake Chrissie, Lake Chrissie - Pan 10, Lake Chrissie - Pan 56, Neethlingpan, Tweelingpan - Pan 17, Tweelingpan - Pan 26, Van Aardt Graspan, Van Aardt Kaalpan, West Tweelingpan.	-C: 82.5 -D/E/F: 14.2 -N/A: 2.0 ▪ Notable wetlands: Shokwe Pan, Banzi Pan (Ndumo).

12.6 W7: STATUS QUO DESCRIPTION OF THE INTEGRATED UNIT OF ANALYSIS

Table 12.6 W7 Catchment: Status quo description of the IUAs

IUA	W70-a	W70-b
Name	Kosi	Sibaya
Surface Water Resources	▪ Small streams and Lake Shengesa supplying surrounding communities.	▪ Lake Sibaya supplying Mseleni and Mbaswane communities.
Groundwater Resources	▪ Stress Index: 0 - 0.1. ▪ Potable water quality fraction: 0.84. ▪ Groundbaseflow as % of baseflow: 97. It should be noted that in W70A, although registered groundwater use is only 2.34, there is a registered use for abstraction from the lake of 2776835 m^3/a for domestic supply from lake Sibaya and another 546590 m^3/a from lake Shengeza. Since the lakes are groundwater fed, this is equivalent to a groundwater abstraction. There is also domestic groundwater use and additional small scale irrigation, and registered water use by forestry. The total estimated groundwater use is 34.87 Mm^3/a (DWS, 2016). Although the stress index is low, concentrated abstraction from lakes may have an impact on lake levels, dependent the rate of flow from the underlying aquifer to the lake.	
Economics	▪ Extensive commercial forestry. ▪ Tourism activities.	▪ Extensive commercial forestry. ▪ Tourism activities.
Water quality	▪ Moderate water quality across the area with one priority area due to urban impacts and a dysfunctional WWTW.	▪ Moderate water quality across the area with one priority area due to extensive settlements and elevated nutrients.
Ecosystem Services	▪ IUA Dense Rural and then feeder steam into Kosi Bay.	▪ IUA is feeder into Lake Sibaya.
River (Ecology)	▪ - B EC for river within iSimangaliso Wetland Park. ▪ -C EC (urban areas, WWTW, forestry).	▪ - D EC (Water quality impacts from township, hospital).
Wetland (Ecology)	▪ HGM (Ha in IUA): -CVB: 184 -DEPR: 4102 -EST: 21970 -FLOOD: 1441 -RIVER: 0 -SEEP: 243 -UVB: 1527 **Total: 29467** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 3.4 -C: 0.9 -D/E/F: 21.1 -N/A: 74.6 ▪ Notable wetlands: Kosi - Kosi Bay, Kosi – KuKalwe, Kosi – Ngweve, Kukalwe, KuZilonde, Apeisdraai, Enkathweni, Kosi - Swamanzi tributary, KuNkanini, Matitimane, Mtando, Swamanzi, Enkathweni, KuMzinganwane, Mvelabusha, Nlangu mire complex, Sihadla, Kozi -aManzamnyama, Kushengeza, deep peats at Vazi.	▪ HGM (Ha in IUA): -CVB: 3 -DEPR: 29085 -EST: 1633 -FLOOD: 20647 -RIVER: 0 -SEEP: 938 -UVB: 1351 **Total: 53656** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 3.4 -C: 13.5 -D/E/F: 80.0 -N/A: 3.0 ▪ Notable wetlands: Cele, Gazani, Mloli, Muzi Swamps, Ndlovu, Sileza Vlei, KuMzingwane, Shazibe, Mgobozeleni – Shazibe.
Estuary (Ecology)	▪ A/B Category. ▪ Low cumulative pressure, except for overfishing (increase in fish traps) and groundwater abstraction.	▪ uMgobezeleni. ▪ B Category. ▪ Low cumulative pressure, except for overfishing.

12.7 W2 AND W3: STATUS QUO DESCRIPTION OF THE INTEGRATED UNIT OF ANALYSIS - ST LUCIA

Table 12.7 Status quo description of the IUA St Lucia

IUA	IUA St Lucia
Name	IUA St Lucia
Surface Water Resources	▪ Transfer from lower Umfolozi to Mhlathuze catchment. ▪ Run of River abstraction for Mtubatuba Town and sugar mill.
Economics	▪ Tourism activities. ▪ Extensive commercial forestry.
Water quality	▪ An area of high water quality impact, particularly in the lower reaches, with three priority areas identified. Impacts from dysfunctional WWTW and irrigation return flows. Estuarine pollution pressures are high.
River (Ecology)	▪ River PES for feeder rivers low. Main purpose is to ensure that the management objectives of St Lucia are achieved.
Wetland (Ecology)	▪ HGM (Ha in IUA): -CVB: 585 -DEPR: 7751 -EST: 727476 -FLOOD: 4505 -RIVER: 461 -SEEP: 2669 -UVB: 1095 **Total: 744541** ▪ Wetland Condition (% of wetlands in IUA): -A/B: 0.8 -C: 0.1 -D/E/F: 1.3 -N/A: 97.8 ▪ Notable wetlands: Teza, Lake Teza, Umfolozi Swamp, Mavuya Pan, Lake Mfuthululu, Mfuthululu, Collin's Lake, St Lucia – Mbazwana, Mfula Pan, Siphudwini, Mhlazi Pan, St Lucia – Manzibomvu, Mdlaze Pan, Mpanze Pan, Mkuze Floodplain, Mkuze Swamp System, Ntshangwe Lake, Ku Ndlebeni, Tshanetshe.
Estuary (Ecology)	▪ Form part of St Lucia Lake Complex. ▪ South Africa's largest estuary (> 50% of surface area). ▪ D to D/E Category (Downwards trajectory). ▪ High cumulative pressure: Flow reduction, extensive mouth manipulation, formal and subsistence agriculture, pollution, overfishing (illegal gillnetting), invasive alien vegetation.

13 REFERENCES

African Development Bank, MKONDVO-NGWAVUMA WATER AUGMENTATION PROGRAM (MNWAP) STUDY. Model Information and data sets received from Zutari, Personal Communication, March 2022.

Adams, J.B., Taljaard, S., Van Niekerk, L. and Lemley, D.A. 2020. Nutrient enrichment as a threat to the ecological resilience and health of microtidal estuaries. *African Journal of Aquatic Science* **45:23-40**.

Barletta, M., Lima, A.R.A. and Costa, M.F. 2019. Distribution, sources and consequences of nutrients, persistent organic pollutants, metals and microplastics in South American estuaries. *Science of the Total Environment* **651**:1199-1218.

Begg, G. 1989. The Wetlands of Natal (Part 3). The location status and function of the priority wetlands of Natal. Natal Town and Regional Planning Report Volume 73, Pietermaritzburg, South Africa.

Cowan GI 1995. Wetland regions of South Africa. In Wetlands of South Africa, ed GI Cowan,Department of Environmental Affairs and Tourism, Pretoria, 21–31.

Cyrus, D., Jerling, H., MacKay, F., Vivier, L. 2011. Lake St Lucia, Africa's largest estuarinelake in crisis: Combined effects of mouth closure, low levels and hypersalinity. *South African Journal of Science* **107** (3/4, 13 pages. DOI:10.4102/sajs.v107i3/4.291).

Dayaram, A., Skowno, A.L., Driver, A., Sink, K., Van Deventer, H., Smith-Adao, L., Van Niekerk, L., Harris, L.R., Job, N. & Nel, J.L. 2021. The South African National Ecosystem Classification System Handbook: First Edition. South African National Biodiversity Institute, Pretoria, South Africa. http://hdl.handle.net/20.500.12143/7150.

Department of Forestry, Fisheries and Environment (DFFE). 2022. Scoping Study: A Blue Carbon Sinks Assessment for South Africa. Department of Forestry, Fisheries, and the Environment. Pretoria, South Africa.

Department of Water Affairs, South Africa, July 2013. Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: Status quo assessment, IUA delineation and biophysical node identification. Prepared by: Rivers for Africa eFlows Consulting (Pty) Ltd. DWA Report: RDM/WMA11/00/CON/CLA/0113.

Department of Water Affairs (DWA). 2014a. Resource Directed Measures: Reserve determination study of selected surface water and groundwater resources in the Usutu/Mhlathuze Water Management Area. Integrated Groundwater-Wetland Water Resource Units. Volume 1: Wetland Prioritisation. Report produced by Wetland Consulting Services (Pty) Ltd for Tlou Consulting (Pty) Ltd for the Department of Water and Sanitation. Report no: RDM/WMA6/CON/COMP/1013.

Department of Water Affairs and Forestry (DWAF). 1999. Resource Directed Measures for Protection of Water Resources. Volume 3: River Ecosystems Version 1.0, Pretoria.

Department of Water Affairs and Forestry (DWAF). 2004. Internal Strategic Perspective: Usutu to Mhlatuze Water Management Area. DWAF Report No. PB WMA 06/000/00/0304. Prepared by Tlouw & Matji (Pty) Ltd.

Department of Water Affairs and Forestry (DWAF). 2006. Groundwater Resource Assessment Phase II: Methodology for Groundwater-surface water interactions.

Department of Water Affairs and Forestry (DWAF), South Africa. 2008a. Comprehensive Reserve Determination Study for Selected Water Resources (Rivers, Groundwater and Wetlands) in the Inkomati Water Management Area, Mpumalanga. Sabie and Crocodile Systems: Resource Unit Delineation: Prepared by Water for Africa, authored by Louw, MD. Report no. 26/8/3/10/12/006.

Department of Water Affairs and Forestry (DWAF) 2008b. Resource Directed Measures for Protection of Water Resources: Methodologies for the determination of ecological water requirements for estuaries. Version 2. Pretoria.

Department Water Affairs and Forestry (DWAF). 2009. Mhlathuze Water Availability Assessment Study (Final Report): Report no. PWMA 06/000/00/1007 conducted by WRP Consulting Engineers (Pty) Ltd in association with DMM Development Consultants CC, Laubscher Smith Engineers and WSM Leshika (Pty) Ltd. in 2009, for the Department of Water Affairs and Forestry Directorate: Water Resource Planning Systems, Pretoria, South Africa.

Department of Water and Sanitation (DWS), South Africa. 2014e. A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa. Compiled by RQIS-RDM: **Error! Hyperlink reference not valid.**.

Department of Water and Sanitation (DWS). 2014b. Resource Directed Measures: Reserve determination study of selected surface water and groundwater resources in the Usutu/Mhlathuze Water Management Area. River Intermediate EWR – Volume 3: Specialist Reports produced by Tlou Consulting (Pty) Ltd. Report no: RDM/WMA6/CON/COMP/0713.

Department of Water and Sanitation (2016) Water Supply and Drought Operating Rules for Stand-Alone Dams and Schemes Typical of Rural/Small Municipal Water Supply Schemes: Eastern Cluster. P RSA 000/00/14711/ - The Eshowe Water Supply Scheme: Rutledge and Eshlazi Dams. Report Prepared by AECOM

Department of Water and Sanitation (DWS). 2020. Assessment of water quality and land use impacts in Primary Drainage Regions as per the 9 Water Management Areas (WMA): Report on the Planning Level Review of the Water Quality in the Pongola to Mtamvuna WMA. Prepared by Grobler, Viljoen and Mosoa. DWS Report No. P RSA 000/00/22618/24. Study Report Index No. 24.

Department of Water and Sanitation (DWS). 2021. Development, Updating and Review of Strategies to Reconcile Water Availability and Requirement in the East Planning Area Comprising Water Supply Systems for Mbombela, Richards Bay, Mgeni and All Other Towns and Clusters of Villages – Inception Report. October 2021. Prepared by iX engineers, supported by Wakhiwe, WSM Leshika, WRP Consulting Engineers & Specialists, DWS, Pretoria, South Africa.

Driver, A., Maze, K., Rouget, M., Lombard, A.T, Nel, J., Turpie, J.K., Cowling, R.M., Desmet, P, Goodaaan, R, Harris, J., Jonas, Z., Reyers, B., Sink, K. & Strauss, T. 2005. National Spatial Biodiversity Assessment 2004: priorities for biodiversity conservation in South Africa. Strelitzia 1 7. South African National Biodiversity Institute, Pretoria

Green Drop. 2022a. Green Drop: KwaZulu-Natal. Prepared by the Department of Water and Sanitation (DWS); released April 2022.

Green Drop. 2022b. Green Drop: Mpumalanga. Prepared by the Department of Water and Sanitation (DWS); released April 2022.

Grundling,P-L., Grundling,AT., Pretorius,L., Mulders, J. and Mitchell, S. (2017). South African Peatlands: Ecohydrological Characteristics and Socio-Economic Value. Report to the Water Research Commission. WRC Report No. 2346/1/17.

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.

Inkomati-Usuthu Catchment Management Agency (IUCMA). 2016. Water Availability Assessment Study for the Usuthu Catchment. Prepared by WRP Consulting Engineers (Pty) Ltd for the IUCMA, Nelspruit, South Africa.

Inkomati-Usuthu Catchment Management Agency (IUCMA). 2020. Ecostatus of the Usuthu Lusutfu Catchment, Inkomati River System: Phase II 2019. Prepared by Roux, Thirion, Hoffman, Diedericks, Scheman and Selepe.

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.

Mander, M., Ntuli, L., Diedericks, N., and Mavundla, K. 2007. South Africa’s traditional medicines industry. Department of Trade and Industry, South Africa.

McCarthy T., Cairncross B., Huizenga J.M. & Bachelor A. (2007). Conservation of the Mpumalanga Lakes District. Unpublished report. Johannesburg.

Nel, J.L., Murray, K.M., Maherry, A.M., Petersen, C.P., Roux, D.J., Driver, A., Hill, L., van Deventer, H., Funke, N., Swartz, E.R., Smith-Adao, L.B., Mbona, N., Downsborough, L., and Nienaber, S. 2011. Technical Report for the National Freshwater Ecosystem Priority Areas Project. WRC Report No. 1801/2/11.

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.

National Integrated Water Information System (NIWIS). 2022. DWS website indicating Climate Change Information. Accessed 16 May 2022. https://www.dws.gov.za/niwis2/ClimateChange.

Ollis, D.J., Day, J.A., Malan, H.L., Ewart-Smith, J.L. and Job, N.M. 2014. Development of Decision-Support Tools for Assessment of Wetland Present Ecological Status (PES) Vol 2: Development of a Decision-Support Framework for Wetland Assessment in South Africa and a Decision-Support Protocol for the Rapid Assessment of Wetland Ecological Condition. Report to the Water Research Commission. WRC Report No. TT 609/14.

Ollis, D.J., Snaddon, C.D., Job, N.M. & Mbona, N. 2013. Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems. *SANBI Biodiversity Series* 22. South African National Biodiversity Institute, Pretoria.

Perrings, C. 2006. Ecological economics after the Millenium Ecosystem Assessment. International Journal of Ecological Economics and Statistics, 6, 8-22.

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.

South African Mine Water Atlas. 2018. Water Research Commission Project No. K5/2234//3. Published by the Water Research Commission, Pretoria, South Africa.

TPTC, 2008. Tripartite Permanent Technical Committee (TPTC) Republic of Moçambique, Republic of South Africa and Kingdom of Swaziland. Joint Maputo River Basin Water Resources Study – Moçambique, Swaziland and South Africa (EuropeAid/120802/D/SV/ZA).

Turpie, J.K., Adams, J.B., Joubert, A., Harrison, T.D., Colloty, B.M., Maree, R.C., Whitfield, A.K., Wooldridge, T.H., Lamberth, S.J., Taljaard, S. & van Niekerk, L. 2002. Assessment of the conservation priority status of South African estuaries for use in management and water allocation. *Water SA* **28**, 191 - 206.

Turpie, J.K., Taljaard, S., Van Niekerk, L., Adams, J., Wooldridge, T., Cyrus, D., Clark, B. and Forbes, N. 2012. The Estuary Health Index: a standardised metric for use in estuary management and the determination of ecological water requirements. WRC Report No. 1930/1/12. Water Research Commission, Pretoria, South Africa.

Van Deventer, H., Smith-Adao, L., Mbona, N., Petersen, C., Skowno, A., Collins, N.B., Grenfell, M., Job, N., Lötter, M., Ollis, D., Scherman, P., Sieben, E. and Snaddon, K. 2018. South African National Biodiversity Assessment 2018: Technical Report. Volume 2a: South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Version 3, final released on 3 October 2019. Council for Scientific and Industrial Research (CSIR) and South African National Biodiversity Institute (SANBI): Pretoria, South Africa. Report Number: CSIR report number CSIR/NRE/ECOS/IR/2018/0001/A; SANBI report number http://hdl.handle.net/20.500.12143/5847.

Van Niekerk, L., Adams, J.B., Bate, G.C., Forbes, N.T., Huizinga, P., Lamberth, S.J., MacKay, C.F., Petersen, C., Taljaard, S., Weerts ,S.P., Whitfield, A.K., and Wooldridge, T.H. 2013. Country-wide assessment of estuary health: An approach for integrating pressures and ecosystem response in a data limited environment. *Estuarine, Coastal and Shelf Science* **130**: 239-251.

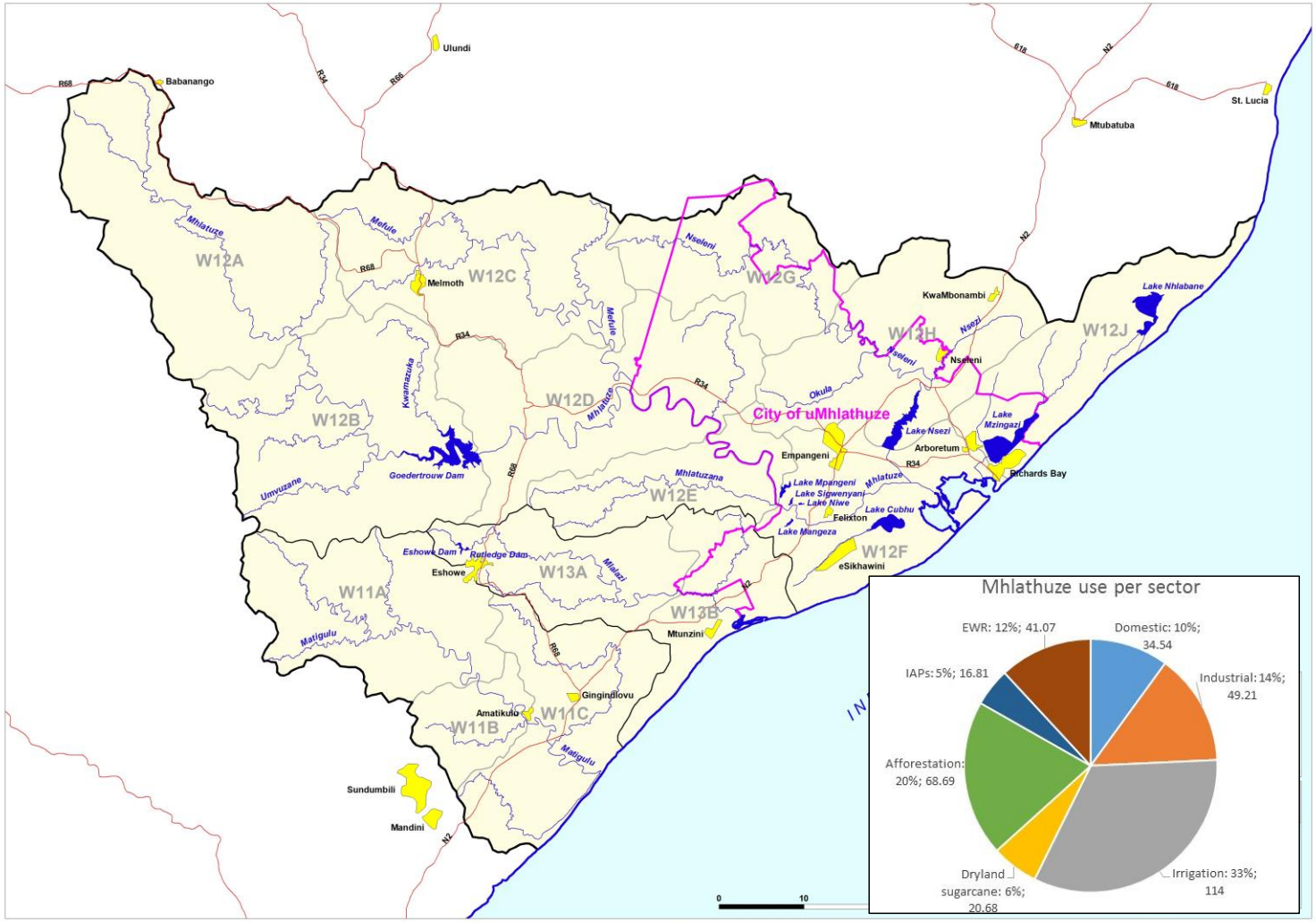
Van Niekerk, L., Adams, J.B., Lamberth, S.J., MacKay, F., Taljaard, S., Turpie, J.K., Weerts S. & Raimondo, D.C., 2019 (eds). South African National Biodiversity Assessment 2018: Technical Report. Volume 3: Estuarine Realm. CSIR report number CSIR/SPLA/EM/EXP/2019/0062/A. South African National Biodiversity Institute, Pretoria. SANBI report number: http://hdl.handle.net/20.500.12143/6373.

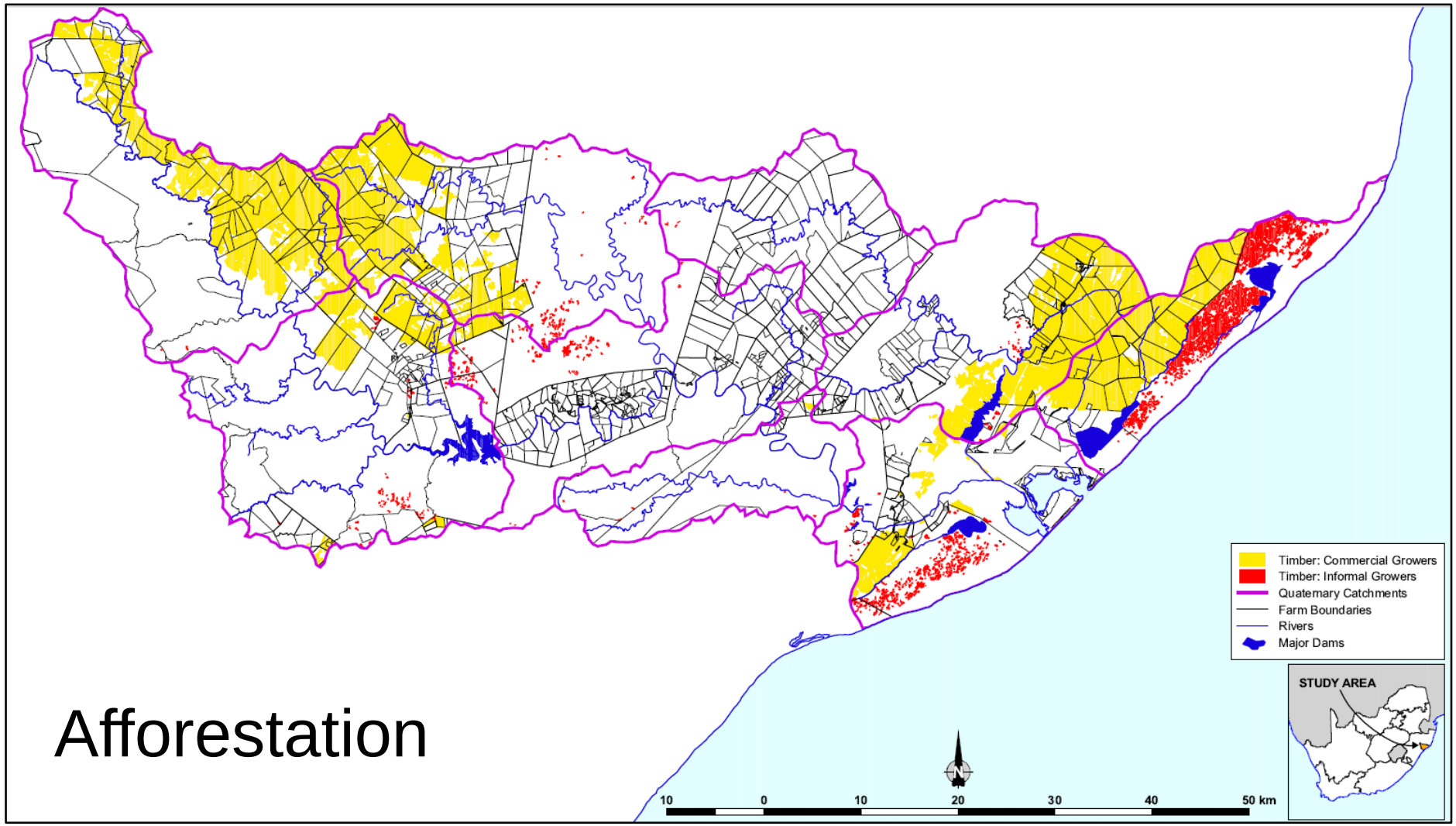
Van Niekerk, L., Adams, J.B., James N., Lamberth S., Mackay F., Rajkaran, A., Turpie J., Weerts, S. and Whitfield, A.K. 2020. An Estuary Ecosystem Classification that encompasses biogeography and a high diversity of types in support of protection and management. *Afr. J. Aquat. Sci*. **45**. 10.2989/16085914.2019.1685934.

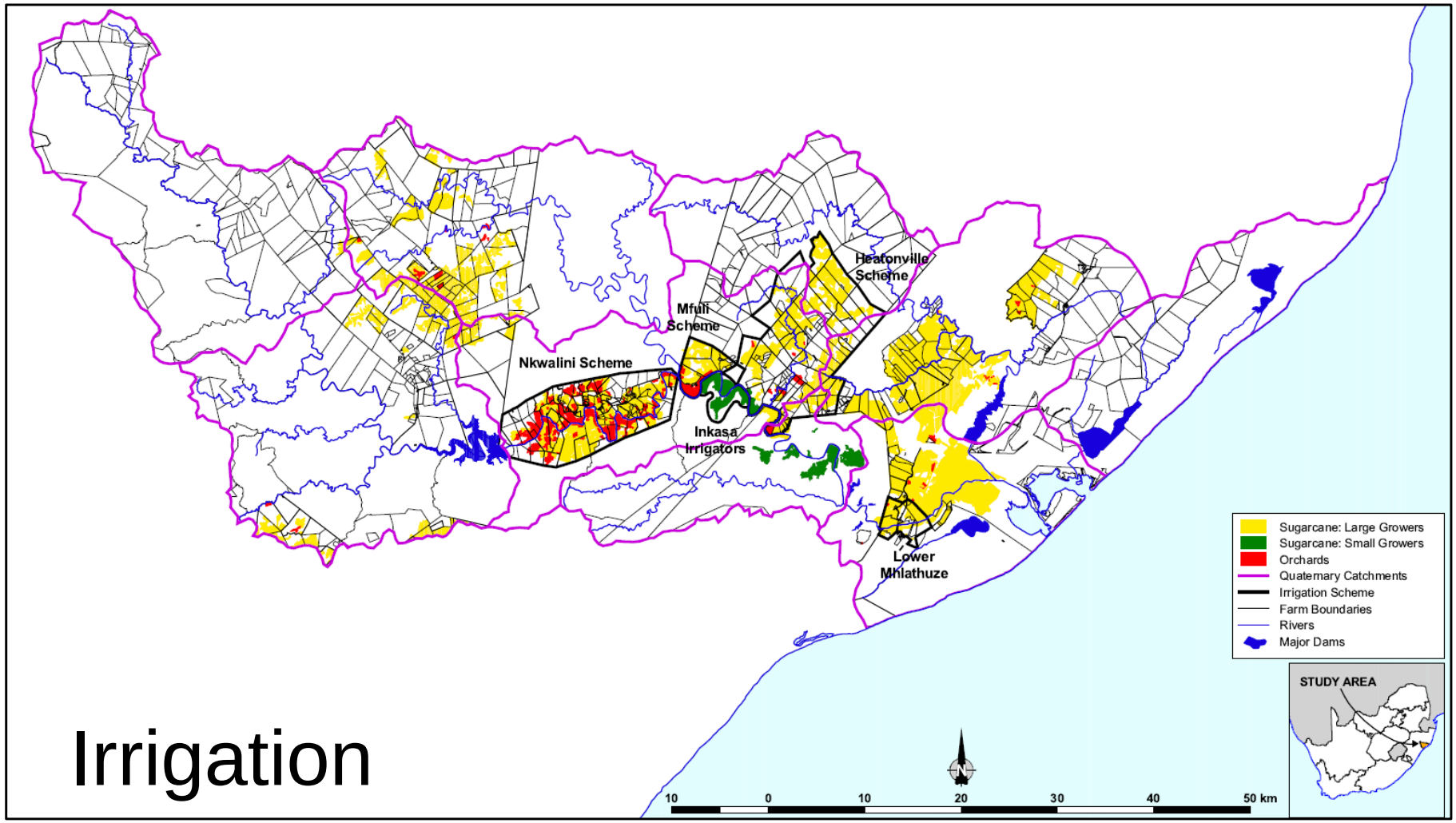
Wilson, N.S.H. 2020. Water sample analysis of Zululand Anthracite Colliery's Mbucwane River Containment Dam. Environmental report prepared by NSH Wilson of The Ecological Partnership (Pty) Ltd. in December 2020.

14 APPENDIX A: LAND USE MAPS

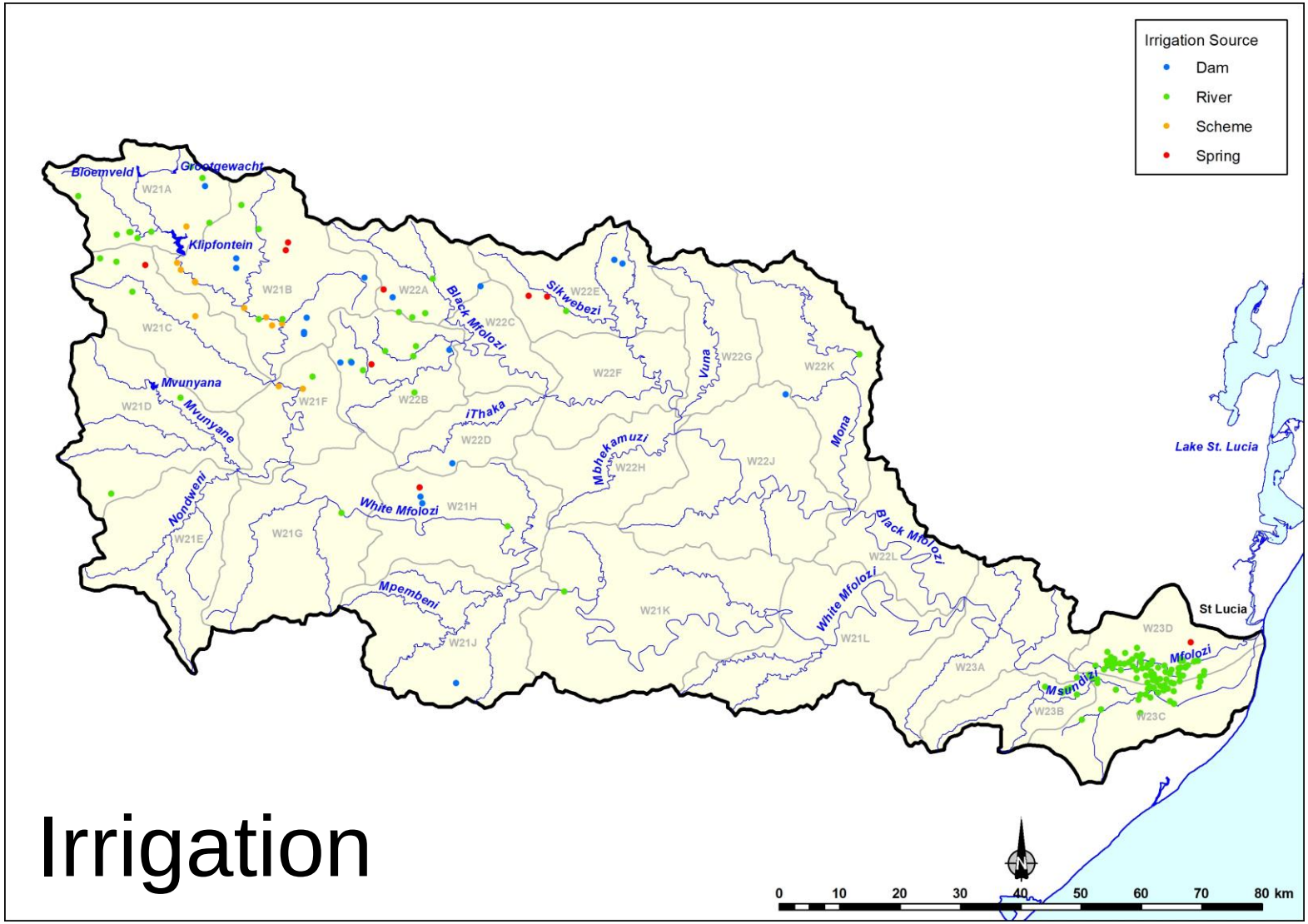
14.1 W1 CATCHMENT (MAIN RIVER: MHLATHUZE)

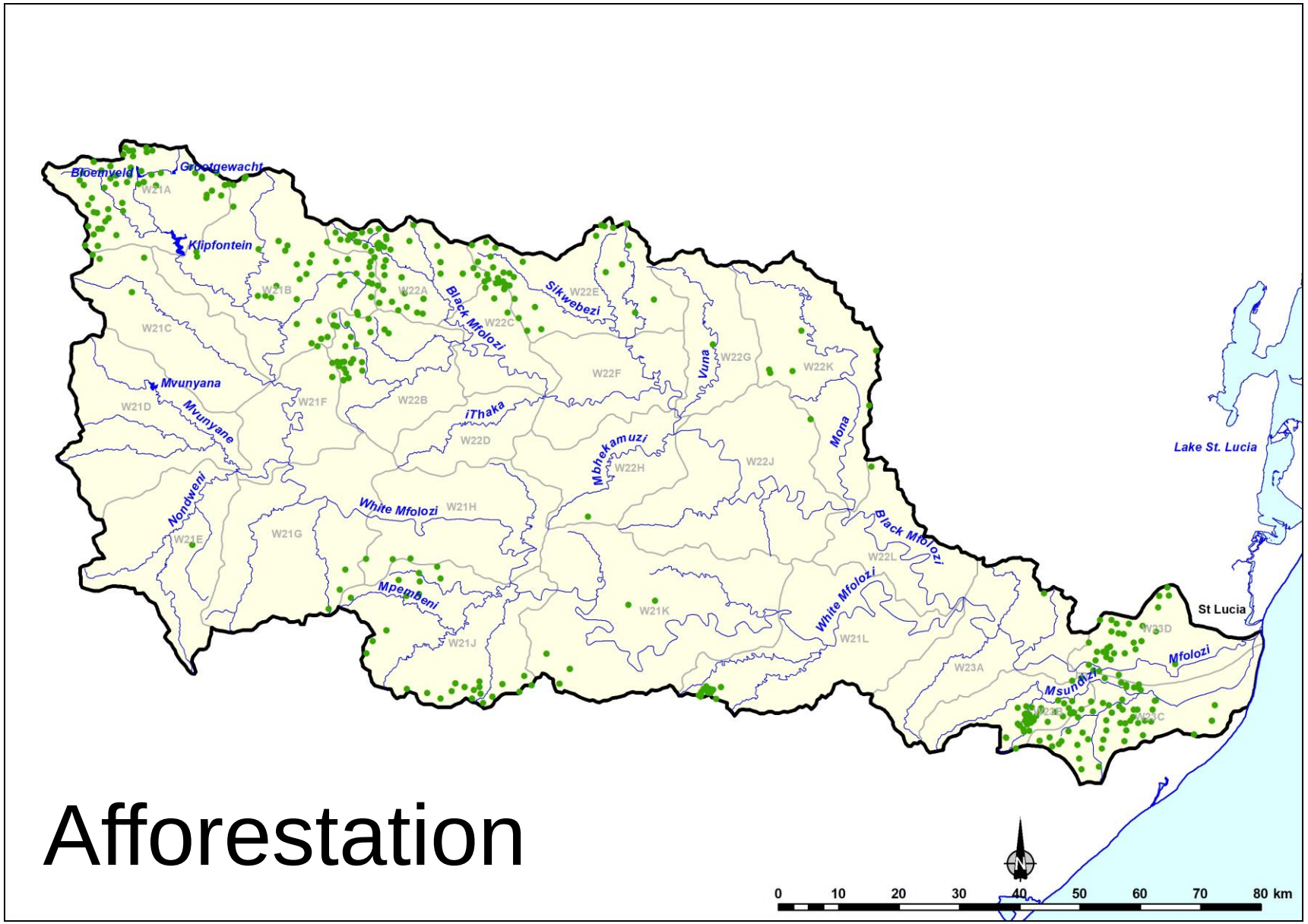


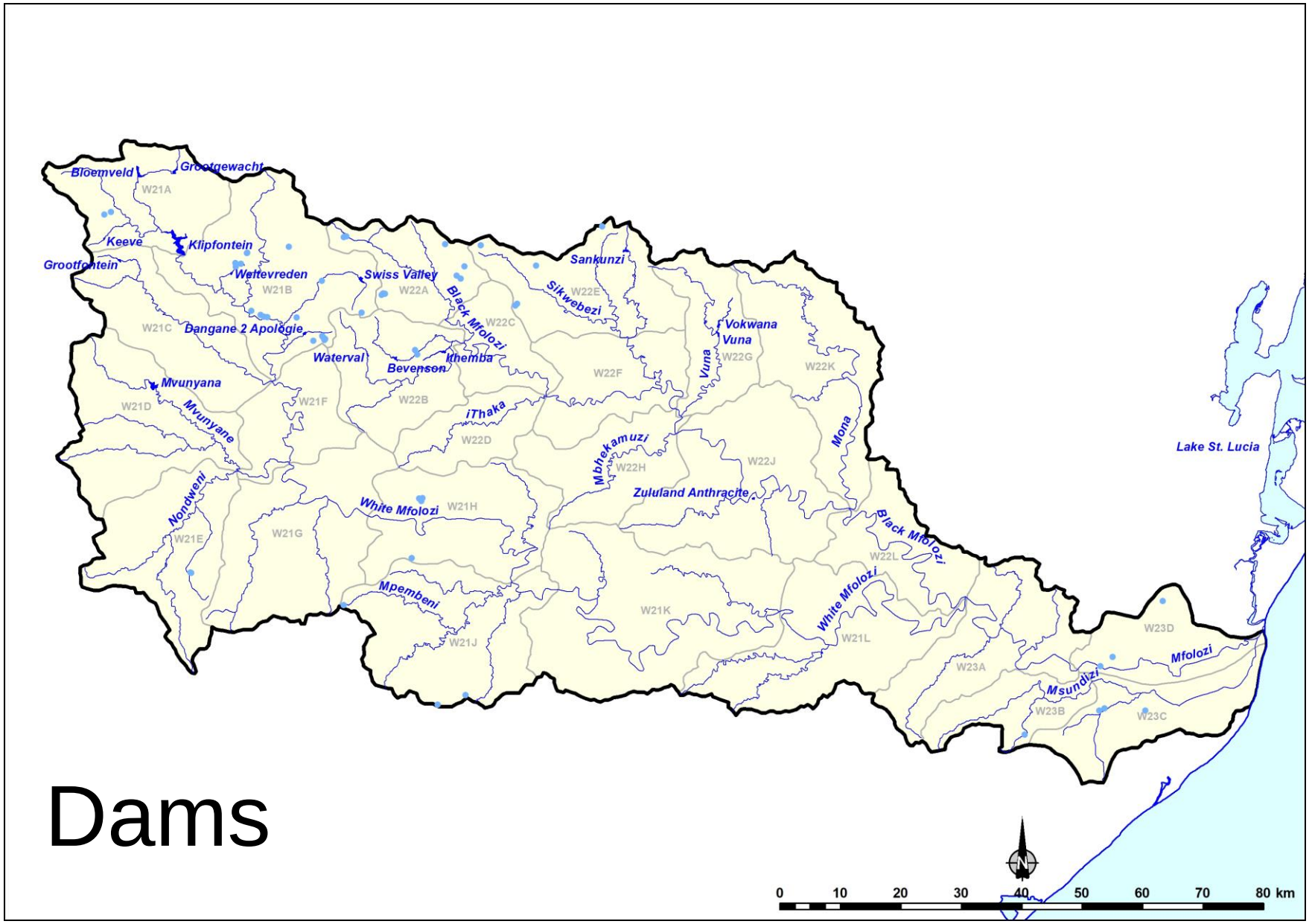

Afforestation
Timber: Commercial Growers
Timber: Informal Growers
Quaternary Catchments
Farm Boundaries
Rivers
Major Dams
STUDY AREA
10 0 10 20 30 40 50 km

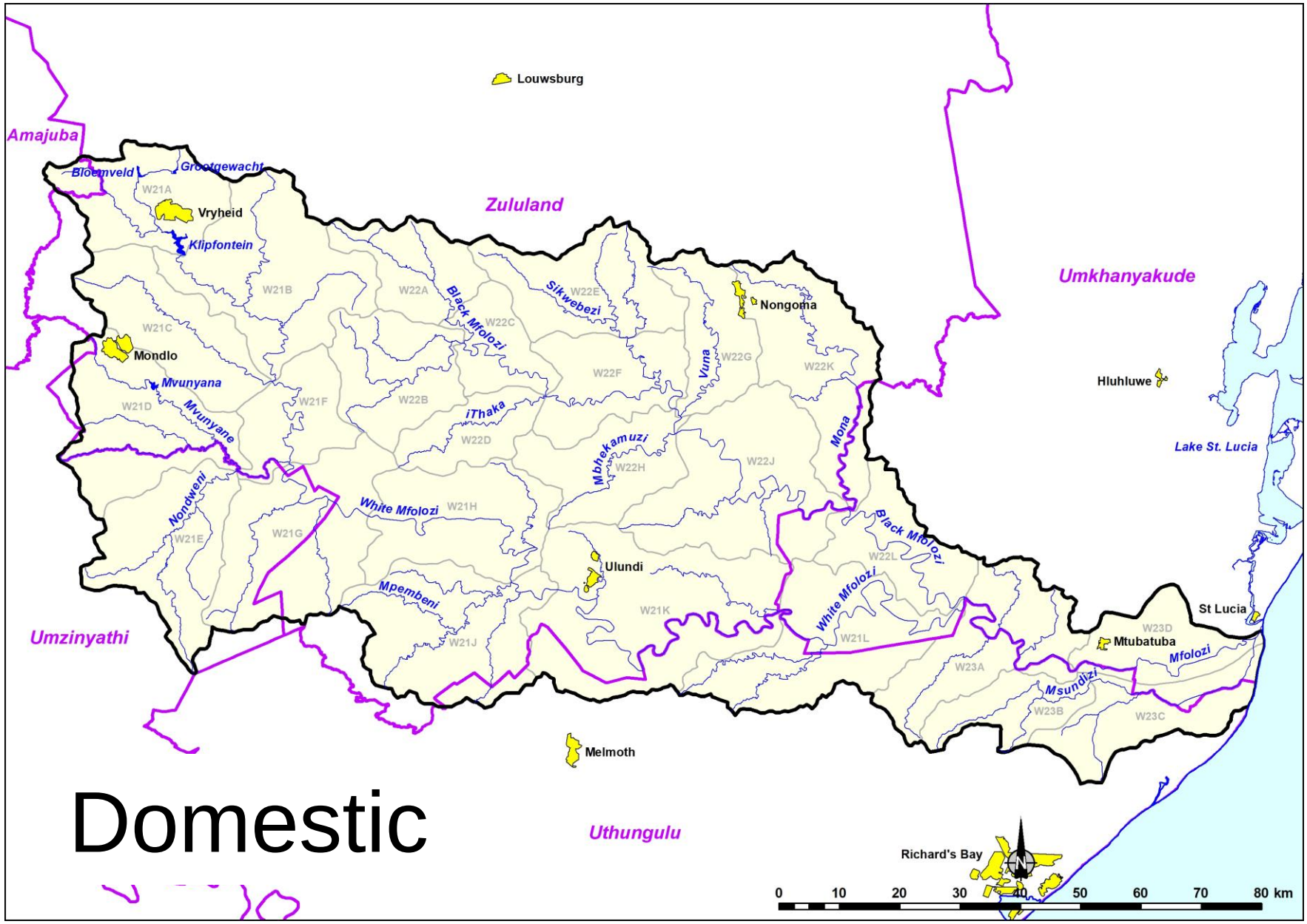

Irrigation
Heatonville Scheme
Mfuli Scheme
Nkwalini Scheme
Inkasa Irrigators
Lower Mhlathuze
Sugarcane: Large Growers
Sugarcane: Small Growers
Orchards
Quaternary Catchments
Irrigation Scheme
Farm Boundaries
Rivers
Major Dams
STUDY AREA
N
10 0 10 20 30 40 50 km

14.2 W2 CATCHMENT (MAIN RIVER: UMFOLOZI)



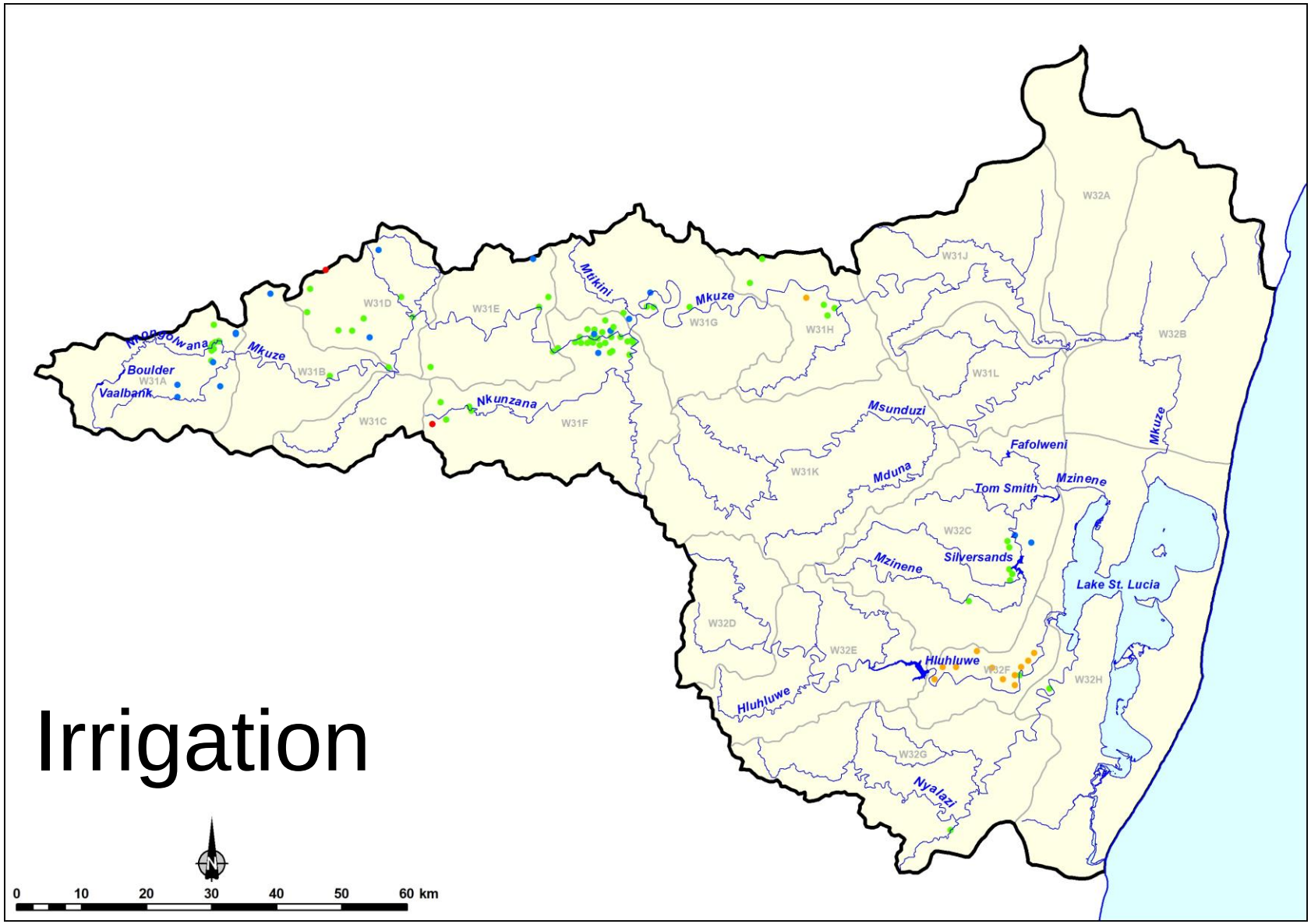

Bloemveld
Grootgewacht
W21A
Klipfontein
W21B
W22A
Black Mfolozi
Sikwebezi
W22E
W21C
W22C
W22F
Vuna
W22G
W22K
Mvunyana
W21D
Mvunyane
W21F
W22B
iThaka
W22D
Mbhekamuzi
W22H
W22J
Mona
Lake St. Lucia
Nondweni
White Mfolozi
W21H
W21G
W21E
Black Mfolozi
W22L
Mpembeni
W21K
White Mfolozi
St Lucia
W21J
W21L
W23D
Mfolozi
W23A
Msunduzi
W23C
Afforestation
N
0
10
20
30
40
50
60
70
80 km

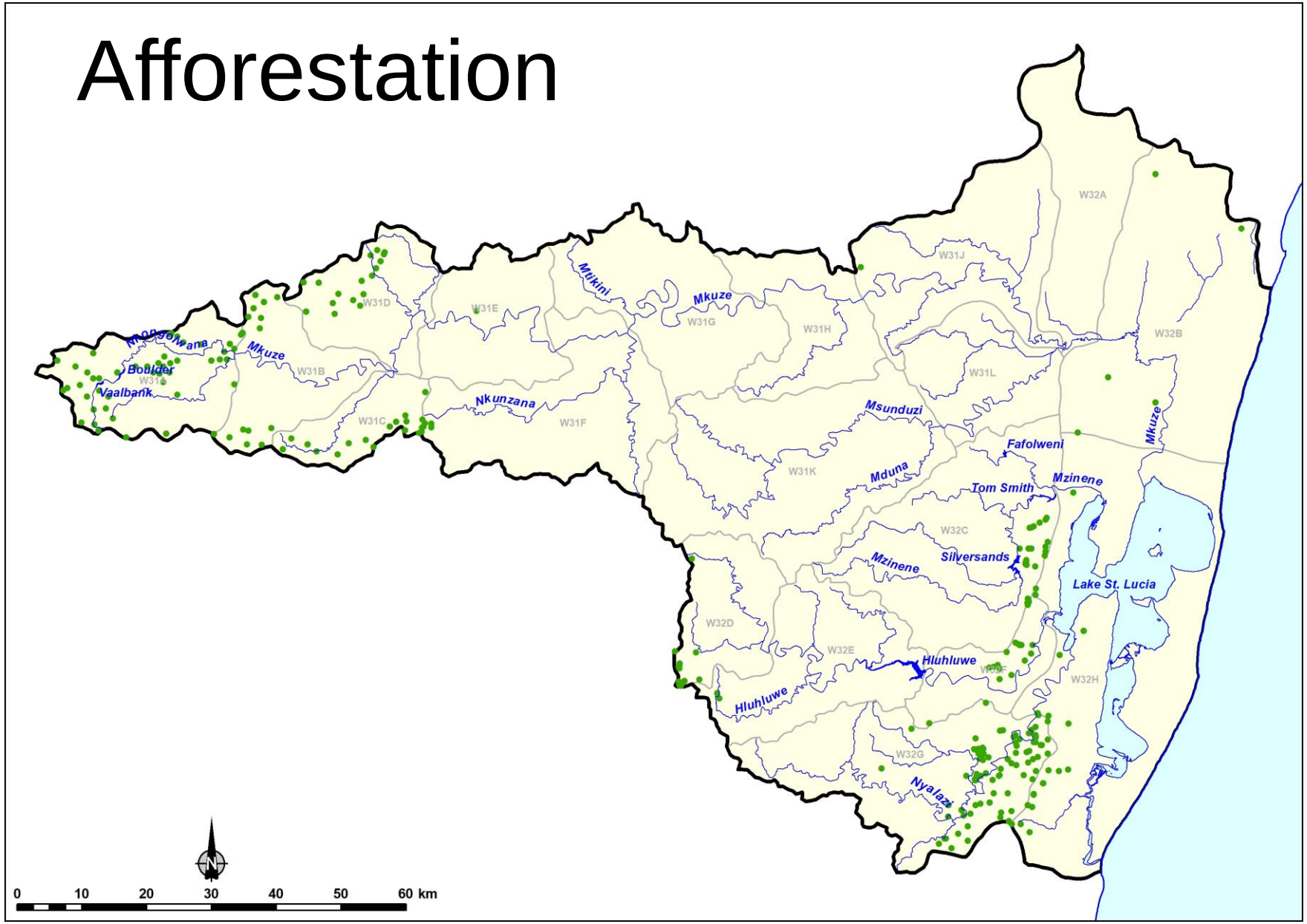

Bloemveld
Grootgewacht
W21A
Keeve
Klipfontein
Grootfontein
Wettevreden
W21B
Swiss Valley
W22A
Black Mfolozi
Sankunzi
W22E
Sikwebezi
W21C
Dangane 2 Apologie
W22C
Vokwana
Vuna
W22G
W22K
Waterval
Bevenson
Ithemba
W22F
Vuna
Mvunyana
W21D
Mvunyane
W21F
W22B
iThaka
W22D
Mona
Lake St. Lucia
Mbhekamuzi
W22H
W22J
Zululand Anthracite
Nondweni
White Mfolozi
W21H
W21E
W21G
Black Mfolozi
W22L
Mpembeni
W21K
White Mfolozi
W21L
W23D
Mfolozi
W21J
W23A
Msundizi
W23B
W23C
Dams
N
0
10
20
30
40
50
60
70
80 km

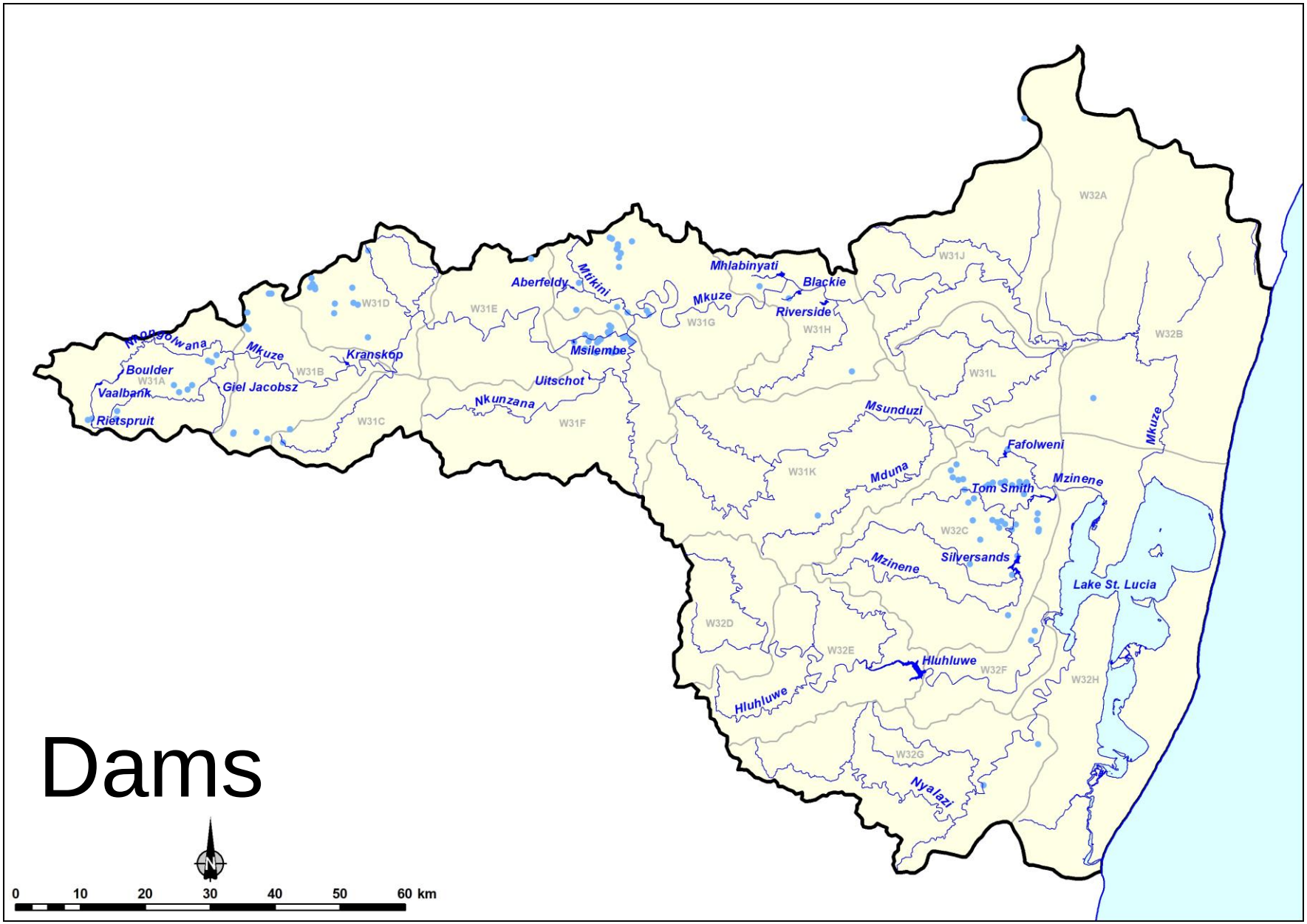

Louwsburg
Amajuba
Bloemveld
Grootgewacht
W21A
Vryheid
Klipfontein
Zululand
Umkhanyakude
W21B
W22A
Black Mfolozi
Sikwebezi
W22E
Nongoma
W21C
W22C
Mondlo
Mvunyana
W22F
Vuna
W22G
W22K
Hluhluwe
W21D
Mvunyane
W21F
W22B
iThaka
W22D
Mona
Lake St. Lucia
Mbhekamuzi
W22H
W22J
Nondweni
White Mfolozi
W21H
W21E
W21G
Black Mfolozi
W22L
Ulundi
White Mfolozi
Mpembeni
W21K
St Lucia
W23D
Umzinyathi
W21L
Mtubatuba
Mfolozi
W21J
W23A
Msundizi
W23B
W23C
Melmoth
Uthungulu
Richard's Bay
0
10
20
30
40
50
60
70
80 km

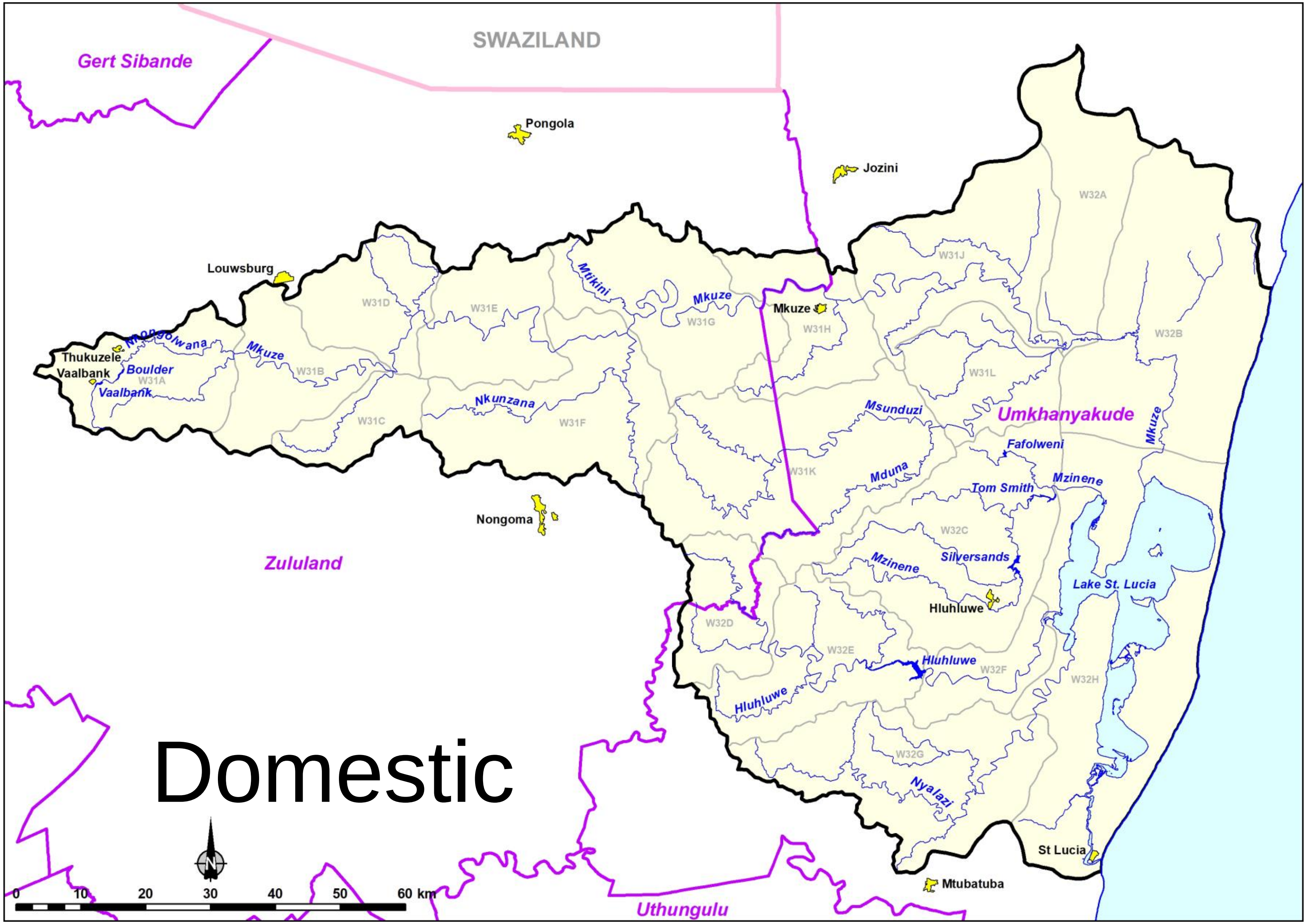
Domestic

14.3 W3 CATCHMENT (MAIN RIVER: MKUZE)

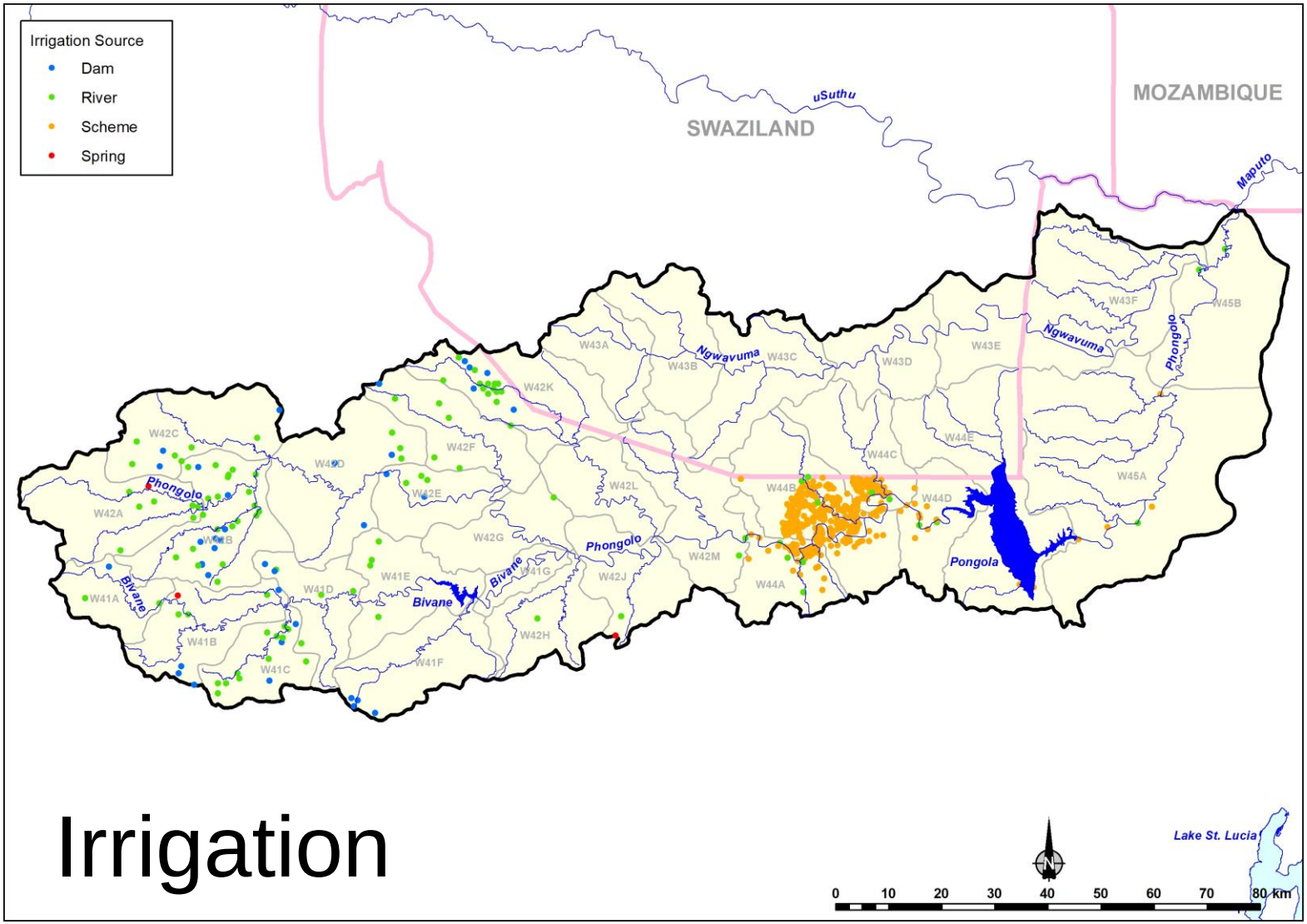


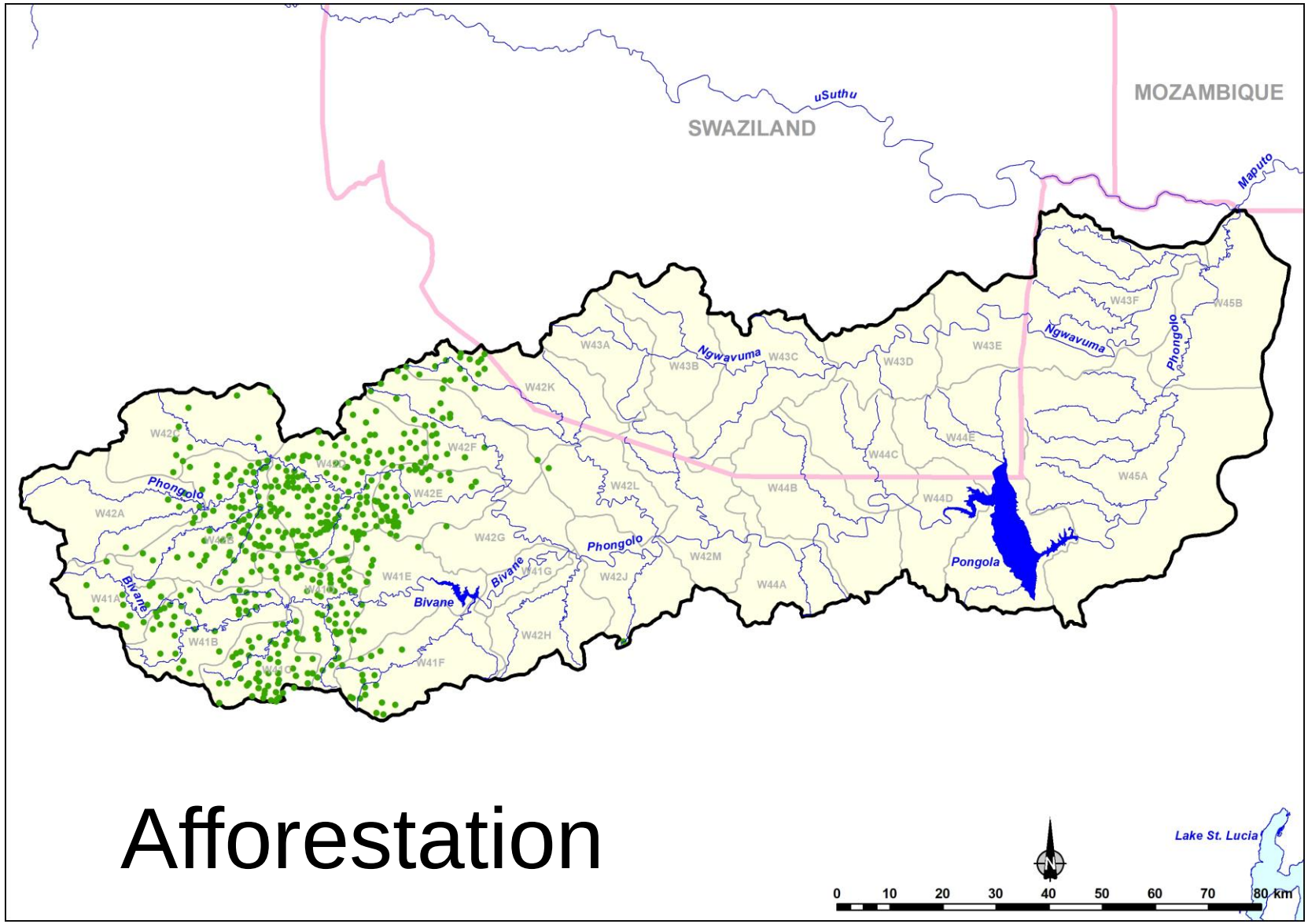

Afforestation
W31A
W31B
W31C
W31D
W31E
W31F
W31G
W31H
W31J
W31K
W31L
W32A
W32B
W32C
W32D
W32E
W32F
W32G
W32H
Mtikini
Mkuze
Nkunzana
Msunduzi
Mduna
Tom Smith
Mzinene
Fafolweni
Silversands
Lake St. Lucia
Hluhluwe
Nyalazi
Boulder
Vaalbank
N
0 10 20 30 40 50 60 km

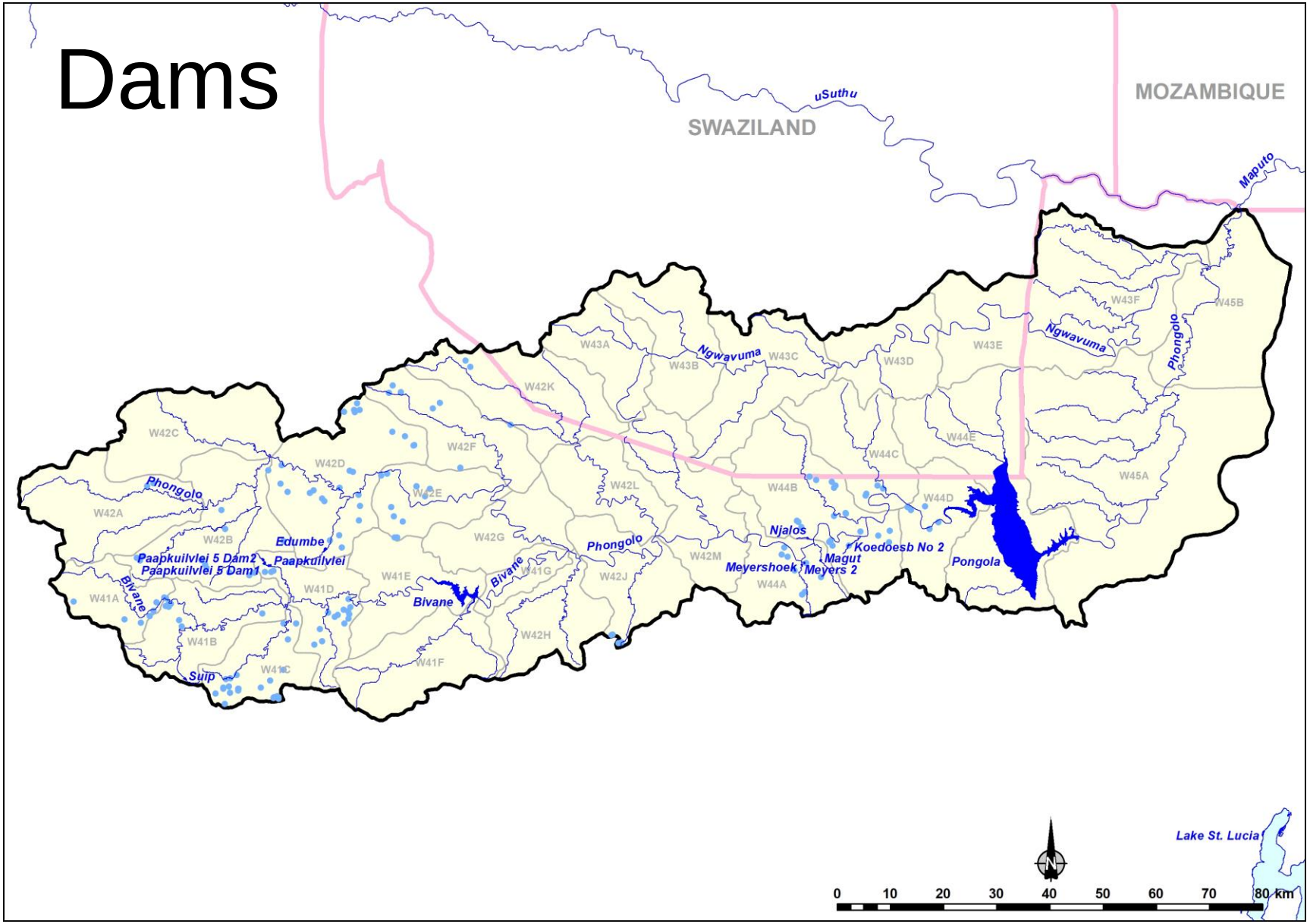

Dams
Mnjoli
Boulder
Vaalbank
Rietspruit
Mkuze
Giel Jacobsz
Kranskop
Aberfeldy
Mtikini
Msilembe
Uitschot
Nkunzana
Mhlabinyati
Blackie
Mkuze
Riverside
Msunduzi
Mduna
Fafolweni
Tom Smith
Mzinene
Silversands
Mzinene
Lake St. Lucia
Mkuze
Hluhluwe
Hluhluwe
Nyalazi
W31A
W31B
W31C
W31D
W31E
W31F
W31G
W31H
W31J
W31K
W31L
W32A
W32B
W32C
W32D
W32E
W32F
W32G
W32H
N
0
10
20
30
40
50
60 km

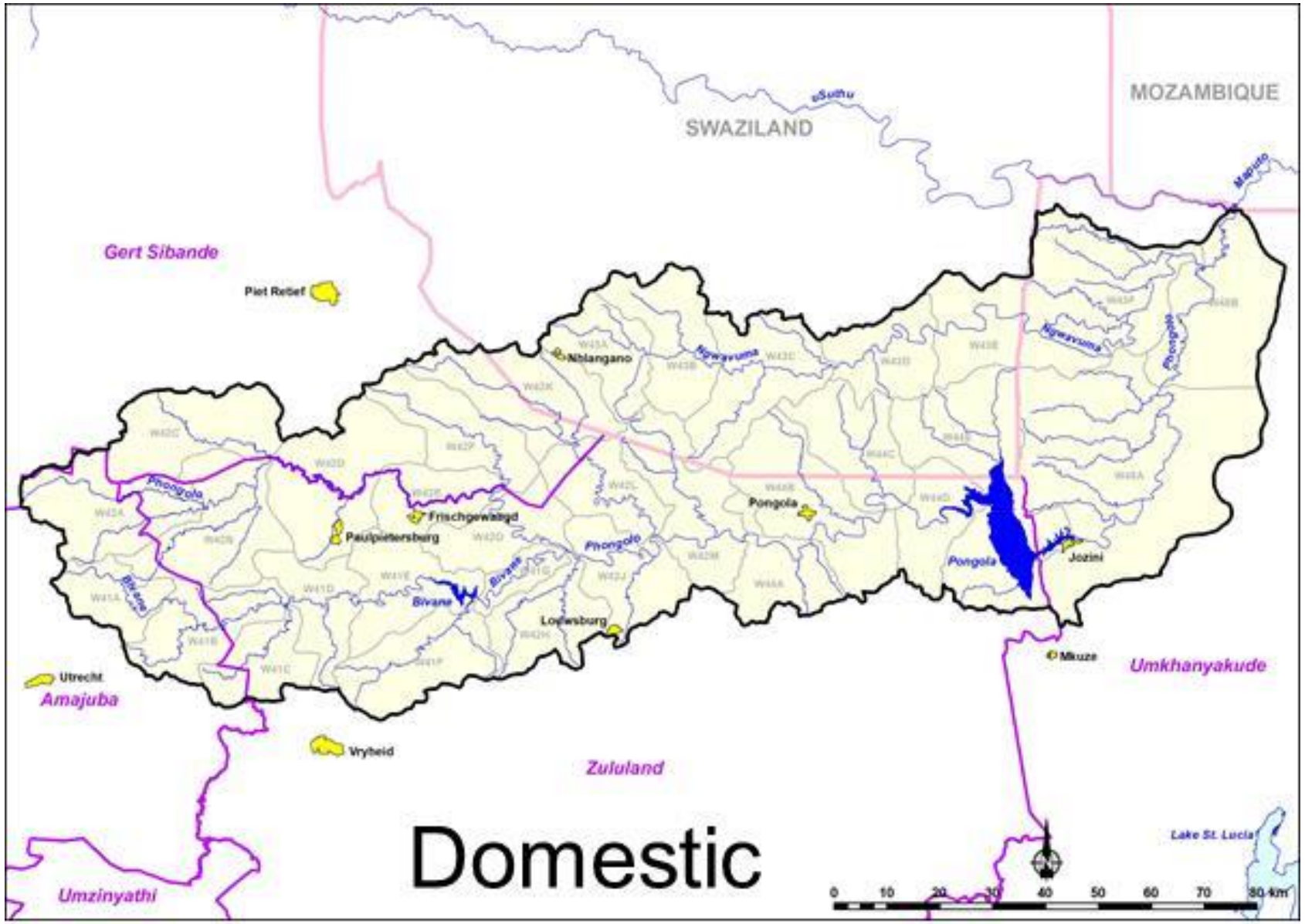

SWAZILAND
Gert Sibande
Pongola
Jozini
Louwsburg
Mkuze
Thukuzele
Vaalbank
Boulder
Vaalbank
Mkuze
Mtikini
Nkunzana
Msunduzi
Umkhanyakude
Fafolweni
Mduna
Tom Smith
Mzinene
Silversands
Mzinene
Hluhluwe
Lake St. Lucia
Nongoma
Zululand
Hluhluwe
Hluhluwe
Nyalazi
St Lucia
Mtubatuba
Uthungulu
W31A
W31B
W31C
W31D
W31E
W31F
W31G
W31H
W31J
W31K
W31L
W32A
W32B
W32C
W32D
W32E
W32F
W32G
W32H
0
10
20
30
40
50
60 km
Domestic

14.4 W4 CATCHMENT (MAIN RIVER: PONGOLA - EXCLUDING ESWATINI)

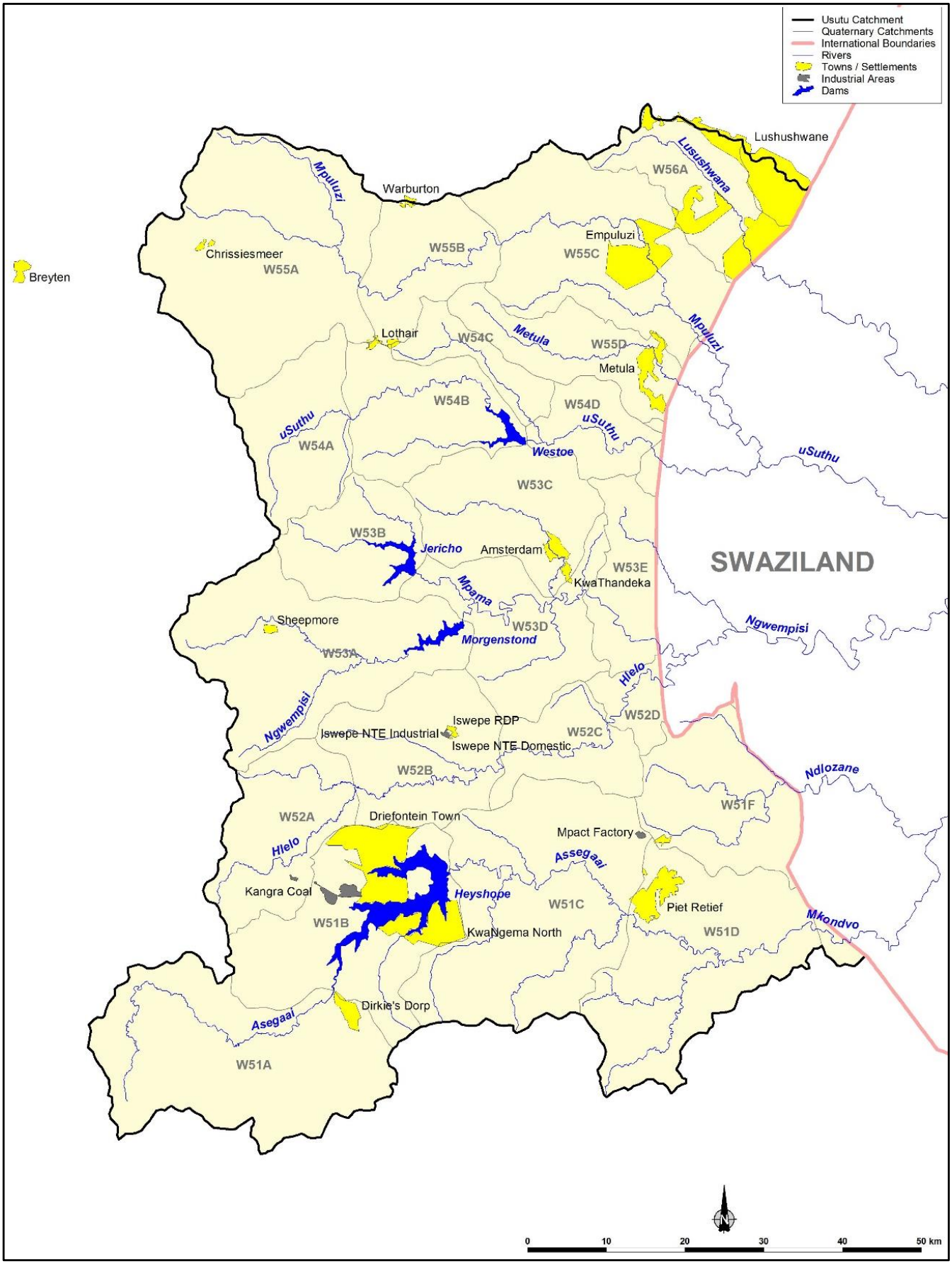



SWAZILAND
MOZAMBIQUE
uSuthu
Maputo
Ngwavuma
Phongolo
Pongola
Bivane
W42A
W42B
W42C
W42D
W42E
W42F
W42G
W42H
W42J
W42K
W42L
W42M
W43A
W43B
W43C
W43D
W43E
W43F
W44A
W44B
W44C
W44D
W44E
W45A
W45B
W41A
W41B
W41C
W41D
W41E
W41F
W41G
Afforestation
Lake St. Lucia
0 10 20 30 40 50 60 70 80 km

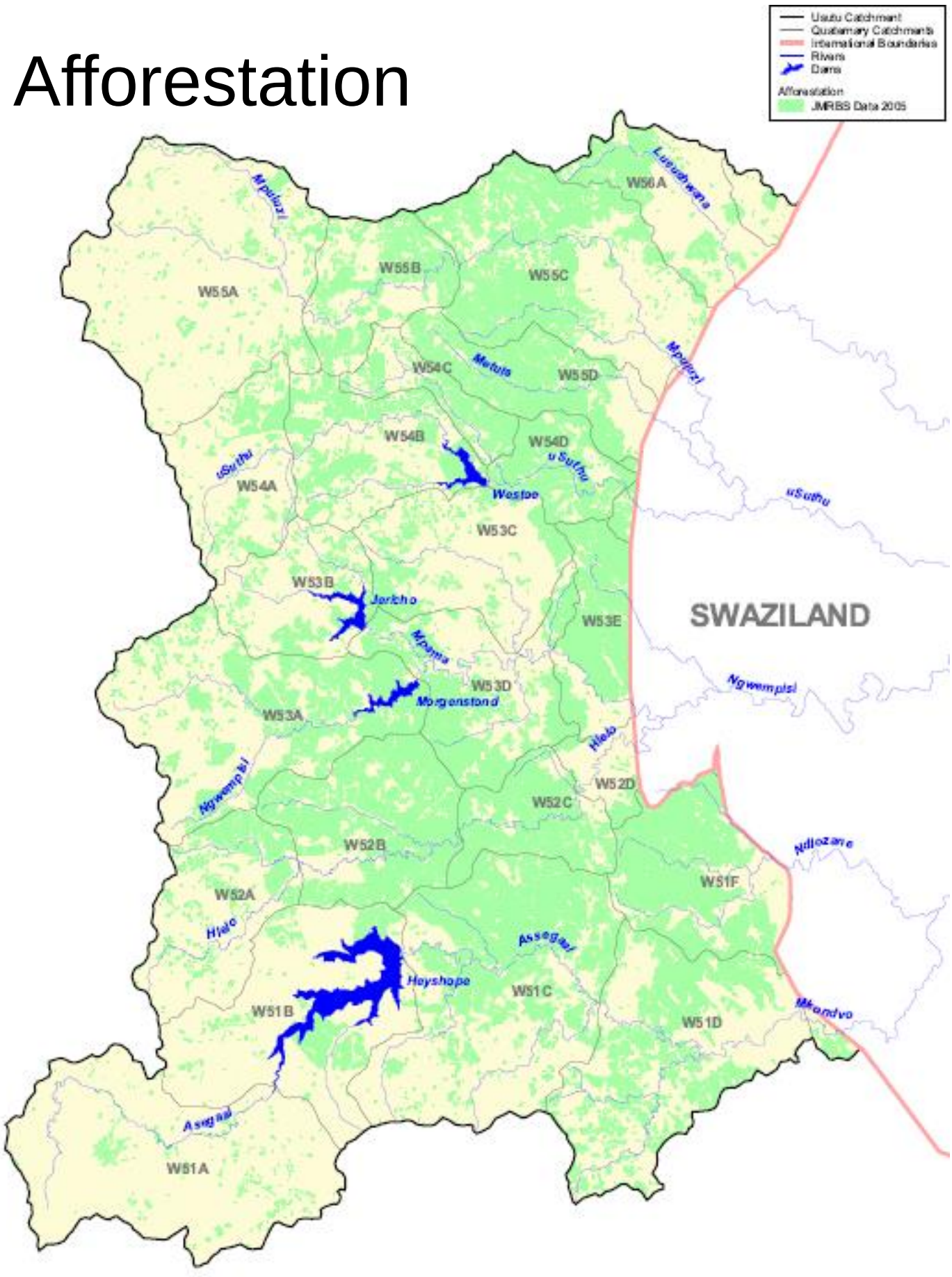

Dams
SWAZILAND
MOZAMBIQUE
uSuthu
Maputo
Ngwavuma
Ngwavuma
Phongolo
Phongolo
Phongolo
Phongolo
Bivane
Bivane
Bivane
Bivane
Edumbe
Paapkuilvlei
Paapkuilvlei 5 Dam2
Paapkuilvlei 5 Dam1
Njalos
Koedoesb No 2
Magut
Meyers 2
Meyershoek
Pongola
Sulp
Lake St. Lucia
W42C
W42A
W42B
W42D
W42F
W42E
W42K
W42L
W42G
W42M
W42J
W42H
W41A
W41B
W41C
W41D
W41E
W41F
W41G
W43A
W43B
W43C
W43D
W43E
W43F
W44A
W44B
W44C
W44D
W44E
W45A
W45B
0 10 20 30 40 50 60 70 80 km


SWAZILAND
MOZAMBIQUE
eSuthu
Maputo
Gert Sibande
Piet Retief
Nhlangano
Ngwavuma
Phongolo
Pongola
Frischgewaagd
Paulpietersburg
Bivane
Louwsburg
Jozini
Mkuze
Utrecht
Amajuba
Vryheid
Zululand
Umkhanyakude
Umzinyathi
Lake St. Lucia
Domestic
0 10 20 30 40 50 60 70 80 km

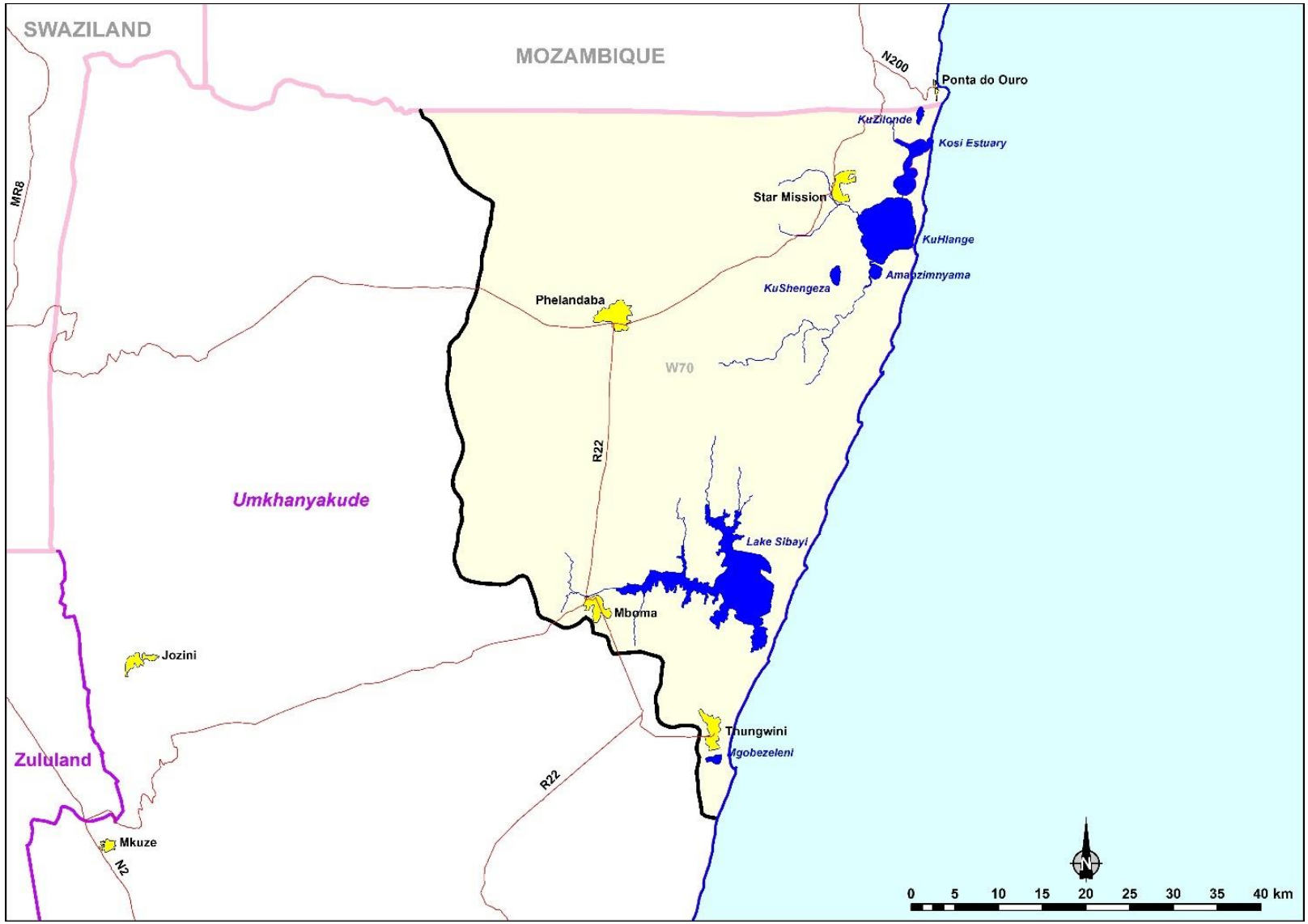
14.5 W5 CATCHMENT (MAIN RIVER: USUTU - EXCLUDING ESWATINI)



Afforestation



14.6 W7 CATCHMENT (KOSI ESTUARY AND SIBAYA LAKE)



15 APPENDIX B: SUB QUATERNARY REACHES GROUPED INTO RESOURCE UNITS

Table B1 SQRs grouped into RUs in W1 (Mhlathuze)

RU number	SQR number
W11-1	W11A-03597
W11-1	W11A-03748
W11-1	W11A-03776
W11-2	W11A-03599
W11-2	W11A-03612
W11-2	W11C-03713
W11-3	W11C-03917
W12-1	W12A-03086
W12-1	W12A-03104
W12-1	W12A-03153
W12-1	W12A-03226
W12-2	W12B-03334
W12-2	W12B-03356
W12-2	W12B-03398
W12-3	W12B-03471
W12-3	W12B-03479
W12-4	W12B-03336
W12-5	W12C-03189
W12-5	W12C-03225
W12-5	W12C-03232
W12-5	W12C-03263
W12-5	W12C-03303
W12-6	W12D-03346
W12-6	W12D-03375
W12-6	W12D-03388
W12-6	W12E-03475
W12-7	W12E-03526
W12-7	W12E-03530
W12-7	W12E-03558
W12-8	W12G-03229
W12-8	W12H-03289
W12-8	W12H-03316
W12-8	W12H-03401
W12-8	W12H-03418
W12-8	W12H-03428
W12-8	W12H-03459
W12-9	W12J-03290
W12-9	W12J-03411
W12-10	W12J-03392
W12-10	W12J-03403
W12-10	W12J-03450
W13-1	W13A-03583
W13-1	W13A-03609
W13-1	W13A-03641
W13-1	W13B-03593
W13-2	W13B-03774

Table B2 SQRs grouped into RUs in W2 (Umfolozi)

RU number	SQR number
W21-1	W21A-02527
W21-1	W21A-02512
W21-1	W21B-02539
W21-1	W21B-02546
W21-2	W21B-02603
W21-2	W21B-02652
W21-2	W21B-02670
W21-3	W21C-02599
W21-3	W21F-02727
W21-4	W21D-02676
W21-4	W21D-02788
W21-4	W21D-02832
W21-4	W21D-02848
W21-4	W21D-02815
W21-4	W21E-02934
W21-4	W21E-02963
W21-4	W21E-02953
W21-4	W21E-02912
W21-4	W21E-02873
W21-5	W21F-02840
W21-5	W21G-03085
W21-5	W21G-03067
W21-5	W21G-02929
W21-5	W21G-02914
W21-5	W21G-02885
W21-5	W21G-02851
W21-5	W21H-02889
W21-5	W21H-02897
W21-5	W21H-03004
W21-6	W21J-03112
W21-6	W21J-03036
W21-6	W21J-03018
W21-6	W21J-03075
W21-6	W21J-03066
W21-6	W21J-03050
W21-6	W21J-03030
W21-7	W21K-02976
W21-7	W21K-03019
W21-7	W21K-02981
W21-7	W21K-03080
W21-8	W21L-03161
W21-8	W21L-03176
W21-8	W21L-03163
W21-8	W21L-03059
W21-8	W21L-03041
W22-1	W22A-02587
W22-1	W22A-02591
W22-1	W22A-02586
W22-1	W22A-02596
W22-1	W22A-02610
W22-1	W22B-02662
W22-1	W22B-02773
W22-1	W22B-02661
W22-1	W22B-02728
W22-1	W22B-02706
W22-2	W22C-02688
W22-2	W22D-02795
W22-2	W22F-02722
W22-3	W22E-02601
W22-3	W22E-02605

RU number	SQR number
W22-3	W22E-02595
W22-3	W22E-02702
W22-3	W22F-02726
W22-4	W22F-02748
W22-4	W22G-02624
W22-4	W22H-02846
W22-5	W22H-02844
W22-5	W22J-02942
W22-5	W22J-02918
W22-5	W22J-02807
W22-5	W22J-02910
W22-5	W22J-02817
W22-5	W22K-02761
W22-5	W22K-02636
W22-5	W22K-02629
W22-5	W22K-02783
W22-5	W22L-02916
W23-1	W23A-03098
W23-1	W23A-03160
W23-1	W23A-03058
W23-1	W23A-03083
W23-1	W23A-03149
W23-1	W23A-03113
W23-2	W23B-03250
W23-2	W23B-03222
W23-3	W23B-03231
W23-3	W23C-03287
W23-3	W23C-03272
W23-3	W23C-03254
W23-3	W23C-03180
W23-3	W23D-03108

Table B3 SQRs grouped into RUs in W3 (Mkuze)

RU number	SQR number
W31-1	W31A-02494
W31-1	W31A-02534
W31-1	W31B-02477
W31-2	W31C-02556
W31-2	W31D-02436
W31-2	W31D-02450
W31-2	W31D-02495
W31-2	W31D-02500
W31-3	W31E-02456
W31-3	W31F-02573
W31-3	W31F-02555
W31-3	W31F-02530
W31-3	W31G-02455
W31-3	W31G-02506
W31-4	W31G-02425
W31-4	W31H-02514
W31-4	W31J-02501
W31-4	W31J-02469
W31-5	W31J-02343
W31-5	W31J-02406
W31-5	W31J-02480
W31-5	W31J-02509
W31-6	W31K-02617
W31-6	W31K-02611
W31-6	W31K-02582
W31-6	W31K-02568
W31-6	W31L-02553

RU number	SQR number
W31-6	W31L-02525
W31-6	W31L-02528
W31-6	W31L-02551
W31-6	W31L-02563
W31-6	W31L-02569
W32_1	W32A-02345
W32_1	W32A-02557
W32_1	W32B-02476
W32_1	W32B-02547
W32-2	W32D-02811
W32-2	W32D-02720
W32-2	W32E-02887
W32-2	W32E-02797
W32-2	W32E-02765
W32-2	W32E-02779
W32-2	W32E-02859
W32-2	W32E-02865
W32-3	W32G-02946
W32-3	W32G-02973
W32-4	W32G-03102
W32-4	W32G-02943
W32-4	W32G-02980
W32-4	W32G-03006
W32-4	W32G-03055
W32-4	W32G-02986
W32-5	W32C-02684
W32-5	W32C-02749
W32-5	W32C-02721
W32-5	W32C-02671
W32-6	W32C-02634
W32-6	W32C-02612
W33-7	W32F-02835
W33-7	W32H-02998
W33-7	W32H-02854

Table B4 SQRs grouped into RUs in W4 (Pongola)

RU number	SQR number
W41-1	W41A-02372
W41-1	W41B-02401
W41-1	W41B-02427
W41-1	W41B-02431
W41-1	W41B-02434
W41-1	W41C-02437
W41-1	W41D-02373
W41-1	W41D-02435
W41-1	W41E-02359
W41-2	W41F-02433
W41-2	W41F-02454
W41-2	W41F-02461
W41-2	W41F-02481
W41-2	W41F-02502
W42-3	W41G-02379
W42-1	W42A-02261
W42-1	W42A-02328
W42-1	W42B-02268
W42-1	W42B-02271
W42-1	W42B-02315
W42-1	W42B-02325
W42-1	W42B-02331
W42-1	W42C-02205

RU number	SQR number
W42-2	W42D-02251
W42-2	W42D-02327
W42-2	W42E-02221
W42-2	W42F-02185
W42-2	W42G-02317
W42-3	W42H-02382
W42-3	W42H-02394
W42-3	W42H-02411
W42-3	W42H-02428
W42-3	W42J-02353
W42-3	W42J-02378
W42-3	W42J-02397
W42-4	W42K-02148
W42-4	W42K-02242
W42-4	W42K-02272
W42-4	W42L-02270
42-5	W42M-02269
42-5	W42M-02294
42-5	W42M-02352
W43-1	W43F-02013
W43-1	W43F-02053
W43-1	W43F-02072
W43-1	W43F-02076
W43-1	W43F-02089
W43-1	W43F-02099
W43-1	W43F-02104
W43-1	W43F-02107
W43-1	W43F-02113
W43-1	W43F-02142
W43-1	W43F-02159
W44-1	W44A-02332
W44-1	W44A-02386
W44-1	W44A-02389
W44-1	W44A-02410
W44-1	W44B-02248
W44-1	W44B-02351
W44-1	W44C-02338
W44-1	W44D-02304
W45-1	W45A-02216
W45-1	W45A-02245
W45-1	W45A-02246
W45-1	W45A-02256
W45-1	W45A-02275
W45-1	W45A-02282
W45-1	W45A-02285
W45-1	W45A-02310
W45-1	W45A-02316
W45-1	W45A-02356
W45-1	W45A-02367
W45-1	W45A-02368
W45-1	W45B-02029
W45-1	W45B-02105

Table B5 SQRs grouped into RUs in W5 (Usutu)

RU number	SQR number
W11-1	W11A-03597
W11-1	W11A-03748
W11-1	W11A-03776
W11-2	W11A-03599
W11-2	W11A-03612
W11-2	W11C-03713

RU number	SQR number
W11-3	W11C-03917
W12-1	W12A-03086
W12-1	W12A-03104
W12-1	W12A-03153
W12-1	W12A-03226
W12-2	W12B-03334
W12-2	W12B-03356
W12-2	W12B-03398
W12-3	W12B-03471
W12-3	W12B-03479
W12-4	W12B-03336
W12-5	W12C-03189
W12-5	W12C-03225
W12-5	W12C-03232
W12-5	W12C-03263
W12-5	W12C-03303
W12-6	W12D-03346
W12-6	W12D-03375
W12-6	W12D-03388
W12-6	W12E-03475
W12-7	W12E-03526
W12-7	W12E-03530
W12-7	W12E-03558
W12-8	W12G-03229
W12-8	W12H-03289
W12-8	W12H-03316
W12-8	W12H-03401
W12-8	W12H-03418
W12-8	W12H-03428
W12-8	W12H-03459
W12-9	W12F-03611
W12-9	W12J-03290
W12-9	W12J-03392
W12-9	W12J-03403
W12-9	W12J-03411
W12-9	W12J-03450
W12-9	W12J-03493
W12-9	W12J-03501
W13-1	W13A-03583
W13-1	W13A-03609
W13-1	W13A-03641
W13-1	W13B-03593
W13-2	W13B-03774

Table B6 SQRs grouped into RUs in W7 (Kosi Estuary and Sibaya Lake)

RU number	SQR number
W70-1	W70A-02079
W70-2	W70A-02112
W70-3	W70A-02301
W70-3	W70A-02381

16 APPENDIX C: WETLANDS FROM THE NATIONAL SPATIAL BIODIVERSITY ASSESSMENT

Detail of named wetlands from the National Spatial Biodiversity Assessment (Driver *et al.*, 2005).

Name	SQR	Source	Description	Status	Threat Status
Cele	Coastal plain, SQR 2030	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	No legal protection	Moderate threat
Cele	Coastal plain, SQR 2030	palustrine	forested peatlands, including peat swamp forest	Unknown	Unknown
Gazani	Coastal plain, SQR 2030	palustrine	forested peatlands, including peat swamp forest	No legal protection	Unknown
Gazini	Coastal plain, SQR 2030	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	No legal protection	Moderate threat
Mloli	Coastal plain, SQR 2030	palustrine	forested peatlands, including peat swamp forest	No legal protection	Unknown
Mloli	Coastal plain, SQR 2030	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	No legal protection	Moderate threat
Muzi Swamps	Coastal plain, SQR 2030	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	Partly protected	High threat
Muzi Swamps	Coastal plain, SQR 2030	palustrine	permanent peat-forming freshwater swamps, including upland valley swamps dominated by Papyrus or Typha	Fully protected	Minor threat
Ndlovu	Coastal plain, SQR 2030	palustrine	forested peatlands, including peat swamp forest	No legal protection	Unknown
Nlovu	Coastal plain, SQR 2030	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	No legal protection	Moderate threat
Sileza Vlei	Coastal plain, SQR 2030	palustrine	seasonal freshwater marshes on inorganic soil, including sloughs, potholes, seasonally flooeded meadows,sedge marshes and dambos	No legal protection	Minor threat
KuMzingwane	Coastal plain, SQR 2278	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	Fully protected	Moderate threat
Shazibe	Coastal plain, SQR 2278	palustrine	forested peatlands, including peat swamp forest	Partly protected	Unknown
Shazibe	Coastal plain, SQR 2278	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	Fully protected	Minor threat
Mgobozeleni - Shazibe	Coastal plain, SQR 2278	lacustrine	permanent freshwater lakes (+8 ha),including shores subject to seasonal or irregular inundation	No information	Moderate threat
Umlalazi	W11C-03713	riverine	riverine floodplains, including river flats, flooded river basins, seasonally flooded grassland	Fully protected	Unknown
Swamp System	W12E-03475	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	Unknown	Unknown
Thulazihleka	W12F-03509	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No information	No information
Mhlatuze Floodplain	W12F-03511	palustrine	permanent peat-forming freshwater swamps, including upland valley swamps	No legal protection	Moderate threat

Name	SQR	Source	Description	Status	Threat Status
			dominated by Papyrus or Typha		
Cubhu	W12F-03611	palustrine	permanent peat-forming freshwater swamps, including upland valley swamps dominated by Papyrus or Typha	No legal protection	Unknown
Cubhu	W12F-03611	lacustrine	permanent freshwater lakes (+8 ha),including shores subject to seasonal or irregular inundation	No legal protection	Moderate threat
Nsezi	W12H-03459	lacustrine	permanent freshwater lakes (+8 ha),including shores subject to seasonal or irregular inundation	No information	Moderate threat
Mzingazi	W12J-03450	lacustrine	permanent freshwater lakes (+8 ha),including shores subject to seasonal or irregular inundation	No information	Moderate threat
Bloemveld Vlei	W21A-02512	palustrine	permanent freshwater marshes and swamps on inorganic soils, with emergent vegetation of which bases lie below the water-table for at least most of the growing season.	No legal protection	Moderate threat
Grootgewaagd Vlei	W21A-02512	palustrine	permanent freshwater marshes and swamps on inorganic soils, with emergent vegetation of which bases lie below the water-table for at least most of the growing season.	No legal protection	Minor threat
Stilwater Vlei	W21A-02527	palustrine	permanent freshwater marshes and swamps on inorganic soils, with emergent vegetation of which bases lie below the water-table for at least most of the growing season.	No legal protection	Moderate threat
Lenjane Vlei	W21B-02603	palustrine	permanent freshwater marshes and swamps on inorganic soils, with emergent vegetation of which bases lie below the water-table for at least most of the growing season.	No legal protection	Minor threat
Fuyeni Reedbed	W21L-03041	palustrine	permanent freshwater marshes and swamps on inorganic soils, with emergent vegetation of which bases lie below the water-table for at least most of the growing season.	No legal protection	No information
Aloeboom Vlei	W22A-02596	palustrine	permanent freshwater marshes and swamps on inorganic soils, with emergent vegetation of which bases lie below the water-table for at least most of the growing season.	No legal protection	Moderate threat
Umfolozi	W23A-03098	riverine	riverine floodplains, including river flats, flooded river basins, seasonally flooded grassland	Partly protected	Unknown
Mvamanzi Pan	W23A-03160	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No legal protection	No known threat
Teza	W23B-03231	lacustrine	seasonal freshwater lakes (+8 ha), including floodplain lakes	Partly protected	Moderate threat
Lake Teza	W23B-03231	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	Fully protected	No information
Umfolozi Swamp	W23C-03180	palustrine	permanent freshwater marshes and swamps on inorganic soils, with emergent vegetation of which bases lie below the water-table for at least most of the growing season.	No legal protection	Moderate threat
Mavuya Pan	W23C-03254	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	Partly protected	No information
Lake Mfuthululu	W23D-03108	lacustrine	seasonal freshwater lakes (+8 ha), including floodplain lakes	No information	Moderate threat

Name	SQR	Source	Description	Status	Threat Status
Mfuthululu	W23D-03108	lacustrine	permanent freshwater lakes (+8 ha),including shores subject to seasonal or irregular inundation	Unknown	Unknown
Collin's Lake	W23D-03108	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	Unknown	Unknown
Nhlonhlela Pan	W31J-02469	lacustrine	seasonal freshwater lakes (+8 ha), including floodplain lakes	Fully protected	High threat
Hlonhlela	W31J-02501	lacustrine	seasonal freshwater ponds, (<= 8 ha),palustrineine emergent	Fully protected	No information
Mkuze Gr Airstrip Pans	W31J-02509	riverine	riverine floodplains, including river flats, flooded river basins, seasonally flooded grassland	Fully protected	Unknown
Nsumu Pan	W31J-02509	lacustrine	permanent freshwater ponds, pans (<= 8 ha) palustrineine emergent	Fully protected	No information
Muzi (South)	W32A-02345	palustrine	permanent peat-forming freshwater swamps, including upland valley swamps dominated by Papyrus or Typha	No information	No information
Neshe	W32A-02345	lacustrine	permanent freshwater ponds, pans (<= 8 ha) palustrineine emergent	Partly protected	No known threat
Yengweni	W32A-02345	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No information	No information
St Lucia - Mbazwana	W32B-02429	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	Fully protected	Moderate threat
St Lucia - Mbazwana	W32B-02429	palustrine	forested peatlands, including peat swamp forest	Fully protected	Unknown
Mfula Pan	W32B-02429	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	Fully protected	No information
Siphudwini	W32B-02462	palustrine	forested peatlands, including peat swamp forest	Partly protected	Unknown
Siphudwini	W32B-02462	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	Fully protected	Moderate threat
St Lucia - Siphudwini	W32B-02462	palustrine	forested peatlands, including peat swamp forest	Fully protected	Unknown
Mhlazi Pan	W32B-02462	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	Fully protected	No information
St Lucia - Manzibomvu	W32B-02476	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	Fully protected	Moderate threat
Mdlaze Pan	W32B-02476	lacustrine	permanent freshwater lakes (+8 ha),including shores subject to seasonal or irregular inundation	Fully protected	Unknown
Mpanze Pan	W32B-02476	lacustrine	seasonal freshwater ponds, (<= 8 ha),palustrineine emergent	Fully protected	Minor threat
Mkuze Floodplain	W32B-02535	riverine	riverine floodplains, including river flats, flooded river basins, seasonally flooded grassland	Partly protected	Unknown
Mkuze Swamp System	W32B-02535	palustrine	permanent peat-forming freshwater swamps, including upland valley swamps dominated by Papyrus or Typha	Fully protected	Moderate threat
Ntshangwe Lake	W32B-02535	palustrine	seasonal freshwater marshes on inorganic soil, including sloughs, potholes, seasonally flooeded meadows,sedge marshes and dambos	Fully protected	No known threat

Name	SQR	Source	Description	Status	Threat Status
Ku Ndlebeni	W32B-02535	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	Partly protected	No known threat
Tshanetshe	W32B-02547	lacustrine	permanent freshwater ponds, pans (<= 8 ha) palustrineine emergent	Partly protected	Minor threat
Hluhluwe Flood Plain	W32C-02749	riverine	riverine floodplains, including river flats, flooded river basins, seasonally flooded grassland	Partly protected	No information
Enseleni	W32E-02765	riverine	permanent rivers and streams, including water falls	Unknown	Unknown
Hluhluwe River Vlei	W32F-02835	palustrine	seasonal freshwater marshes on inorganic soil, including sloughs, potholes, seasonally flooeded meadows,sedge marshes and dambos	Partly protected	No information
Bushlands Pan	W32F-02835	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	Fully protected	No information
Makhakathana Flats	W32H-02818	palustrine	seasonal freshwater marshes on inorganic soil, including sloughs, potholes, seasonally flooeded meadows,sedge marshes and dambos	Fully protected	Unknown
Nyalazi	W32H-02998	palustrine	forested peatlands, including peat swamp forest	Partly protected	Unknown
Nyalazi	W32H-02998	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	Fully protected	High threat
St. Lucia (Mkuze)	W32H-03048	palustrine	permanent freshwater marshes and swamps on inorganic soils, with emergent vegetation of which bases lie below the water-table for at least most of the growing season.	Fully protected	Minor threat
Mtoti Pan	W45A-02245	lacustrine	seasonal freshwater lakes (+8 ha), including floodplain lakes	No legal protection	Unknown
Pongola Floodplain	W45A-02282	riverine	riverine floodplains, including river flats, flooded river basins, seasonally flooded grassland	Partly protected	High threat
Msenyeni Pan	W45A-02285	lacustrine	permanent freshwater lakes (+8 ha),including shores subject to seasonal or irregular inundation	No legal protection	Minor threat
Balamhlanga	W45A-02367	riverine	riverine floodplains, including river flats, flooded river basins, seasonally flooded grassland	No legal protection	Unknown
Mandlankunzi Pan	W45B-02029	lacustrine	seasonal freshwater lakes (+8 ha), including floodplain lakes	No legal protection	Minor threat
Ndumo Game Reserve	W45B-02029	lacustrine	permanent freshwater ponds, pans (<= 8 ha) palustrineine emergent	Fully protected	Moderate threat
Bumbe Pan	W45B-02105	lacustrine	seasonal freshwater lakes (+8 ha), including floodplain lakes	No legal protection	Moderate threat
Khanganzeni Pan	W45B-02105	lacustrine	seasonal freshwater lakes (+8 ha), including floodplain lakes	No legal protection	Unknown
Nhlole Pan	W45B-02105	lacustrine	seasonal freshwater lakes (+8 ha), including floodplain lakes	No legal protection	Unknown
Shalala Pans	W45B-02105	lacustrine	seasonal freshwater lakes (+8 ha), including floodplain lakes	No legal protection	No known threat
Tete Pan	W45B-02105	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No legal protection	No known threat
Langfontein - Pan 3	W51A-02082	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No information	No information

Name	SQR	Source	Description	Status	Threat Status
Upper Black Umfolozi	W51E-02049	riverine	permanent rivers and streams, including water falls	Unknown	Moderate threat
Liefgekozen	W54A-01534	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No legal protection	No known threat
Lusthof - Pan 18	W55A-01375	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No information	Moderate threat
Tevrede Se Pan - Pan 16	W55A-01375	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No information	No information
Tevreden	W55A-01375	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No legal protection	High threat
Blaauwater	W55A-01423	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No legal protection	No information
Florence	W55A-01423	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No legal protection	No information
Blinkpan	W55C-01395	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No information	No information
Coalbank	W55C-01395	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No legal protection	No information
Eilandsmeer	W55C-01395	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No legal protection	Minor threat
Goedehoop - Pan 18	W55C-01395	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	Unknown	Unknown
Grasdal	W55C-01395	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No legal protection	No known threat
Hamilton	W55C-01395	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No information	No information
Lake Banagher	W55C-01395	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No legal protection	No known threat
Lake Banagher - Pan 31	W55C-01395	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	Unknown	Unknown
Lake Banagher - Pan 36	W55C-01395	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	Unknown	Unknown
Lake Chrissie	W55C-01395	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No legal protection	No information
Lake Chrissie - Pan 10	W55C-01395	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No legal protection	No known threat
Lake Chrissie - Pan 56	W55C-01395	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No legal protection	Unknown
Neethlingpan	W55C-01395	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No legal protection	Moderate threat
Tweelingpan - Pan 17	W55C-01395	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	Unknown	Minor threat
Tweelingpan - Pan 26	W55C-01395	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	Unknown	Unknown
Van Aardt Graspan	W55C-01395	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No legal protection	No information
Van Aardt Kaalpan	W55C-01395	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No legal protection	No information

Name	SQR	Source	Description	Status	Threat Status
West Tweelingpan	W55C-01395	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	No legal protection	No information
Shokwe Pan	W57K-01929	lacustrine	permanent freshwater ponds, pans (<= 8 ha) palustrineine emergent	Fully protected	High threat
Banzi Pan (Ndumo)	W57K-01929	endopans	permanent and seasonal, brackish, saline or alkaline lakes, flats, pans and marshes	Fully protected	No information
Kosi - Kosi Bay	W70A-02046	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	Fully protected	No known threat
Kosi - KuKalwe	W70A-02046	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	Partly protected	Moderate threat
Kosi - Ngweve	W70A-02046	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	Partly protected	High threat
Kukalwe	W70A-02046	palustrine	forested peatlands, including peat swamp forest	Partly protected	Unknown
KuZilonde	W70A-02046	lacustrine	permanent freshwater lakes (+8 ha),including shores subject to seasonal or irregular inundation	Unknown	Minor threat
Apeisdraai	W70A-02079	palustrine	forested peatlands, including peat swamp forest	Partly protected	Unknown
Enkathweni	W70A-02079	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	No legal protection	Moderate threat
Kosi - Apiesdraai	W70A-02079	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	Fully protected	Minor threat
Kosi - Matimane	W70A-02079	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	Fully protected	Moderate threat
Kosi - Mtando	W70A-02079	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	Fully protected	No known threat
Kosi - Swamanzi	W70A-02079	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	Fully protected	No known threat
Kosi - Swamanzi tributary	W70A-02079	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	Fully protected	Moderate threat
KuNkanini	W70A-02079	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	No legal protection	Moderate threat
KuNkanini	W70A-02079	palustrine	forested peatlands, including peat swamp forest	No legal protection	Unknown
Matitimane	W70A-02079	palustrine	forested peatlands, including peat swamp forest	Partly protected	Unknown
Mtando	W70A-02079	palustrine	forested peatlands, including peat swamp forest	Partly protected	Unknown
Swamanzi	W70A-02079	palustrine	forested peatlands, including peat swamp forest	Partly protected	Unknown
Enkathweni	W70A-02112	palustrine	forested peatlands, including peat swamp forest	No legal protection	Unknown
Kosi - Siyadla	W70A-02112	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	Fully protected	No known threat

Name	SQR	Source	Description	Status	Threat Status
KuMzinganwane	W70A-02112	palustrine	forested peatlands, including peat swamp forest	No legal protection	Unknown
Mvelabusha	W70A-02112	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	No legal protection	Moderate threat
Mvelabusha	W70A-02112	palustrine	forested peatlands, including peat swamp forest	No legal protection	Unknown
Nlangu mire complex	W70A-02112	palustrine	peatlands, including acidophilous, ombrogenous or soligenous mires covered by moss, herbs or dwarf shrub vegetation, and fens of all types	Partly protected	Unknown
Sihadla	W70A-02112	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	Partly protected	High threat
Siyadla	W70A-02112	palustrine	freshwater swamp forest, including seasonally flooded forest, wooded swamps on inorganic soils	No legal protection	Moderate threat
Siyadla	W70A-02112	palustrine	forested peatlands, including peat swamp forest	No legal protection	Unknown
Siyadla	W70A-02112	palustrine	forested peatlands, including peat swamp forest	Partly protected	Unknown
Kozi -aManzamnyama	W70A-02112	lacustrine	permanent freshwater lakes (+8 ha),including shores subject to seasonal or irregular inundation	Fully protected	No information
KuShengeza	W70A-02112	lacustrine	permanent freshwater lakes (+8 ha),including shores subject to seasonal or irregular inundation	Unknown	Unknown
Kushengeza	W70A-02112	lacustrine	permanent freshwater lakes (+8 ha),including shores subject to seasonal or irregular inundation	No information	No information

17 APPENDIX D: SUMMARY OF EXISTING WETLAND-RELATED DATA AT THE QUINARY SCALE

PES/EI/ES					NWM 2018					NFEPA 2011		
SQR	River Named in SQR	Rip/Wetland Zone Continuity Mod	Riparian-Wetland Zone Mod	Wet PES (surr)	Dom WETCON	Dom HGM	Dom Threat Status	Dom Protection Level	Extent of wetlands within SQR (Ha)	Wetland FEPA	Wetland Cluster	Ramsar
W11A-03597	Matigulu	2	1	B/C	D/E/F	SEEP	CR	Not protected	571.6	Y		N
W11A-03599	Ngoje	2	3	C/D	D/E/F	SEEP	CR	Not protected	9.1	N		N
W11A-03612	Matigulu	2	2	C	No assess	EST	EN	Moderately protected	1451.9	N	Y	N
W11A-03748	uMngwenya	3	1	C	No assess	RIVER	N/A	(blank)	22.6			
W11A-03776	kuMnyameni	2	2	C	No assess							
W11C-03713	Nyezane	3	4	D/E	No assess	EST	EN	Moderately protected	1375.2	Y	Y	N
W11C-03893					No assess	EST	EN	Moderately protected	997.1	N	Y	N
W11C-03917	Nyoni	3	4	D/E	No assess	EST	EN	Moderately protected	1270.4	N	Y	N
W11C-03932					No assess	EST	EN	Moderately protected	988.4	N	Y	N
W12A-03086	Gologodo	1	2	B/C	C	SEEP	CR	Not protected	229.4	N		N
W12A-03104	Mhlatuze	2	3	C/D	C	SEEP	CR	Not protected	0.2	N		N
W12A-03153	Mhlatuze	2	2	C	D/E/F	SEEP	CR	Not protected	700.7	N	Y	N
W12A-03226		2	3	C/D	D/E/F	SEEP	CR	Not protected	234.7	Y		N
W12B-03334	Mhlatuze	1	1	B	D/E/F	SEEP	CR	Not protected	49.1	N		N
W12B-03336	KwaMazula	2	2	C	D/E/F	SEEP	CR	Not protected	6.3	N		N
W12B-03356	Mhlatuze	1	1	B	C	SEEP	CR	Not protected	1.5	N		N
W12B-03398	Mavungwini	1	2	B/C	No assess							
W12B-03471	Nyawushane	1	2	B/C	A/B	SEEP	CR	Not protected	2.1	N		N
W12B-03479	Mhlatuze	1	2	B/C	D/E/F	SEEP	CR	Not protected	38.0	N		N
W12C-03189	Mfule	2	2	C	D/E/F	CVB	CR	Poorly protected	322.0	N		N
W12C-03225	Mfule	1	1	B	D/E/F	RIVER	CR	(blank)	399.0	N		N
W12C-03232	Nhlozane	1	1	B	No assess	RIVER	N/A	(blank)	103.3	N		N
W12C-03263	Mfulazane	1.5	2	C	D/E/F	SEEP	CR	Not protected	228.5	N		N
W12C-03303	Mfule	2	2	C	No assess	RIVER	N/A	(blank)	526.9	N		N
W12D-03346	Ntambanana	2	2	C	No assess	RIVER	N/A	(blank)	476.0	N		N
W12D-03375	Mhlatuze	2	3	C/D	No assess	RIVER	N/A	(blank)	473.8	N		N
W12D-03388	Mhlatuze	3	4	D/E	No assess	RIVER	N/A	(blank)	626.3	N		N
W12E-03475	Mhlatuze	2	3	C/D	No assess	RIVER	N/A	(blank)	607.5	N		N

PES/EI/ES					NWM 2018					NFEPA 2011		
SQR	River Named in SQR	Rip/Wetland Zone Continuity Mod	Riparian-Wetland Zone Mod	Wet PES (surr)	Dom WETCON	Dom HGM	Dom Threat Status	Dom Protection Level	Extent of wetlands within SQR (Ha)	Wetland FEPA	Wetland Cluster	Ramsar
W12E-03526	Mhtatuzana	1	1	B	D/E/F	UVB	CR	Poorly protected	300.3	N		N
W12E-03530	Mateku	2	1	B/C	C	DEPR	VU	Well protected	2.0	N		N
W12E-03558	Mhlatuzana	2	1	B/C	No assess					N		N
W12F-03494	Mhlatuze	3	4	D/E	No assess	EST	EN	Poorly protected	8532.7	N		N
W12F-03509	Mzingazi				No assess	EST	EN	Poorly protected	6440.7	N		N
W12F-03511	Mhlatuze				No assess	EST	EN	Poorly protected	13191.0	N		N
W12F-03611	Mzingwenya	3	3	D	No assess	EST	EN	Poorly protected	6169.2	N		N
W12G-03229	Nseleni	2	2	C	C	UVB	CR	Poorly protected	82.1	N	Y	N
W12H-03289	Mbabe	2	3	C/D	D/E/F	UVB	CR	Poorly protected	190.0	N		N
W12H-03316	Mposa	1	3	C	D/E/F	UVB	CR	Poorly protected	590.9	N		N
W12H-03401	Okula	3	4	D/E	D/E/F	UVB	CR	Poorly protected	229.5	N		N
W12H-03418	Nseleni	3	2	C/D	No assess	RIVER	N/A	(blank)	190.2	N		N
W12H-03428	Mbabe	3	4	D/E	D/E/F	RIVER	N/A	(blank)	324.0	N		N
W12H-03459	Nseleni	3	1	C	No assess	EST	EN	Poorly protected	15300.1	N		N
W12J-03290	Nhlabane	2	3	C/D	No assess	EST	EN	Poorly protected	2419.6	N		N
W12J-03390	Nhlabane				No assess	EST	EN	Poorly protected	1851.3	N		N
W12J-03392	Mpisini	2	2	C	No assess	EST	EN	Poorly protected	6607.9	N		N
W12J-03403		2	2	C	No assess	EST	EN	Poorly protected	6535.0	N		N
W12J-03411		2	2	C	No assess	EST	EN	Poorly protected	1888.7	N		N
W12J-03450	Nundwane	2	2	C	No assess	EST	EN	Poorly protected	6469.9	N		N
W12J-03485					No assess	EST	EN	Poorly protected	6311.4	N		N
W12J-03489	Mzingazi				No assess	EST	EN	Poorly protected	6356.1	N		N
W12J-03493		2	3	C/D	No assess	EST	EN	Poorly protected	6293.0	N		N
W12J-03501	Kondweni	2	3	C/D	No assess	EST	EN	Poorly protected	6308.8	N		N
W13A-03583	Mlalazi	2	2	C	No assess	RIVER	N/A	(blank)	94.5	N		N
W13A-03609	Mlalazi	3	2	C/D	No assess	EST	EN	Moderately protected	1988.4	N		N
W13A-03641	Mkukuze	2	2	C	No assess	RIVER	N/A	(blank)	125.5			
W13B-03593	KwaGugushe	2	2	C	No assess	EST	EN	Moderately protected	1843.6	Y		N
W13B-03673	Mlalazi				No assess	EST	EN	Moderately protected	1899.7	Y	Y	N
W13B-03774	Manzamnyama	1	1	B	No assess	EST	EN	Moderately protected	3228.3	Y	Y	N
W21A-02527	White Mfolozi	2	2	C	D/E/F	SEEP	CR	Poorly protected	562.9	Y	Y	N

PES/EI/ES					NWM 2018					NFEPA 2011		
SQR	River Named in SQR	Rip/Wetland Zone Continuity Mod	Riparian-Wetland Zone Mod	Wet PES (surr)	Dom WETCON	Dom HGM	Dom Threat Status	Dom Protection Level	Extent of wetlands within SQR (Ha)	Wetland FEPA	Wetland Cluster	Ramsar
W21A-02512	aMagoda	2	2	C	D/E/F	SEEP	CR	Not protected	794.4	N		N
W21B-02603	Lenjane	1	1	B	No assess	RIVER	N/A	(blank)	2906.3	N		N
W21B-02539	iShoba	1.5	1.5	B/C	No assess	RIVER	N/A	(blank)	2409.0	Y		N
W21B-02546	White Mfolozi	1	3	C	No assess	RIVER	N/A	(blank)	2341.8	Y	Y	N
W21B-02652	White Mfolozi	1	1	B	No assess	RIVER	N/A	(blank)	1590.6	N		N
W21B-02670	White Mfolozi	1	1	B	No assess	RIVER	N/A	(blank)	2008.6	N		N
W21C-02599	Sandspruit	2	1	B/C	No assess	RIVER	CR	(blank)	3696.8	N	Y	N
W21D-02676	Mvunyane	3	3	D	No assess	RIVER	N/A	(blank)	3002.9	N	Y	N
W21D-02788	Vumankala	4	4	E	No assess	RIVER	N/A	(blank)	1630.0	N		N
W21D-02832	Jojosi	3	3	D	No assess	RIVER	N/A	(blank)	2373.3	N		N
W21D-02848	Jojosi	3	3	D	No assess	RIVER	N/A	(blank)	1550.4	N		N
W21D-02815	Mvunyane	2	2	C	No assess	RIVER	N/A	(blank)	1805.5	N		N
W21E-02934	Vuwankala	3	2	C/D	No assess	RIVER	N/A	(blank)	295.0	N		N
W21E-02963	Nondweni	4	4	E	No assess	SEEP	CR	Not protected	335.0	Y	Y	N
W21E-02953	Ngwebini	3	3	D	D/E/F	SEEP	CR	Not protected	773.0	N		N
W21E-02912	Nondweni	3	3	D	D/E/F	SEEP	CR	Not protected	423.2	N		N
W21E-02873	Nondweni	2	2	C	No assess	RIVER	N/A	(blank)	1838.6	N		N
W21F-02727	White Mfolozi	2	2	C	No assess	RIVER	N/A	(blank)	2610.3	N		N
W21F-02840	Mvunyane	1.5	2	C	No assess	RIVER	N/A	(blank)	1615.7	N		N
W21G-03085	Ntinini	2	2.5	C	A/B	DEPR	EN	Not protected	3.0	N		N
W21G-03067		3	3	D	D/E/F	DEPR	EN	Not protected	0.3	N		N
W21G-02929	Nsubeni	2	2	C	No assess	RIVER	N/A	(blank)	1827.1	N		N
W21G-02914	Ntinini	2	2	C	No assess	RIVER	N/A	(blank)	2095.3	N		N
W21G-02885	White Mfolozi	2	1	B/C	No assess	RIVER	N/A	(blank)	1548.1	N		N
W21G-02851	White Mfolozi	2	1.5	C	No assess	RIVER	N/A	(blank)	1918.6	N	Y	N
W21H-02889	Mhlahlane	1	2	B/C	D/E/F	SEEP	EN	Poorly protected	213.2	N	Y	N
W21H-02897	White Mfolozi	1	2	B/C	No assess	RIVER	N/A	(blank)	2197.4	N	Y	N
W21H-03004	White Mfolozi	2	1	B/C	No assess					N		N
W21J-03112	Mzinhlanga	1	2	B/C	D/E/F	SEEP	EN	Poorly protected	1120.8	N	Y	N
W21J-03036	Mpembeni	1	2	B/C	A/B	SEEP	EN	Poorly protected	731.8	N		N
W21J-03018	Maphophoma	2	2	C	D/E/F	SEEP	EN	Poorly protected	234.9	N		N

PES/EI/ES					NWM 2018					NFEPA 2011		
SQR	River Named in SQR	Rip/Wetland Zone Continuity Mod	Riparian-Wetland Zone Mod	Wet PES (surr)	Dom WETCON	Dom HGM	Dom Threat Status	Dom Protection Level	Extent of wetlands within SQR (Ha)	Wetland FEPA	Wetland Cluster	Ramsar
W21J-03075	Mkumbane	1	2	B/C	A/B	UVB	CR	Poorly protected	166.7	N		N
W21J-03066	Mpembeni	2	2	C	C	SEEP	EN	Poorly protected	74.7	N		N
W21J-03050	Mpembeni	1	2	B/C	No assess					N		N
W21J-03030	White Mfolozi	2	1	B/C	D/E/F	SEEP	EN	Poorly protected	7.3	N		N
W21K-02976	Mbilane	3	3	D	D/E/F	SEEP	EN	Poorly protected	135.0	N		N
W21K-03019	Nhlungwane	1	2	B/C	A/B	SEEP	EN	Poorly protected	85.1	N		N
W21K-02981	White Mfolozi	1	1	B	D/E/F	SEEP	EN	Poorly protected	94.3	N		N
W21K-03080	White Mfolozi	1	1	B	D/E/F	SEEP	CR	Poorly protected	187.0	N		N
W21L-03161	Munywana	1	1.5	B	C	SEEP	EN	Poorly protected	50.1	N		N
W21L-03176	Mayayeni	1	1.5	B	A/B	SEEP	EN	Poorly protected	179.0	N		N
W21L-03163	Munywana	1	1	B	No assess					N		N
W21L-03059	White Mfolozi	1	1	B	A/B	SEEP	EN	Poorly protected	91.7	N		N
W21L-03041	White Mfolozi	1	1	B	A/B	SEEP	EN	Poorly protected	648.4	N		N
W22A-02587	Mgobhozi	1	1	B	D/E/F	SEEP	CR	Not protected	57.9	N		N
W22A-02591		2.5	2	C	D/E/F	CVB	CR	Not protected	259.9	N		N
W22A-02586	Black Mfolozi	1	1	B	D/E/F	CVB	CR	Not protected	333.8	N		N
W22A-02596	Black Mfolozi	1	1	B	D/E/F	CVB	CR	Not protected	427.0	N		N
W22A-02610	Black Mfolozi	1	1	B	D/E/F	SEEP	EN	Poorly protected	1154.5	N	Y	N
W22B-02662	KwaMbizankulu	2	1	B/C	D/E/F	SEEP	EN	Poorly protected	304.4	N		N
W22B-02773	Hlangabende	1	1	B	D/E/F	SEEP	CR	Not protected	392.3	N	Y	N
W22B-02661	Hlonyana	1	1	B	D/E/F	SEEP	CR	Poorly protected	420.2	N		N
W22B-02728	Hlonyane	1	1	B	A/B	SEEP	EN	Poorly protected	187.5	N		N
W22B-02706	Hlonyane	1	1	B	No assess	RIVER	N/A	(blank)	112.6	N		N
W22C-02688	Black Mfolozi	2	1	B/C	D/E/F	SEEP	EN	Poorly protected	404.4	N	Y	N
W22D-02795	iThaka	1.5	1	B	D/E/F	SEEP	CR	Poorly protected	323.5	Y	Y	N
W22E-02601	Bululwana	3	3	D	D/E/F	SEEP	EN	Poorly protected	449.0	N		N
W22E-02605	Sikwebezi	2	2	C	D/E/F	SEEP	EN	Poorly protected	341.1	N	Y	N
W22E-02595		1	2	B/C	D/E/F	SEEP	EN	Poorly protected	157.3	N		N
W22E-02702	Sikwebezi	2	3	C/D	D/E/F	SEEP	EN	Poorly protected	83.1	N		N
W22F-02726	Sikwebezi	2	2	C	D/E/F	SEEP	EN	Poorly protected	333.7	N		N
W22F-02722	Black Mfolozi	1.5	1.5	B/C	D/E/F	SEEP	EN	Poorly protected	138.6	N	Y	N

PES/EI/ES					NWM 2018					NFEPA 2011		
SQR	River Named in SQR	Rip/Wetland Zone Continuity Mod	Riparian-Wetland Zone Mod	Wet PES (surr)	Dom WETCON	Dom HGM	Dom Threat Status	Dom Protection Level	Extent of wetlands within SQR (Ha)	Wetland FEPA	Wetland Cluster	Ramsar
W22F-02748	Black Mfolozi	1	1.5	B	D/E/F	SEEP	EN	Poorly protected	15.6	N		N
W22G-02624	Vuna	2	2	C	No assess	SEEP	EN	Poorly protected	175.1	N	Y	N
W22H-02844	Mbhekamuzi	2	2	C	D/E/F	SEEP	EN	Poorly protected	336.7	N	Y	N
W22H-02846	Black Mfolozi	1	2	B/C	C	DEPR	VU	Well protected	0.9	N		N
W22J-02942	Mvalo	2	3	C/D	D/E/F	SEEP	EN	Poorly protected	41.9	N		N
W22J-02918	Wela	2	2	C	D/E/F	SEEP	EN	Poorly protected	194.1	N		N
W22J-02807	Black Mfolozi	2	3	C/D	D/E/F	SEEP	EN	Poorly protected	93.7	N		N
W22J-02910	Black Mfolozi	2	3	C/D	A/B	SEEP	EN	Poorly protected	32.0	N		N
W22J-02817	Black Mfolozi	1	2	B/C	C	SEEP	EN	Poorly protected	222.9	N		N
W22K-02761	Mapopoma	1	2	B/C	No assess	SEEP	EN	Poorly protected	448.3	N	Y	N
W22K-02622		2	2	C	D/E/F	SEEP	EN	Poorly protected	117.1	N	Y	N
W22K-02636	Manzimakulu	2	2.5	C	D/E/F	SEEP	EN	Poorly protected	354.0	Y	Y	N
W22K-02629	Mona	2	2	C	D/E/F	SEEP	EN	Poorly protected	1567.7	Y	Y	N
W22K-02783	Mona	1	1.5	B	No assess	RIVER	N/A	(blank)	300.1	N	Y	N
W22L-02916	Black Mfolozi	1	1	B	A/B	SEEP	EN	Poorly protected	355.2	N	Y	N
W23A-03098	Nkatha	2	3	C/D	D/E/F	SEEP	EN	Poorly protected	172.0	N		N
W23A-03160	Mvamanzi	1	2	B/C	D/E/F	SEEP	EN	Poorly protected	1545.9	Y	Y	N
W23A-03058	Mbukwini	3	2	C/D	D/E/F	SEEP	EN	Poorly protected	217.3	N		N
W23A-03083	Mfolozi	1	2	B/C	D/E/F	SEEP	EN	Poorly protected	187.6	N		N
W23A-03149	Mfolozi	1	2	B/C	A/B	SEEP	EN	Poorly protected	6.8	Y		N
W23A-03113	Mfolozi	1	2	B/C	D/E/F	SEEP	EN	Poorly protected	136.4	N		N
W23B-03250	Ntobozi	2	3	C/D	D/E/F	SEEP	EN	Poorly protected	207.3	N		N
W23B-03222	Msunduzi	1	2	B/C	D/E/F	SEEP	EN	Poorly protected	932.4	N	Y	N
W23B-03231	Msunduzi	3	4	D/E	D/E/F	SEEP	CR	Not protected	135.3	N		N
W23C-03287	Mavuya	3	3	D	D/E/F	DEPR	VU	Well protected	45.2	N		N
W23C-03272	Ntenja	4	4	E	D/E/F	SEEP	CR	Not protected	12.6	N		N
W23C-03254	Mavuya	4	4	E	D/E/F	UVB	CR	Poorly protected	1.9	N		N
W23C-03180	Msunduzi	4	4	E	No assess	EST	EN	Poorly protected	8037.6	Y	Y	N
W23D-03108	Mfolozi	4	4	E	No assess	EST	EN	Poorly protected	19852.2	N	Y	N
W23D-03154	Mfolozi				No assess	EST	EN	Poorly protected	83755.2	Y	Y	Y
W31A-02494	Nkongolwana	3	3	D	No assess	RIVER	N/A	(blank)	83.4	N		N

PES/EI/ES					NWM 2018					NFEPA 2011		
SQR	River Named in SQR	Rip/Wetland Zone Continuity Mod	Riparian-Wetland Zone Mod	Wet PES (surr)	Dom WETCON	Dom HGM	Dom Threat Status	Dom Protection Level	Extent of wetlands within SQR (Ha)	Wetland FEPA	Wetland Cluster	Ramsar
W31A-02534	Mkuze	2	2	C	A/B	UVB	CR	Poorly protected	55.6	N		N
W31B-02477	Mkuze	2	2	C	C	SEEP	CR	Poorly protected	82.1	N		N
W31C-02556	Sihlengeni	1	1	B	D/E/F	SEEP	CR	Not protected	43.5	Y		N
W31D-02436	Manzimhlope	1	1.5	B	A/B	DEPR	LC	Poorly protected	3.2	N		N
W31D-02450	Ntutshe	1.5	2	C	D/E/F	SEEP	EN	Poorly protected	141.6	N	Y	N
W31D-02495	Mkuze	1	1	B	A/B	DEPR	VU	Well protected	1.1	N		N
W31D-02500	Mkuze	1	1	B	No assess							
W31E-02456	Mkuze	2	1	B/C	A/B	DEPR	VU	Well protected	33.8	N		N
W31F-02573	Mpuphisi	1.5	2	C	A/B	DEPR	VU	Well protected	4.2	N	Y	N
W31F-02555	Nkunzana	2	2	C	No assess	RIVER	N/A	(blank)	100.1	N	Y	N
W31F-02530	Nkunzana	2	2	C	D/E/F	DEPR	VU	Well protected	3.6	N		N
W31G-02455	Mtiki	1	1	B	A/B	DEPR	VU	Well protected	11.2	N		N
W31G-02506	Mkuze	2	3	C/D	D/E/F	DEPR	VU	Well protected	6.1	N		N
W31G-02425	Mkuze	2	2	C	D/E/F	SEEP	EN	Poorly protected	345.2	N		N
W31H-02514	KwaSekane	2	1	B/C	A/B	DEPR	VU	Well protected	4.2	N		N
W31J-02343	Mthambalala	2	3	C/D	No assess	RIVER	N/A	(blank)	394.7	Y		Y
W31J-02406	Ndlamyane	2	3	C/D	D/E/F	RIVER	N/A	Poorly protected	790.5	Y	Y	Y
W31J-02501	Nhlohlela	1	1	B	A/B	DEPR	VU	Well protected	7.8	Y		N
W31J-02497	Ndlamyane				No assess	RIVER	N/A	(blank)	493.8	Y		Y
W31J-02469	Mkuze	1.5	1	B	A/B	DEPR	VU	Well protected	6.7	Y		N
W31J-02480	Mkuze	2	2	C	No assess	DEPR	VU	Well protected	814.1	Y	Y	Y
W31J-02509	Mkuze	2.5	1	C	A/B	FLOOD	CR	Poorly protected	2354.4	Y	Y	Y
W31K-02617	Mduna	1	1	B	D/E/F	DEPR	VU	Well protected	3.2	N	Y	N
W31K-02611	Msebe	1.5	1.5	B/C	No assess	RIVER	N/A	(blank)	200.9	N		N
W31K-02582	Ntweni	1.5	1.5	B/C	A/B	DEPR	VU	Well protected	13.2	N		N
W31K-02568	Msunduzi	1	1	B	D/E/F	SEEP	EN	Poorly protected	139.7	N		N
W31L-02553	Nsumu	1	1	B	D/E/F	DEPR	VU	Well protected	2.0	N	Y	N
W31L-02525		0.5	0.5	A/B	A/B	FLOOD	CR	Poorly protected	954.6	Y		Y
W31L-02528	Masundwini	1	1	B	A/B	DEPR	VU	Well protected	1.8	N		N
W31L-02551	Nsumu	0.5	0.5	A/B	A/B	FLOOD	CR	Poorly protected	953.6	Y		Y
W31L-02563	Nsumu	0.5	0.5	A/B	A/B	FLOOD	CR	Poorly protected	953.6	Y		Y

PES/EI/ES					NWM 2018					NFEPA 2011		
SQR	River Named in SQR	Rip/Wetland Zone Continuity Mod	Riparian-Wetland Zone Mod	Wet PES (surr)	Dom WETCON	Dom HGM	Dom Threat Status	Dom Protection Level	Extent of wetlands within SQR (Ha)	Wetland FEPA	Wetland Cluster	Ramsar
W31L-02569	Msunduzi	1	1	B	A/B	FLOOD	CR	Poorly protected	1048.1	Y	Y	Y
W32A-02345	Neshe	2	3	C/D	C	FLOOD	CR	Poorly protected	1386.2	Y	Y	Y
W32A-02557	Mkuze	1.5	2	C	C	FLOOD	CR	Poorly protected	2454.8	Y	Y	Y
W32B-02476	Khobeyane	1	1	B	A/B	DEPR	VU	Well protected	202.8	Y	Y	Y
W32B-02429	Mbazwana	4	4	E	A/B	UVB	CR	Poorly protected	196.1	Y	Y	Y
W32B-02489		3	3	D	A/B	UVB	CR	Poorly protected	100.9	Y		Y
W32B-02462	Siphudwini	3	3	D	No assess	EST	VU	Moderately protected	1303.5	Y	Y	Y
W32B-02467	Mbazwana	1	1	B	A/B	DEPR	VU	Well protected	1948.2	Y	Y	Y
W32B-02547	Mkuze	2	2	C	No assess	EST	EN	Poorly protected	69203.9	Y		Y
W32B-02535	Mkuze				No assess	EST	EN	Poorly protected	71228.0	Y	Y	Y
W32C-02684	Ngweni	2	2	C	D/E/F	SEEP	EN	Poorly protected	372.4	N	Y	N
W32C-02749	Mzinene	2	2	C	D/E/F	UVB	CR	Poorly protected	496.7	N	Y	N
W32C-02634	Mhlosinga	1	1	B	D/E/F	SEEP	EN	Poorly protected	274.5	N		N
W32C-02612	Munywana	1	1	B	No assess	EST	EN	Poorly protected	67994.3	Y	Y	Y
W32C-02721	Mzinene	2.5	2	C	D/E/F	DEPR	VU	Well protected	136.3	N		N
W32C-02671	Mzinene	1.5	1	B	No assess	EST	EN	Poorly protected	67981.6	Y		Y
W32D-02811	Nzimane	2	2.5	C	D/E/F	SEEP	EN	Poorly protected	22.0	N	Y	N
W32D-02720	Wela	2	2	C	No assess	RIVER	N/A	(blank)	36.0	N		N
W32E-02887	Hluhluwe	2	2	C	No assess	RIVER	N/A	(blank)	364.4	N	Y	N
W32E-02797	Manzabomvu	1	1	B	D/E/F	SEEP	EN	Poorly protected	573.5	N		N
W32E-02765	Mansiya	3	3	D	No assess	RIVER	N/A	(blank)	243.9	N		N
W32E-02779	Nzimane	2	2	C	No assess	RIVER	N/A	(blank)	262.6	N		N
W32E-02859	Nzimane	1	1	B	No assess	RIVER	N/A	(blank)	243.9	N		N
W32E-02865	Hluhluwe	1	1	B	No assess	RIVER	N/A	(blank)	243.9	N		N
W32F-02835	Hluhluwe	3	4	D/E	No assess	EST	EN	Poorly protected	68566.3	Y	Y	Y
W32G-03102	Nsane	2	3	C/D	D/E/F	SEEP	CR	Not protected	73.9	N		N
W32G-02946	Sikhathula	2	2	C	D/E/F	UVB	CR	Poorly protected	72.7	N		N
W32G-02943	Hlazane	2	2	C	No assess					N		N
W32G-02973	Nyalazi	1	1.5	B	A/B	SEEP	EN	Poorly protected	28.4	N	Y	N
W32G-02980	Mnyaba	3	3	D	A/B	DEPR	VU	Well protected	0.4	N		N
W32G-03006	Nyalazi	2	3	C/D	D/E/F	DEPR	VU	Well protected	1.5	N		N

PES/EI/ES					NWM 2018					NFEPA 2011		
SQR	River Named in SQR	Rip/Wetland Zone Continuity Mod	Riparian-Wetland Zone Mod	Wet PES (surr)	Dom WETCON	Dom HGM	Dom Threat Status	Dom Protection Level	Extent of wetlands within SQR (Ha)	Wetland FEPA	Wetland Cluster	Ramsar
W32G-03055	Nyalazi	2	3	C/D	C	DEPR	CR	Well protected	16.2	N		N
W32G-02986	Hlazane	3	3	D	D/E/F	DEPR	VU	Well protected	11.8	N		N
W32H-02998	Mpate	1	1	B	No assess	EST	EN	Poorly protected	68924.7	Y		Y
W32H-02854	Nyalazi	3	2	C/D	No assess	EST	EN	Poorly protected	69196.8	Y		Y
W32H-02801	St Lucia				No assess	EST	EN	Poorly protected	68279.8	Y		Y
W32H-02804	St Lucia				No assess	EST	EN	Poorly protected	68302.2	Y		Y
W32H-02818	St Lucia				No assess	EST	EN	Poorly protected	70655.0	Y		Y
W32H-03048	St Lucia				No assess	EST	EN	Poorly protected	75982.3	Y		Y
W41A-02372	Bivane	2	2	C	A/B	SEEP	CR	Poorly protected	2339.4	Y	Y	N
W41B-02401	uBivanyana	3	3	D	D/E/F	SEEP	CR	Poorly protected	53.2	N		N
W41B-02427	Bivane	3	3	D	D/E/F	SEEP	CR	Poorly protected	147.3	N		N
W41B-02431	Bivane	1	1.5	B	No assess	RIVER	N/A	(blank)	21.8			
W41B-02434	Soetmelks	2	2	C	D/E/F	SEEP	CR	Poorly protected	1187.7	N	Y	N
W41C-02437	Mpemvana	2	3	C/D	D/E/F	SEEP	CR	Not protected	693.6	N	Y	N
W41D-02373	Bivane	1	2	B/C	D/E/F	SEEP	CR	Poorly protected	398.4	N		N
W41D-02435	iNxwayi	2	2	C	C	SEEP	CR	Poorly protected	77.7	Y		N
W41E-02359	Bivane	2	2	C	No assess	RIVER	N/A	(blank)	187.7	N		N
W41F-02433	Manzana	1	1	B	No assess	RIVER	N/A	(blank)	53.1	N		N
W41F-02454	Manzana	1	1.5	B	No assess	RIVER	N/A	(blank)	118.2	N		N
W41F-02461	KwaCeba	2	2	C	No assess	RIVER	N/A	(blank)	37.4			
W41F-02481	Manzana	2	3	C/D	D/E/F	SEEP	CR	Poorly protected	26.0	N		N
W41F-02502		2	2	C	C	SEEP	CR	Poorly protected	18.6	N		N
W41G-02379	Bivane	1	1	B	No assess	RIVER	N/A	(blank)	2532.9	N		N
W42A-02261	Phongolo	3	2	C/D	A/B	SEEP	CR	Poorly protected	1037.7	Y	Y	N
W42A-02328	Pandana	3	2	C/D	D/E/F	SEEP	CR	Poorly protected	276.5	N	Y	N
W42B-02268	Phongolo	2	2	C	D/E/F	SEEP	CR	Poorly protected	232.1	Y		N
W42B-02271	Phongolo	2	2	C	D/E/F	FLOOD	CR	Not protected	321.8	Y		N
W42B-02315	Tsakwe	2	1.5	C	No assess	RIVER	N/A	(blank)	61.8	Y		N
W42B-02325	Tsakwe	4	3	D/E	D/E/F	SEEP	CR	Poorly protected	519.3	Y	Y	N
W42B-02331	Bazangoma	3	3	D	D/E/F	SEEP	CR	Poorly protected	449.0	Y		N
W42C-02205	Ntombe	2	3	C/D	D/E/F	SEEP	CR	Poorly protected	966.6	N	Y	N

PES/EI/ES					NWM 2018					NFEPA 2011		
SQR	River Named in SQR	Rip/Wetland Zone Continuity Mod	Riparian-Wetland Zone Mod	Wet PES (surr)	Dom WETCON	Dom HGM	Dom Threat Status	Dom Protection Level	Extent of wetlands within SQR (Ha)	Wetland FEPA	Wetland Cluster	Ramsar
W42D-02251	Phongolo	3	3	D	No assess	RIVER	N/A	(blank)	1446.4	N		N
W42D-02327		2	2	C	No assess	RIVER	N/A	(blank)	1064.2	N		N
W42E-02221	Phongolo	2	2	C	No assess	RIVER	N/A	(blank)	1431.5	N		N
W42F-02185	Wit	1	2	B/C	No assess	RIVER	N/A	(blank)	1166.9	N		N
W42G-02317	Phongolo	1	1	B	No assess	RIVER	N/A	(blank)	3354.0	N		N
W42H-02382	Phongolo	1	1	B	No assess	RIVER	N/A	(blank)	2530.3	N		N
W42H-02394	iThalu	1	1	B	No assess	RIVER	N/A	(blank)	2530.3			
W42H-02411	iThalu	2	1	B/C	No assess	RIVER	N/A	(blank)	2548.8	N		N
W42H-02428	Mbizane	1	1	B	No assess	RIVER	N/A	(blank)	2531.5	N		N
W42J-02353	Phongolo	1	2	B/C	No assess	RIVER	N/A	(blank)	2530.5	N		N
W42J-02378	Phongolo	1	2	B/C	No assess	RIVER	N/A	(blank)	2531.1	N		N
W42J-02397	Mhulumbela	2	2	C	No assess	RIVER	N/A	(blank)	2542.9	N		N
W42K-02148	Mozana	3	3.5	D	C	SEEP	CR	Poorly protected	703.0	N		N
W42K-02169	Nyamane	2	2	C	No assess	RIVER	N/A	(blank)	83.7	N		N
W42K-02242		2	2	C	C	CVB	CR	Poorly protected	234.7	N		N
W42K-02272	Mozana	1	1.5	B	No assess	RIVER	N/A	(blank)	81.5			
W42L-02270	Mozana	1	1	B	No assess	RIVER	N/A	(blank)	2724.2	N		N
W42M-02239	Spekboom	2	2.5	C	No assess	RIVER	N/A	(blank)	2530.3	N		N
W42M-02269	Mtokotshwala	2	2.5	C	No assess	RIVER	N/A	(blank)	2544.8	N		N
W42M-02294	Spekboom	1	1.5	B	No assess	RIVER	N/A	(blank)	2544.2	N		N
W42M-02352	Phongolo	1	1.5	B	No assess	RIVER	N/A	(blank)	2533.6	N		N
W43F-02013	uMsunduzi	2	2	C	D/E/F	DEPR	VU	Well protected	6.8	N		N
W43F-02053		2	2	C	D/E/F	DEPR	VU	Well protected	3.8	N	Y	N
W43F-02072	Ngwavuma	2	3	C/D	D/E/F	CVB	CR	Poorly protected	1781.0	Y		Y
W43F-02076	Msunduzi	5	5	F	D/E/F	SEEP	EN	Poorly protected	229.0	N		N
W43F-02089	Ngwavuma	3	3	D	D/E/F	UVB	CR	Poorly protected	1157.0	N		N
W43F-02099	Ngwavuma	2	3	C/D	No assess	RIVER	N/A	(blank)	388.9	Y	Y	N
W43F-02104	Mnvoni	1.5	1.5	B/C	No assess	RIVER	N/A	(blank)	367.1	N	Y	N
W43F-02107		2	2	C	D/E/F	UVB	CR	Poorly protected	936.4	N		N
W43F-02113	Ngwavuma	3	3	D	D/E/F	UVB	CR	Poorly protected	1322.6	N	Y	N
W43F-02142		1	2	B/C	No assess	RIVER	N/A	(blank)	364.5	Y		N

PES/EI/ES					NWM 2018					NFEPA 2011		
SQR	River Named in SQR	Rip/Wetland Zone Continuity Mod	Riparian-Wetland Zone Mod	Wet PES (surr)	Dom WETCON	Dom HGM	Dom Threat Status	Dom Protection Level	Extent of wetlands within SQR (Ha)	Wetland FEPA	Wetland Cluster	Ramsar
W43F-02159	Ngwavuma	2	3	C/D	No assess	RIVER	N/A	(blank)	362.9	Y		N
W44A-02332	Phongolo	2	2	C	No assess	RIVER	N/A	(blank)	2544.0	N		N
W44A-02386	Phongolo	2	2	C	No assess	RIVER	N/A	(blank)	2588.8	N		N
W44A-02389	Voyizana	3	3	D	D/E/F	FLOOD	CR	Poorly protected	110.2	N		N
W44A-02410	Mdlavenga	2	2	C	C	SEEP	EN	Poorly protected	8.0	N		N
W44B-02248	Manzawakho	3	3	D	No assess	RIVER	N/A	(blank)	2553.5	N		N
W44B-02351	Phongolo	3	3	D	No assess	RIVER	N/A	(blank)	2638.5	N		N
W44C-02298	Sitilo	2	2	C	No assess	RIVER	N/A	(blank)	2531.9	N		N
W44C-02338	Phongolo	3	2	C/D	No assess	RIVER	N/A	(blank)	2543.6	N		N
W44D-02304	Phongolo	1	2	B/C	No assess	RIVER	N/A	(blank)	2620.6	N		N
W44E-02405	Mhlanganisi	1	1	B	D/E/F	SEEP	EN	Poorly protected	453.2	N		N
W45A-02216	Zibayeni	2	2	C	D/E/F	CVB	CR	Poorly protected	94.3	N	Y	N
W45A-02245	Zibayeni	3	3	D	D/E/F	CVB	CR	Poorly protected	2236.7	Y	Y	Y
W45A-02246	Phongolo	3	4	D/E	D/E/F	CVB	CR	Poorly protected	3147.2	Y	Y	Y
W45A-02256	Lubambo	2	2	C	D/E/F	CVB	CR	Poorly protected	77.8	N		N
W45A-02275	Mpontshane	2	2.5	C	D/E/F	DEPR	VU	Well protected	4.7	N		N
W45A-02282	Phongolo	3	4	D/E	D/E/F	FLOOD	CR	Poorly protected	6049.9	Y	Y	Y
W45A-02285	Mpontshane	2.5	2.5	C/D	D/E/F	CVB	CR	Poorly protected	2961.6	Y	Y	Y
W45A-02310	Mangqwashi	2	2	C	D/E/F	CVB	CR	Poorly protected	132.4	N		N
W45A-02316	Mfongosi	2	2.5	C	D/E/F	CVB	CR	Poorly protected	2198.0	Y		Y
W45A-02356	Mlambo	2	2	C	D/E/F	CVB	CR	Poorly protected	2200.0	Y		Y
W45A-02367	Phongolo	3	3	D	D/E/F	CVB	CR	Poorly protected	3033.6	Y	Y	Y
W45A-02368	Phongolo	2	3	C/D	D/E/F	CVB	CR	Poorly protected	2852.2	N	Y	N
W45B-02029	Phongolo	2.5	3	D	D/E/F	FLOOD	CR	Poorly protected	5529.4	Y		Y
W45B-02105	Phongolo	3.5	4	E	D/E/F	FLOOD	CR	Poorly protected	4964.2	Y	Y	Y
W51A-02082	Assegaai	2.5	2.5	C/D	D/E/F	SEEP	CR	Poorly protected	3125.4	Y	Y	N
W51B-02101	Ngulane	3	3	D	D/E/F	CVB	CR	Not protected	417.3	Y		N
W51C-01981	Assegaai	1	2.5	C	D/E/F	CVB	CR	Not protected	1920.0	N		N
W51C-02011		1	2	B/C	C	CVB	CR	Not protected	324.2	N		N
W51C-02022	Assegaai	3	3	D	D/E/F	CVB	CR	Not protected	1559.5	Y	Y	N
W51C-02067	Assegaai	1	2	B/C	D/E/F	FLOOD	CR	Not protected	427.3	Y		N

PES/EI/ES					NWM 2018					NFEPA 2011		
SQR	River Named in SQR	Rip/Wetland Zone Continuity Mod	Riparian-Wetland Zone Mod	Wet PES (surr)	Dom WETCON	Dom HGM	Dom Threat Status	Dom Protection Level	Extent of wetlands within SQR (Ha)	Wetland FEPA	Wetland Cluster	Ramsar
W51C-02074	Anysspruit	2	2	C	D/E/F	CVB	CR	Not protected	1262.2	Y	Y	N
W51C-02109	Boesmanspruit	1	1.5	B	D/E/F	FLOOD	CR	Not protected	875.3	N	Y	N
W51D-02044	Assegaai	1	2	B/C	D/E/F	FLOOD	CR	Not protected	1016.6	N		N
W51D-02151	Swartwater	1	1	B	No assess	RIVER	N/A	(blank)	217.4	N		N
W51D-02160		1	1	B	D/E/F	CVB	CR	Not protected	49.4			
W51D-02171	Klein-Assegaai	2	2	C	D/E/F	CVB	CR	Not protected	76.9	N		N
W51D-02177	Klein-Assegaai	1	1.5	B	D/E/F	CVB	CR	Not protected	51.2	N		N
W51D-02193	Swartwater	2	2	C	D/E/F	CVB	CR	Not protected	392.4	N		N
W51E-02049	Mhkondvo	1	1	B	No assess	RIVER	CR	(blank)	485.5	N		N
W51F-01919	Ndlozane	2	2	C	D/E/F	CVB	CR	Not protected	14.1	N		N
W51F-01951		2	2.5	C	D/E/F	SEEP	CR	Poorly protected	544.1	N		N
W51F-01986	Blesbokspruit	2	2	C	D/E/F	CVB	CR	Not protected	77.1	N		N
W51F-02019	Blesbokspruit	2	3	C/D	D/E/F	CVB	CR	Not protected	650.4	N		N
W52A-01934		1.5	2	C	D/E/F	FLOOD	CR	Not protected	2678.5	N	Y	N
W52A-01983	Hlelo	2	2	C	D/E/F	FLOOD	CR	Not protected	2610.4	N	Y	N
W52B-01890		3.5	3	D	D/E/F	CVB	CR	Not protected	1490.6	N		N
W52B-01964	Hlelo	3	3	D	D/E/F	FLOOD	CR	Not protected	2531.4	N	Y	N
W52C-01867	Hlelo	1.5	2	C	D/E/F	CVB	CR	Not protected	2106.3	N		N
W52C-01888	Tweelingspruit	1	1.5	B	D/E/F	CVB	CR	Not protected	437.1	N		N
W52D-01862	Hlelo	1	2	B/C	D/E/F	CVB	CR	Not protected	710.0	N		N
W53A-01757	Sandspruit	1	1.5	B	D/E/F	CVB	CR	Not protected	3239.2	N	Y	N
W53A-01804	Ngwempisi	3	3	D	D/E/F	CVB	CR	Not protected	1060.9	N	Y	N
W53A-01853	Ngwempisi	3	3	D	D/E/F	CVB	CR	Poorly protected	1382.9	N	Y	N
W53B-01694		1	2	B/C	D/E/F	CVB	CR	Not protected	349.0	N	Y	N
W53B-01710	Mpama	2.5	2.5	C/D	D/E/F	CVB	CR	Not protected	2522.7	N	Y	N
W53C-01679	Thole	1.5	2	C	C	CVB	CR	Not protected	716.4	Y		N
W53D-01751		2	2	C	A/B	SEEP	CR	Poorly protected	2.6			
W53D-01764	Mpama	1	2	B/C	D/E/F	CVB	CR	Not protected	493.4	N	Y	N
W53D-01773	Ngwempisi	2	2.5	C	D/E/F	CVB	CR	Not protected	361.8	N		N
W53D-01801	Ngwempisi	1	1	B	No assess					N		N
W53D-01809	Ngwempisi	1	1	B	D/E/F	CVB	CR	Not protected	246.7			

PES/EI/ES					NWM 2018					NFEPA 2011		
SQR	River Named in SQR	Rip/Wetland Zone Continuity Mod	Riparian-Wetland Zone Mod	Wet PES (surr)	Dom WETCON	Dom HGM	Dom Threat Status	Dom Protection Level	Extent of wetlands within SQR (Ha)	Wetland FEPA	Wetland Cluster	Ramsar
W53D-01814	Swartwaterspruit	1.5	1.5	B/C	D/E/F	CVB	CR	Not protected	583.1	N		N
W53E-01706	Mlambo	1	1	B	C	SEEP	CR	Poorly protected	60.3	N		N
W53E-01790	Ngwempisi	2	2	C	No assess	RIVER	N/A	(blank)	240.6	N		N
W54A-01534	uSuthu	2	2	C	D/E/F	CVB	CR	Not protected	3387.6	Y	Y	N
W54A-01630		1.5	2	C	D/E/F	CVB	CR	Not protected	1027.1	Y	Y	N
W54B-01569	uSuthu	1	1.5	B	D/E/F	CVB	CR	Not protected	1220.4	Y	Y	N
W54B-01623	Seganagana	1	2	B/C	D/E/F	CVB	CR	Not protected	1262.0	Y	Y	N
W54C-01512	Bonnie Brook	0	1	A/B	D/E/F	CVB	CR	Not protected	190.7	N	Y	N
W54C-01552	Bonnie Brook	1	1.5	B	D/E/F	CVB	CR	Not protected	295.0	N	Y	N
W54C-01556	Bonnie Brook	1	1.5	B	D/E/F	CVB	CR	Not protected	247.4	N		N
W54D-01593	uSuthu	2	2	C	D/E/F	SEEP	CR	Poorly protected	290.8	N		N
W54D-01645	uSuthu	1	3	C	No info					N		N
W55A-01375	Mpuluzi	1	1	B	D/E/F	SEEP	CR	Not protected	7596.0	Y	Y	N
W55A-01423	Majosie se Vlei	1	1	B	D/E/F	CVB	CR	Poorly protected	3961.7	Y	Y	N
W55C-01395	Mpuluzi	1	1.5	B	D/E/F	DEPR	CR	Poorly protected	12389.8	Y	Y	N
W55C-01489	Swartwater	1	2	B/C	D/E/F	CVB	CR	Not protected	341.1	N		N
W55D-01506	Metula	1	2	B/C	D/E/F	CVB	CR	Not protected	670.1	Y		N
W55E-01477	Mpuluzi	1	1	B	D/E/F	CVB	CR	Not protected	183.5	N		N
W56A-01372	Lusushwana	2	3	C/D	D/E/F	CVB	CR	Not protected	573.7	N	Y	N
W56B-01413	Motjane		4	E	C	CVB	CR	Not protected	56.5	N		N
W57J-01923	uSuthu	0	0	A	No assess	RIVER	N/A	(blank)	161.9	Y		Y
W57K-01929	uSuthu	0	0	A	C	FLOOD	CR	Poorly protected	2273.2	Y	Y	Y
W57K-02025		0	0	A	C	FLOOD	CR	Poorly protected	4308.5	Y		Y
W70A-02079	Swamanzi	4	4	E	No assess	EST	VU	Moderately protected	8569.6	Y	Y	Y
W70A-02112	Malangeni	1.5	2	C	No assess	EST	VU	Moderately protected	13383.7	Y	Y	Y
W70A-02301		4	4	E	D/E/F	DEPR	CR	Poorly protected	8389.1	Y	Y	Y

18 APPENDIX E: COMMENTS AND RESPONSES REGISTER

No.	Sect	Comment	From	Addressed?
1	Front page	STATUS QUO AND DELINEATION OF INTERGRATED UNITS OF ANALYSIS AND RESOURCE UNIT REPORT.	M Mnisi	Yes
2	3.2	Please explain - The concept of stressed water resources is addressed by the NWA but is not defined quantitatively.	M Mnisi	Part 8 of the Act provides the following **qualitative** examples of 'water stress': • Where demands for water are approaching or exceed the available supply; • Where water quality problems are imminent or already exist; or • Where water resource quality is under threat. These are not quantitative. The concept of stress index is only defined quantitatively in the GRDM process and generally taken as a stress index of 0.65.
3	Figure 3.13	On the legend, only one GRU is shown.	P Khoza	Yes
4	Table 4.7	Check Table please.	M Mnisi	Addressed.
5	Whole report	Can we be consistent with WWTWs throughout the report?	M Mnisi	WWTW is the correct form. Updated throughout.
6		WWRW – Is this Waste Water Reticulation Works?	M Mnisi	Apologies; an error. Corrected.
7	8.3.1		M Mnisi	Updated.
8	Tables, Sec 8	Please fill in blanks in all tables.	M Mnisi	Tables updated
9	10.2.1	Check legislation.	M Mnisi	Yes
10	11	Can we rearrange start with IUA delineation section followed by RU section? Reason - IUA is the mother set whilst RU is a subset.	M Mnisi	Note that IUAs are set based on the groupings of RUs, meaning that the RUs have to be delineated first.
11	Table 12.5	Check comment in Table.	M Mnisi	Yes
12	App C	Fill empty spaces in Table.	M Mnisi	This table consists of summarised data from various databases. Blank spaces in the table are directly from these databases and it is assumed no data was originally provided.
13	Pg ix	First paragraph under Status quo: comment: localized water quality problems also arise due to failing sewage infrastructure.	R Pillay	Updated
14	Pg xi	There is also coal mining in the upper reaches of the catchment,	R Pillay	Updated

No.	Sect	Comment	From	Addressed?
		around the town of Vryheid, impacts water resource and upper reaches of Black Mfolozi catchment (W2 catchment).		
15	Pg xv table and Pg 11-1	(Table 11.1) - can the table showing the proposed RUs also include the quaternary catchments that are located within each RU?	R Pillay	As the RUs include the tertiary catchments, e.g. W11 and WK12, it is implicit that all the quaternary catchments per tertiary are covered.
16	Page xviii	IUA W22 – upper reaches of Black Mfolozi River affected by acid mine drainage issues and IUA W31 a (Upper Mkhuze): The Mfolozi catchment impacts on the water quality of the Mkuze catchment. This is due to mine-water decant into the upper reaches of the Mkuze which results in low pH and high TDS river flows (DWS, 2004 & 2020).	R Pillay	This information is covered in the Water Quality chapter, but tables on pg xviii have been modified.
17	Page xxii	IUA St Lucia – include salinity issues.	R Pillay	Lake St Lucia naturally experiences large changes in physico-chemical characteristics, both temporally and spatially, as a result of flood and drought events. During recent droughts, reductions in freshwater flow have resulted in periods of mouth closure with salinities that have reached over 150 (with sea water 35). These reductions have been seriously exacerbated by human interventions such as the separation of the Mfolozi from St Lucia and flow reduction from the catchments (Cyrus *et al* 2011). Several ecological 'states', from fresh through estuarine and marine to hypersaline, may occur in the lake system at different times, with the marine-estuarine being the dominant state.
18	Figs 2.1 to 2.5	Can the maps be updated to show the transfers either in or out of the catchment using an arrow?	R Pillay	Addressed.
19	Pg 3-9	Table 3.7 W1 Catchment: Groundwater use per sector: under column W1, one of the rows says W5 – What is this meant to be? There also appears to be repeated water use categories. Please verify.	R Pillay	Yes
20	Table 3.16	Page 3-17, Table 3.16, the values in the percentage column does not total 100% - currently totals 9.85%. Amended in red below (PSP to recheck)	R Pillay	Yes.
21	Pg 5-4	– The sentence that reads "Water quality management strategies have been set for the following catchments (DWS, 2020):" – These strategies are from the ISP document (2004). An updated WQM strategy still has to be developed.	R Pillay	Text corrected.
22		Suggest including a section on climate change for the study area. Information/Maps obtained from DWS National Integrated Water Information System (NIWIS) can be used to show predicted	R Pillay	Addressed.

No.	Sect	Comment	From	Addressed?
		percentage change in streamflow, rainfall, evapotranspiration, etc. for the study area.		
23		It recommended that land use maps are also included in the report.	R Pillay	Yes (in appendix).
24		For additional and latest land cover information, you can conduct Dr. Boyd Escott of KZN Wildlife at Boyd.Escott@kznwildlife.com	R Pillay	Included info from other sources (DWS WARMS database).
25		I have attached a community survey conducted for KZN by Stats SA in 2016 – not sure if this information might be of any additional use to the PSP. This has some information regarding (population size, household information, access to services according to Districts and local municipality).	R Pillay	Noted.
26	Exec Sum	Significant water resources of catchments - May we include the transfers in this Table? What are the transferred volumes?	T Sawunyama	Yes.
27	Fig 1.1	Consider a legend.	T Sawunyama	A sentence has been added in the text to explain coloured blocks on Fig 1.1.
28	3.2	IUCMA have recently completed work of Groundwater Assessment for the whole WMA, and has more up to date data for Usutu catchment.	T Sawunyama	Report requested.