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

SCENARIO DESCRIPTION REPORT

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Department of Water and Sanitation

Chief Directorate: Water Ecosystem Management

PROJECT NUMBER**:** WP 11387

Scenario Description Report

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

MARCH 2023

REFERENCE

This report is to be referred to in bibliographies as:

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REPORT SCHEDULE

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 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 and Site Visit 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, Volume 2: Estuaries**

Index Number	DWS Report Number	Report Title
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**
18	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**
	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**
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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 indicates this report.

APPROVAL

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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 summarise the scenarios that have been assessed using the water resources models. Inputs to the Classification process require the historical time series of flows under both the natural and present day conditions in order to set the environmental requirements at specific predetermined EWR sites. However, it is acknowledged that present day flows will not necessarily continue into the future as a result of changing conditions (both climatic and man-made) in the catchments. Varying scenarios are therefore simulated with the water resources models in order to assess the potential impacts on the EWR sites.

This report summarises the scenarios that have been assessed as well as the results provided to the River Specialists and Estuary Specialists forming part of the Study Team. The results will be further assessed as part of two workshops scheduled for February 2023, and the impacts of the scenarios will then be determined.

RIVER SCENARIOS

The following river flow related scenarios have been assessed:

Site	Reference	Scenario
Amatigulu	MA1_CC	Natural inflow files scaled for climate change scenario
Nseleni	NS1_CC	Natural inflow files scaled for climate change scenario
Black Mfolozi	BM1_CC	Natural inflow files scaled for climate change scenario
White Mfolozi	WM1_CC	Natural inflow files scaled for climate change scenario
	WM1_HFY no ewr	HFY abstracted from upstream dams, no EWR on
	WM1_HFY with ewr	HFY (12.9) abstracted from upstream dams, with EWR on (yield is not affected by EWR)
	WM1_raise klip with ewr	Raised Klipfontein HFY (14.3) abstracted from upstream dams, with EWR on (yield is not effected by EWR)
Mkuze	MK1_CC	Natural inflow files scaled for climate change scenario
	MK1_2040	PD scenario with increased upstream domestic use
	MK1_IRR	PD scenario with increased return flows due to increased irrigation supplied from Pongolapoort Dam
Pongola	UP1_CC	Natural inflow files scaled for climate change scenario
	UP1_2040	PD scenario with increased upstream domestic use (upgraded Fritz WTW)
Assegaai	AS1_CC	Natural inflow files scaled for climate change scenario
	AS1_2040	PD scenario with increased upstream domestic use
	AS1_EWR	PD scenario with EWR as provided included (no impact on yield of Heyshope)
	AS1_noEWR	PD scenario with no EWR
Ngwempisi	NG1_CC	Natural inflow files scaled for climate change scenario
	NG1_2040	PD scenario with increased upstream domestic use
	NG1_EWR	PD scenario with EWR as provided included (Yield of Jericho drops from 58 to 49)

ESTUARY SCENARIOS

The following estuary flow related scenarios have been assessed:

Site	Scenario Reference	Description
Amatigulu (north & south)	AMA_10%red	Reduction of present day MAR by 10%
	AMA_20%red	Reduction of present day MAR by 20%
	AMA_30%red	Reduction of present day MAR by 30%
	AMA_15%incr	Increase of present day MAR by 15%
Siyaya	SIY_15%incr	Increase of present day MAR by 15%
	SIY_15%red	Reduction of present day MAR by 15%
Mlalazi	MLA_WWTW	Present day including the upgrade of the Mtunzini WWTW increased to a 1.5 Ml/d plant
	MLA_Scen1	Present day including additional demand of 10% on present day MAR supplied by Eshowe Dam with an increased capacity of 15 million m^3.
	MLA_Scen2	Present day reduced by 10% through abstraction from lower reaches of river
	MLA_Scen3	Present day reduced by 20% through abstraction from lower reaches of river
	MLA_Scen4	Scenario 3 including additional demand of 10% on present day MAR supplied by Eshowe Dam with an increased capacity of 20 million m^3.
Mhlathuze	MHL_15%incr	Increase of present day MAR by 15%

	MHL_10%incr	Increase of present day MAR by 10%
	MHL_2030	2030 year projected water requirements on the system (including increased transfer from Thukela to Goedertrouw)
	MHL_2040	2040 year projected water requirements on the system (including increased transfer from Thukela to Goedertrouw)
Nhlabane	NHL_EWR	Present Day including EWR releases from Lake Nhlabane as obtained from MWAAS (DWAF, 2009)
	NHL_rest	Restoration Scenario to allow for mouth breaching each year. Increase of flows as follows, if natural flow is < 0.25 m^3/s, restoration flow is 0, if 0.25 m^3/s < natural flow < 0.3 m^3/s, restoration flow is 0.1 m^3/s, if 0.3 m^3/s < natural flow < 0.5 m^3/s, restoration flow is 0.3 m^3/s, if natural flow is > 0.5 m^3/s, restoration flow is present day flow

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BHN	Basic Human Needs
BID	Background Information Document
CD: WEM	Chief Directorate: Water Ecosystems Management
CMA	Catchment Management Agency
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 Category
EcoSpecs	Ecological Specifications
EFZ	Estuarine Functional Zone
EI	Ecological Importance
EIS	Ecological Importance and Sensitivity
EWR	Ecological Water Requirements
GIS	Geographic Information System
GRAII	Groundwater Resource Assessment Phase II
GRU	Groundwater Resource Unit
HFY	Historic Firm Yield
HGM	Hydrogeomorphic
IRR	Issues and Responses Report
IUA	Integrated Unit of Analysis
IUCMA	Inkomati-Usutu Catchment Management Agency
IWRM	Integrated Water Resource Management
MAR	Mean Annual Runoff
NBA	National Biodiversity Assessment
NFEPA	National Freshwater Ecosystem Priority Area
NGO	Non-Governmental Organization
NWM5	National Wetland Map (version) 5
PES	Present Ecological State
PES/EI/ES	Present Ecological State, Ecological Importance and Ecological Sensitivity
PMC	Project Management Committee
PMT	Project Management Team
PSC	Project Steering Committee
PSP	Professional Service Provider
RDM	Resource Directed Measures
REC	Recommended Ecological Category
RGDP	Regional Gross Domestic Product
RGM	Reference Group Meetings
RQO	Resource Quality Objectives
RU	Resource Unit
SAIIAE	South African Inventory of Inland Aquatic Ecosystems
SAM	Social Accounting Matrix
SAWS	South African Weather Service
SCI	Socio-Cultural Importance
SEP	Stakeholder Engagement Plan
SMME	Small, Medium and Micro Enterprise

SQR	Sub Quaternary Reach
SWSA	Strategic Water Source Area
SWSA-gw	Strategic Water Source Area - groundwater
SWSA-sw	Strategic Water Source Area – surface water
TEC	Target Ecological Category
TOR	Terms of Reference
TTT	Technical Task Team
WARMS	Water use Authorization & Registration Management System
WMA	Water Management Area
WRCS	Water Resource Classification System
WRP	WRP Consulting Engineers
WRPM	Water Resource Planning Model
WRSM2000	Water Resources Simulation Model 2000.
WRUI	Water Resource Use Importance
WRYM	Water Resource Yield Model
WSA	Water Source Area

SPELLING

There are multiple references to the spelling of various Rivers, Lakes, Dams and Estuaries, depending on the source of information. For the purposes of this report, the following Table presents the selected spelling of indicated water resources and places.

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	

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” (NWA, 1998).
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 toward 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.
Historic Firm Yield	The maximum volume of water (yield) that can be abstracted from a dam over the historical time period

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 Government Gazette 33541 as Regulation 810. The WRCS is a stepwise 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) must 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.

Thus, the Chief Directorate: Water Ecosystems Management (CD: WEM) of the Department of Water and Sanitation (DWS) initiated a study for determining 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, 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 that has been divided into six drainage areas and secondary catchment areas as follows **(refer to the locality map provided as Figure 1.1)**:

- 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 estuary and Lake Sibaya).

Note that all assessments within eSwatini are excluded apart from the hydrological modelling required to assess any downstream rivers in South Africa that either run through eSwatini or originate (source) 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.

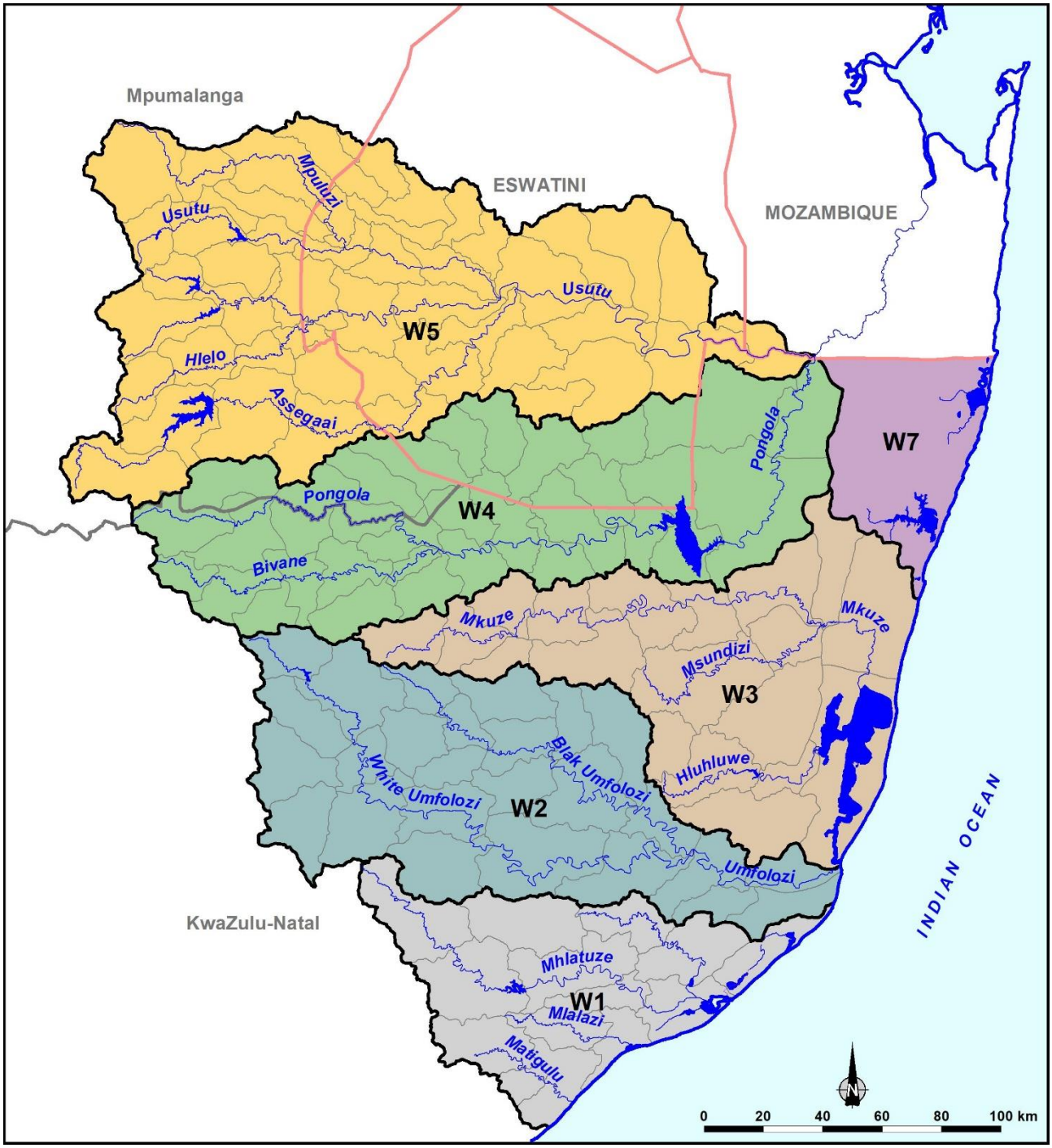

Figure 1-1: Locality Map of the Study Area

1.3 Purpose of this Report

The purpose of this report is to summarise the scenarios that have been assessed using the water resources models. Inputs to the Classification process require the historical time series of flows under both the natural and present day conditions in order to set the environmental requirements at specific predetermined EWR sites. However, it is acknowledged that present day flows will not necessarily continue into the future as a result of changing conditions (both climatic and man-made) in the catchments. Varying scenarios are therefore simulated with the water resources models in order to assess the potential impacts on the EWR sites.

This report summarises the scenarios that have been assessed as well as the results provided to the River Specialists and Estuary Specialists forming part of the Study Team. The results will be

further assessed as part of two workshops scheduled for February 2023, and the impacts of the scenarios will then be determined. The results form part of Task 4: Identify and Evaluate scenarios within IWRM (**Figure 1.2**).

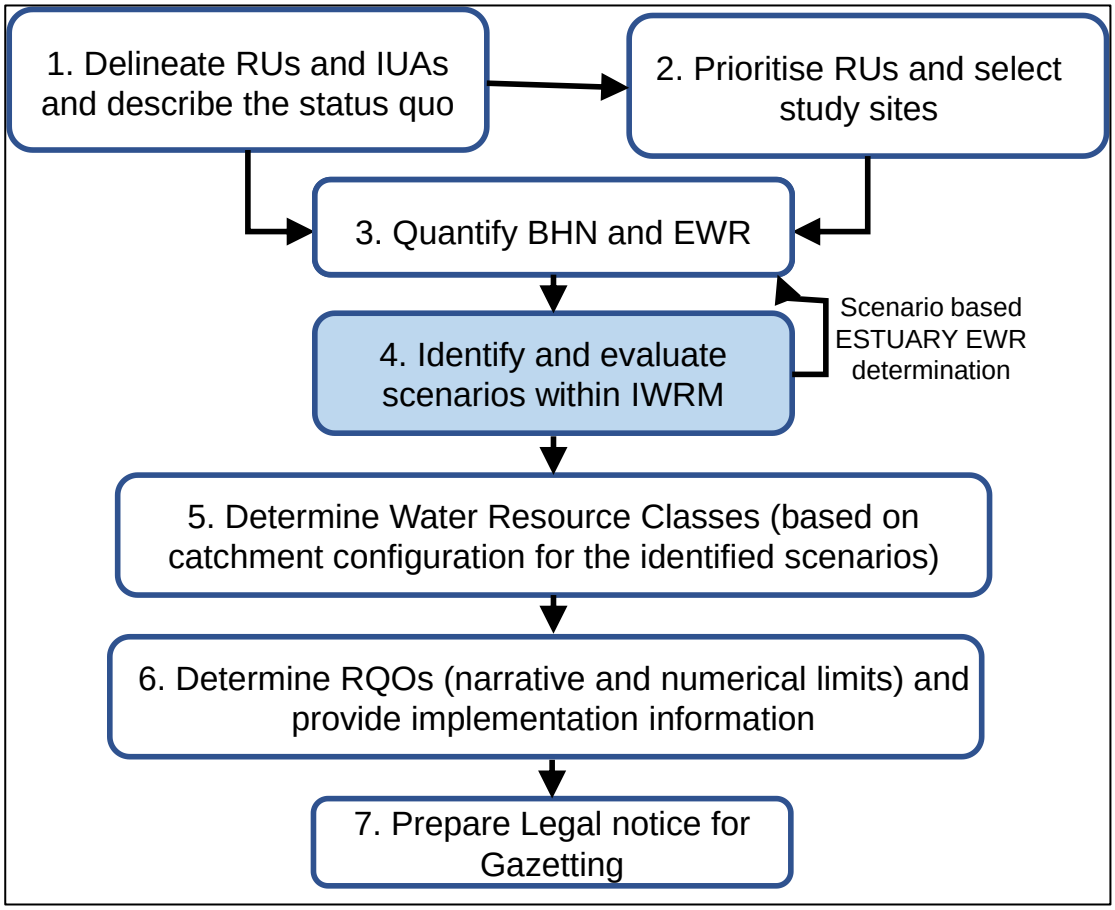

Figure 1-2: Project Plan for the Usutu-Mhlathuze Classification study

1.4 Report Outline

After this Introduction Section, a Section presenting the background to the scenarios is included. This is followed by the detailed descriptions of each scenario assessed for both the River and Estuary requirements. **Section 4** presents the results of the scenarios.

2 BACKGROUND TO SCENARIOS

2.1 Overview

A key component of the WRCS is to find the appropriate balance between protection of the ecology and using water to sustain the desired socio-economic activities that depend on the water resources. According to the WRCS guidelines this evaluation should occur in line with prevailing integrated water resource management practices that are taking place in the catchments or river systems. The approach to determine this desirable balance is therefore to identify and analyse responses to a range of different scenarios, where each scenario results in a certain level of protection and use. Generally, the higher the water use, the lower the level of protection achieved. However, these relationships are complex and opportunities to find optimal solutions are usually possible.

Scenarios, in the context of water resource management and planning are plausible definitions (settings) of all the factors (variables) that influence the water balance and water quality in a catchment and the system as a whole. The scale (resolution) of the analysis requires the aggregation of land-use effects, and therefore individual and localised small-scale developments will not significantly influence the classification of a water resource. However significant small-scale impacts on priority water resources should be managed by setting the RQOs at the specific point to protect the said water resource, especially in the case of sensitive aquatic resources.

Possible variables that make up scenarios have been identified for the Usutu-Mhlathuze Catchments. These variables have been combined into different scenarios which are described in this document. The variables and scenarios are illustrated in matrices that show scenario naming and which variables are applicable to each scenario. The **operational scenarios** are based on **flow** related aspects and not on non-flow related aspects. Mitigation measures to address non-flow related aspects will be identified and will be addressed as part of the RQO identification process.

The range of scenario and associated variables were presented and discussed with the DWS and stakeholders, and a final (representative) range selected for the purposes of modelling and scenario assessment.

2.2 Evaluation Sites

The evaluation of scenarios is limited to pre-determined EWR sites which have undergone detailed assessment both in the past and as part of this Study. **Table 2-1** provides a summary of these sites, and **Figure 2-1** presents them on a locality map. Only scenarios that would potentially affect the flows at these sites have been defined.

Table 2-1: Summary of sites at which scenarios have been assessed

Type	Catchment / River	Tertiary Catchment	Reference Name
River	Amatigulu	W1	MA1
River	Nseleni	W1	NS1
River	Black Umfolozi	W2	BM1
River	White Umfolozi	W2	WM1

Type	Catchment / River	Tertiary Catchment	Reference Name
River	Mkuze	W3	MK1
River	Pongola	W4	UP1
River	Assegaai	W5	AS1
River	Ngwempisi	W5	NG1
Estuary	Amatigulu	W1	Amat_nth
Estuary	Amatigulu	W1	Amat_sth
Estuary	Mlalazi	W1	Siy
Estuary	Mlalazi	W1	Mla
Estuary	Mhlathuze	W1	Mhl
Estuary	Nhlabane	W1	Nhl

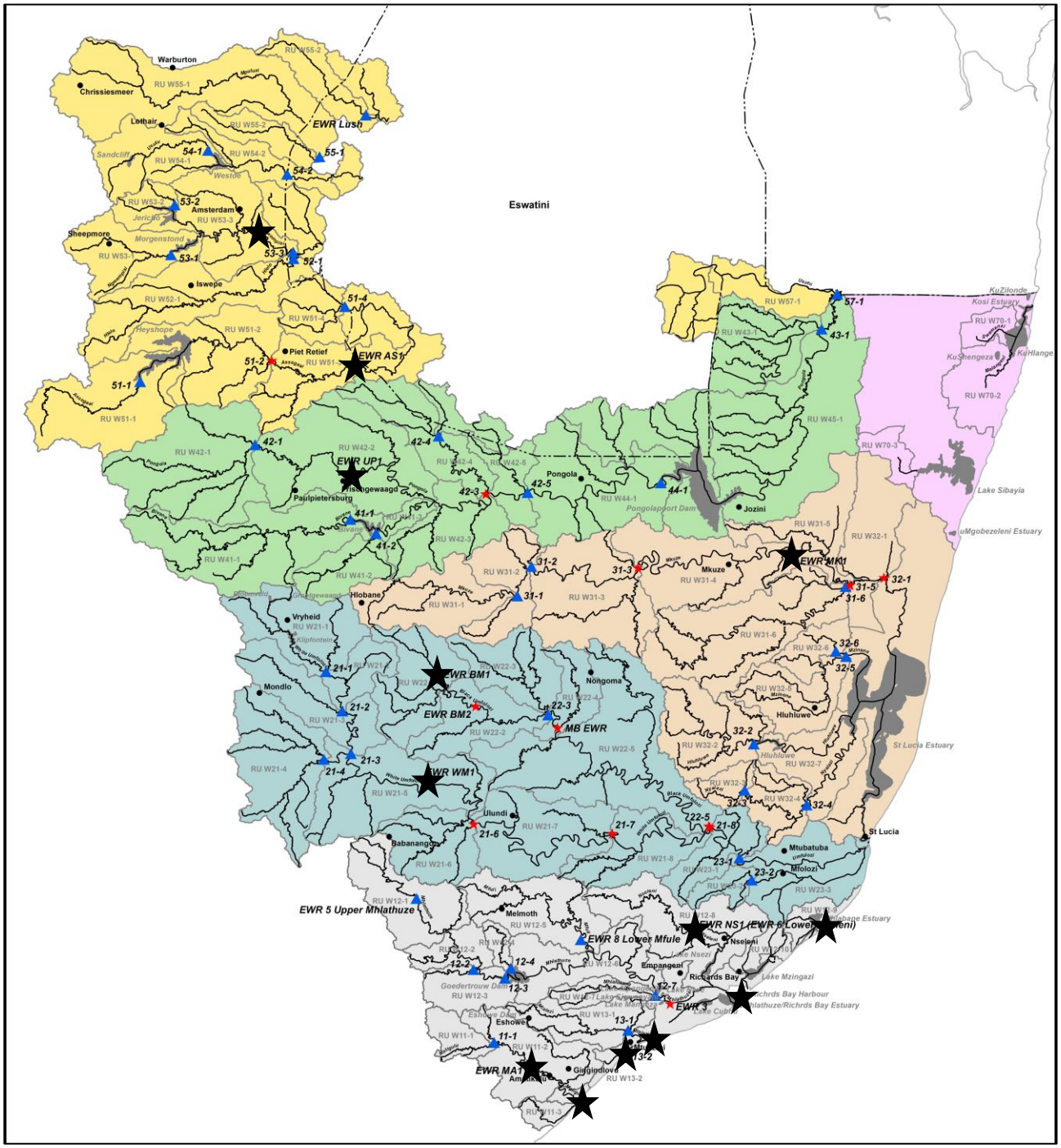

Figure 2-1: Locations of sites at which scenarios have been assessed (indicated with black stars)

Appendix A provides more detailed images of each site's location.

2.3 Natural Flow Scenario

The natural flow forms the baseline (also referred to as the reference) against which all scenarios will be assessed. Further details of the natural hydrology used are provided in the Hydrology Systems Analyses report (DWS, 2022a) prepared as part of this study. However, a summary is presented in **Table 2-2**.

Table 2-2: Natural Hydrology included per site

Type	Catchment / River	Reference Name	Hydrology reference names included	MAR (million m^3/annum)
River	Amatigulu	MA1_nat	W11A	55.17
River	Nseleni	NS1_nat	W12G, 7.2%W12H	31.23
River	Black Umfolozi	BM1_nat	W22A1, W22A2	34.70
River	White Umfolozi	WM1_nat	W21A, W21B, W21C, W21D, W21E, W21F, W21G, 33.9%W21H	222.5
River	Mkuze	MK1_nat	W31A, W31B, W31C, W31D, W31E, W31F, W31G, W31H, 27%W31J	158.80
River	Pongola	UP1_nat	W42A, W42B, W42C, W42D, 45%W42E	356.80
River	Assegaai	AS1_nat	W51A, W51B, W51C, W51D	328.61
River	Ngwempisi	NG1_nat	W53A, W53B, W53C, W53D	156.33
Estuary	Amatigulu	Amat_nth_nat	W11A, W11B, W11C1, W11C2	109.70
Estuary	Amatigulu	Amat_sth_nat	W11C3	31.47
Estuary	Mlalazi	Siy_nat	10.5%W13B1	4.70
Estuary	Mlalazi	Mla_nat	W13A1, W13A2, W13A3, W13B	119.34
Estuary	Mhlathuze	Mhl_nat	W12A1, W12B1, W12C1, W12C2, W12D1, W12D2, W12E1, W12E2, W12F1, W12F2, W12F3, W12G1, W12H1	470.08
Estuary	Nhlabane	Nhl_nat	W12J2	30.40

2.4 Present Day Flow Scenario

The present day hydrology flows were also summarised in the Hydrology Systems Analyses Report (DWS, 2022a). However, as part of the work undertaken for the scenario analyses, some minor adjustments were made to the present day flows. The final set of present day flows are summarised in **Table 2-3**.

Table 2-3: Present day flows per site

Type	Catchment / River	Reference Name	MAR (million m^3/annum)
River	Amatigulu	MA1_pd	41.85
River	Nseleni	NS1_pd	31.56
River	Black Umfolozi	BM1_pd	28.08
River	White Umfolozi	WM1_pd	191.80
River	Mkuze	MK1_pd	106.13
River	Pongola	UP1_pd	299.39
River	Assegaai	AS1_pd	164.10
River	Ngwempisi	NG1_pd	79.15
Estuary	Amatigulu	Amat_nth_pd	100.33
Estuary	Amatigulu	Amat_sth_pd	13.45

Type	Catchment / River	Reference Name	MAR (million m^3/annum)
Estuary	Mlalazi	Siy_pd	3.4
Estuary	Mlalazi	Mla_pd	99.55
Estuary	Mhlathuze	Mhl_pd	289.59
Estuary	Nhlabane	Nhl_pd	21.31

3 SCENARIO DESCRIPTIONS

3.1 Introduction and Sources of Information

Scenarios represent plausible future options of changes to the catchment configuration that would affect the flows at EWR sites and estuaries. Scenarios were identified from different sources of information and ongoing planning processes undertaken by the Department of Water and Sanitation, and municipalities. Some of the main sources of information were from discussions with DWS and municipalities as well as some of the information included but not limited to the following reports:

- Implementation and Maintenance of the Water Reconciliation Strategy for Richards Bay and Surrounding Towns: Reconciliation Strategy (DWS, 2021a)
- Development, Updating and Review of Strategies to Reconcile Water Availability and Requirements in the East Planning Area Comprising Water Supply Systems for Mbombela, Richards Bay, Mgeni and all Other Towns and Clusters of Villages (DWS, 2022b)
- Zululand District Municipality Integrated Development Plan: 2021/2022 Review (ZDM, 2021)
- Umkhanyakude District Municipality Water and Sanitation Master Plan Update (UDM, 2020)

3.2 Scenarios

The following sub-sections present the variables adjusted for each scenario assessed and include motivations why the scenario is included as well as references for the information used.

3.2.1 Climate Change

The National Integrated Water Information System (NIWIS) was developed by the Department of Water and Sanitation with the purpose of providing information products, in the form of dashboards, to facilitate efficient analysis and reporting across the water value chain in South Africa. The Climate Change dashboard relates to climate change indicators including changes in rainfall, temperature, wet spells, dry spells, irrigation demand, potential evaporation, and streamflow. The available climate change data used is at quinary scale (i.e. sub-division of the quaternary). However, the maps are delineable into quaternary and water management area levels. The dashboard is accessed from (http://niwis.dwa.gov.za/niwis2/climatechange). The observation agrees with other studies done by MacKellar et al. (2014) and Kruger and Nxumalo (2017), about changes in rainfall and increase in temperature.

This NIWIS information was used to determine the climate change scenario for modelling purposes. **Figure 3-1** and **Figure 3-2** present the percentage change in streamflow predicted for climate change for the KwaZulu Natal province and Inkomati-Usutu WMA respectively. **Table 3-1** presents a summary of the factors applied to the various natural hydrology files for the climate change scenarios. These adjusted files were then used in the water resources models under present day conditions to determine the impact of climate change on the flows passed the relevant sites.

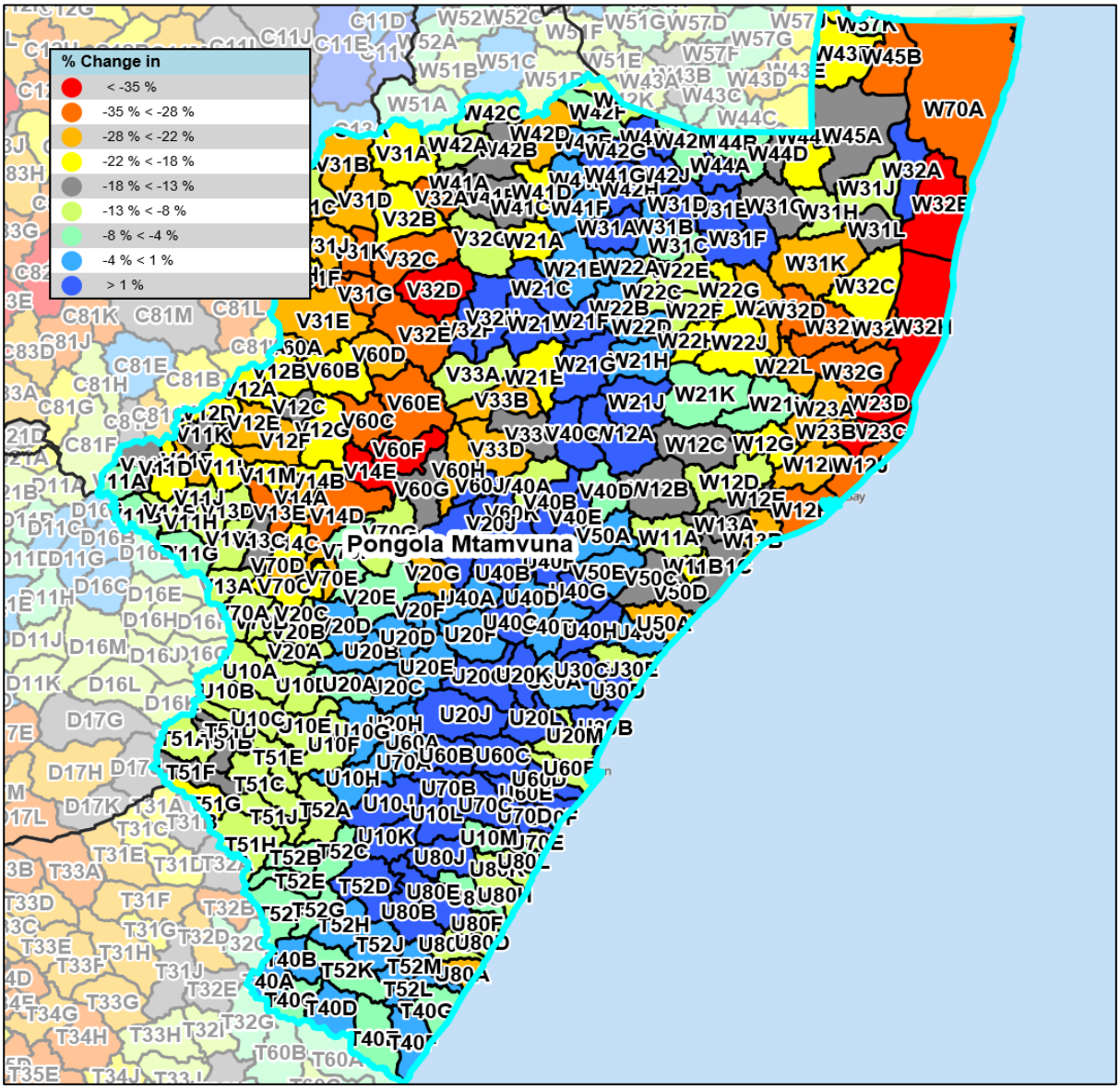

Figure 3-1: Map indicating percentage adjustment to streamflow due to climate change in the KwaZulu Natal Province (Source: NIWIS)

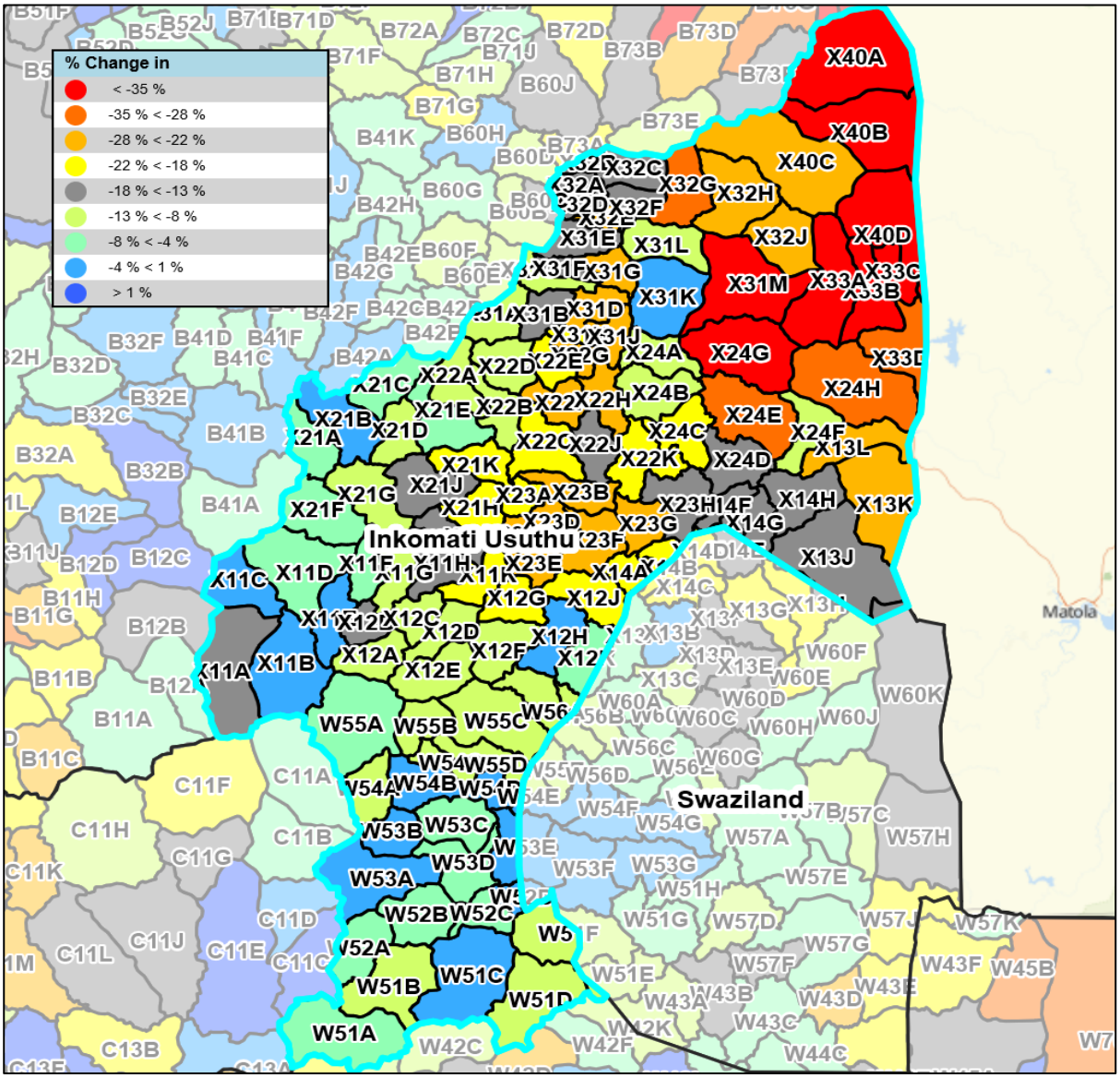

Figure 3-2: Map indicating percentage adjustment to streamflow due to climate change in the Inkomati Usutu Water Management Area (Source: NIWIS)

Table 3-1: Factors applied to each catchment to model climate change

Hydrology file	Factor to apply for climate change conditions	Hydrology file	Factor to apply for climate change conditions
W12A1	1.01	W11A1	0.9
W12B1	0.84	W11B1	0.8
W12C1	0.84	W11C1	0.84
W12C2	0.84	W11C2	0.84
W12D1	0.9	W11C3	0.84
W12D2	0.9		
W12E1	0.84	W22A	0.98
W12E2	0.84	W21A	0.8
W12F1	0.68	W21B	0.98

Hydrology file	Factor to apply for climate change conditions	Hydrology file	Factor to apply for climate change conditions
W12F2	0.68	W21C	1.01
W12F3	0.68	W21D	1.01
W12G1	0.8	W21E	0.8
W12H1	0.75	W21F	1.01
W12J2	0.68	W21G	1.01
		W21H	0.98
W31A	1.01		
W31B	0.98	W42A	0.9
W31C	0.94	W42B	0.84
W31D	1.01	W42C	0.9
W31E	1.01	W42D	0.75
W31F	1.01	W42E	0.98
W31G	0.84		
W31H	0.9	W51A	0.94
W31J	0.9	W51B	0.9
		W51C	0.98
W13A1	0.84	W51D	0.9
W13A2	0.84	W53A	0.98
W13A3	0.84	W53B	0.98
W13B1	0.75	W53C	0.94
		W53D	0.94
		W53E	0.98

3.2.2 2040 Water Requirements (River sites)

Growth in water requirements and return flows are focussed on the domestic sector. **Table 3-2** provides a summary comparing the relevant present day requirements with the 2040 year projections as used in the river site scenarios. Not all sites are affected by growth in domestic water requirements. Only those impacted are presented in the table.

Table 3-2: Adjustments to water requirements for 2040 scenario

Site	Supply scheme	Present Day requirement (million m^3/a)	2040 future requirement (million m^3/a)	Motivation
MK1	Hlobane Corronation Ubombo	0.73 0.16 0.09	0.79 0.91 0.18	Increase in requirement up to maximum 1 in 50 year dam yield
UP1	Paul Pietersburg Fritzgewaardt WTW	1.29 0.73	1.29 5.5	No increase in Paul Pietersburg due to maximum yield

Site	Supply scheme	Present Day requirement (million m^3/a)	2040 future requirement (million m^3/a)	Motivation
				removed from Edumbe Dam Fritzgewaardt WTW upgrade currently taking place
AS1	Piet Retief	2.95	5.90	Assume doubling of demand for scenario assessment
NG1	Amsterdam	0.24	0.48	Assume doubling of demand for scenario assessment

3.2.3 Future Infrastructure

The only scenario that incorporates a specific change to existing infrastructure affects the White Umfolozi river site (WM1). There is a possibility that the upstream Klipfontein Dam could be raised in the future, in order to provide additional water to the domestic areas of Vryheid and Emondlo. A scenario was therefore assessed assuming a future dam capacity of 25 million m^3. The existing capacity is just over 18 million m^3.

3.2.4 Including – Excluding EWR

Scenarios incorporating the EWRs are only assessed for sites that fall downstream of existing infrastructure that allows for a release for the EWR from the dam. This situation occurs at three river sites, a summary of which are included in **Table 3-3**. In all cases, the present ecological state (PES) is the same as the recommended ecological state (REC) and therefore only one EWR scenario was simulated. The detailed EWR flows included in the model are presented in **Appendix B**.

Table 3-3: Sites at which EWR flow scenarios were assessed

Site	Upstream Dam	PES & REC Status
WM1	Klipfontein	B/C
AS1	Heyshope	C
NG1	Jericho & Morgenstond	B/C

3.2.5 Other Variations

Other variations of scenarios included an increase in irrigation in the Mkuze catchment, upstream of the EWR site MK1. The increased irrigation has already received an allocation, however, the area to be irrigated is still to be developed. The water resource to supply the irrigation is from the Pongolapoort Dam through an inter catchment transfer. However, it is likely that the increased irrigation will result in increased return flows entering the Mkuze river upstream of the EWR site. The estimated increase in return flows amounted to 1.5 million m^3/annum.

Additional scenarios were also assessed for site WM1 on the White Umfolozi downstream of Klipfontein Dam. The current abstraction from Klipfontein Dam for Vryheid included in the present

day scenario is 2.7 million m^3/annum (WTW capacity of 7.5 Ml/d). However, the historic firm yield (HFY) (total volume that the dam can supply) is determined to be 12.9 million m^3/annum. An additional scenario was undertaken whereby the full HFY was abstracted from the Klipfontein Dam.

3.2.6 River Scenarios Summary

Table 3-4 presents a summary of the scenarios that were assessed as part of the river site evaluations.

Table 3-4: Summary of river scenarios assessed

Site	Reference	Scenario
Amatigulu	MA1_CC	Natural inflow files scaled for climate change scenario
Nseleni	NS1_CC	Natural inflow files scaled for climate change scenario
Black Mfolozi	BM1_CC	Natural inflow files scaled for climate change scenario
White Mfolozi	WM1_CC	Natural inflow files scaled for climate change scenario
	WM1_HFY no ewr	HFY abstracted from upstream dams, no EWR on
	WM1_HFY with ewr	HFY (12.9) abstracted from upstream dams, with EWR on (yield is not affected by EWR)
	WM1_raise klip with ewr	Raised Klipfontein HFY (14.3) abstracted from upstream dams, with EWR on (yield is not effected by EWR)
Mkuze	MK1_CC	Natural inflow files scaled for climate change scenario
	MK1_2040	PD scenario with increased upstream domestic use
	MK1_IRR	PD scenario with increased return flows due to increased irrigation supplied from Pongolapoort Dam
Pongola	UP1_CC	Natural inflow files scaled for climate change scenario
	UP1_2040	PD scenario with increased upstream domestic use (upgraded Fritz WTW)
Assegaai	AS1_CC	Natural inflow files scaled for climate change scenario
	AS1_2040	PD scenario with increased upstream domestic use
	AS1_EWR	PD scenario with EWR as provided included (no impact on yield of Heyshope)
	AS1_noEWR	PD scenario with no EWR
Ngwempisi	NG1_CC	Natural inflow files scaled for climate change scenario
	NG1_2040	PD scenario with increased upstream domestic use
	NG1_EWR	PD scenario with EWR as provided included (Yield of Jericho drops from 58 to 49)

3.2.7 Estuary Scenarios Summary

The scenarios assessed for the estuary sites were specifically requested by the estuary specialists. This was because, in some cases, comparisons were required with scenario analyses results from previous studies. **Table 3-5** presents a summary of the estuary scenarios that were configured and assessed using the water resources models.

Table 3-5: Summary of estuary scenarios assessed

Site	Scenario Reference	Description
	AMA_10%red	Reduction of present day MAR by 10%

Amatigulu (north & south)	AMA_20%red	Reduction of present day MAR by 20%
	AMA_30%red	Reduction of present day MAR by 30%
	AMA_15%incr	Increase of present day MAR by 15%
Siyaya	SIY_15%incr	Increase of present day MAR by 15%
	SIY_15%red	Reduction of present day MAR by 15%
Mlalazi	MLA_WWTW	Present day including the upgrade of the Mtunzini WWTW increased to a 1.5 Ml/d plant
	MLA_Scen1	Present day including additional demand of 10% on present day MAR supplied by Eshowe Dam with an increased capacity of 15 million m^3.
	MLA_Scen2	Present day reduced by 10% through abstraction from lower reaches of river
	MLA_Scen3	Present day reduced by 20% through abstraction from lower reaches of river
	MLA_Scen4	Scenario 3 including additional demand of 10% on present day MAR supplied by Eshowe Dam with an increased capacity of 20 million m^3.
Mhlathuze	MHL_15%incr	Increase of present day MAR by 15%
	MHL_10%incr	Increase of present day MAR by 10%
	MHL_2030	2030 year projected water requirements on the system (including increased transfer from Thukela to Goedertrouw)
	MHL_2040	2040 year projected water requirements on the system (including increased transfer from Thukela to Goedertrouw)
Nhlabane	NHL_EWR	Present Day including EWR releases from Lake Nhlabane as obtained from MWAAS (DWAF, 2009)
	NHL_rest	Restoration Scenario to allow for mouth breaching each year. Increase of flows as follows, if natural flow is < 0.25 m^3/s, restoration flow is 0, if 0.25 m^3/s < natural flow < 0.3 m^3/s, restoration flow is 0.1 m^3/s, if 0.3 m^3/s < natural flow < 0.5 m^3/s, restoration flow is 0.3 m^3/s, if natural flow is > 0.5 m^3/s, restoration flow is present day flow

4 SCENARIO RESULTS

The results of all the assessed scenarios have been provided to the river and estuary teams of specialists for further assessment relating to the impact of the scenarios. Results are provided in the form of historical time series files. The mean annual runoff for each scenario has been included in **Table 4-1** for the river scenarios and **Table 4-2** for the estuary scenarios.

Table 4-1: River scenario results

Site	File name	MAR (million m^3/a)
Amatigulu	MA1_CC	36.42
Nseleni	NS1_CC	25.07
Black Mfolozi	BM1_CC	27.43
White Mfolozi	WM1_CC	178.82
	WM1_HFY no ewr	184.31
	WM1_HFY with ewr	184.45
	WM1_raise klip with ewr	183.08
Mkuze	MK1_CC	102.52
	MK1_2040	105.34
	MK1_IRR	107.60
Pongola	UP1_CC	248.62
	UP1_2040	295.54
Assegaai	AS1_CC	154.30
	AS1_2040	169.85
	AS1_EWR	171.66
	AS1_noEWR	171.52
Ngwempisi	NG1_CC	72.91
	NG1_2040	78.90
	NG1_EWR	88.25

Table 4-2: Estuary scenario results

Site	File name	MAR (million m^3/a)
Amatigulu (north & south)	AMA_CC	94.79
	AMA_10%red	106.08
	AMA_20%red	98.97
	AMA_30%red	92.46
	AMA_15%incr	125.65
Siyaya	SIY_CC	2.22
	SIY_15%incr	3.91
	SIY_15%red	2.89
Mlalazi	MLA_CC	69.08
	MLA_WWTW	99.25
	MLA_Scen1	95.95
	MLA_Scen2	88.92

Site	File name	MAR (million m^3/a)
	MLA_Scen3	79.12
	MLA_Scen4	75.67
Mhlathuze	MHL_CC	211.50
	MHL_15%incr	360.09
	MHL_10%incr	318.55
	MHL_2030	281.44
	MHL_2040	278.31
Nhlabane	NHL_CC	10.09
	NHL_EWR	21.33
	NHL_rest	26.35

The river workshop is scheduled for 7 – 10 February 2023 and the estuary workshop for 22 – 26 February 2023. Variations on the scenarios presented in this report may be requested as a result of the impact assessments at the workshop, and a description thereof will be included as an Addendum to this report.

5 REFERENCES

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.

DWS (2021a) Implementation and Maintenance of the Water Reconciliation Strategy for Richards Bay and Surrounding Towns: Reconciliation Strategy. Prepared by BJ/iX/WRP Joint Venture for the Department of Water and Sanitation, South Africa

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Department of Water and Sanitation (DWS). 2022a. Classification of Significant Water Resources and Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: Hydrology Systems Analysis Report. Report no. WEM/WMA3/4/00/CON/CLA/0422

Department of Water and Sanitation (DWS). 2022b. Hydrology report to be compiled as part of the 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 – Hydrology Report. June 2022, DWS, Pretoria, South Africa.

Umkhanyakude District Municipality (UDM), 2020. Water and Sanitation Master Plan Update

Zululand District Municipality (ZDM). 2021. Integrated Development Plan

6 APPENDIX A: LOCATION OF SITES ASSESSED

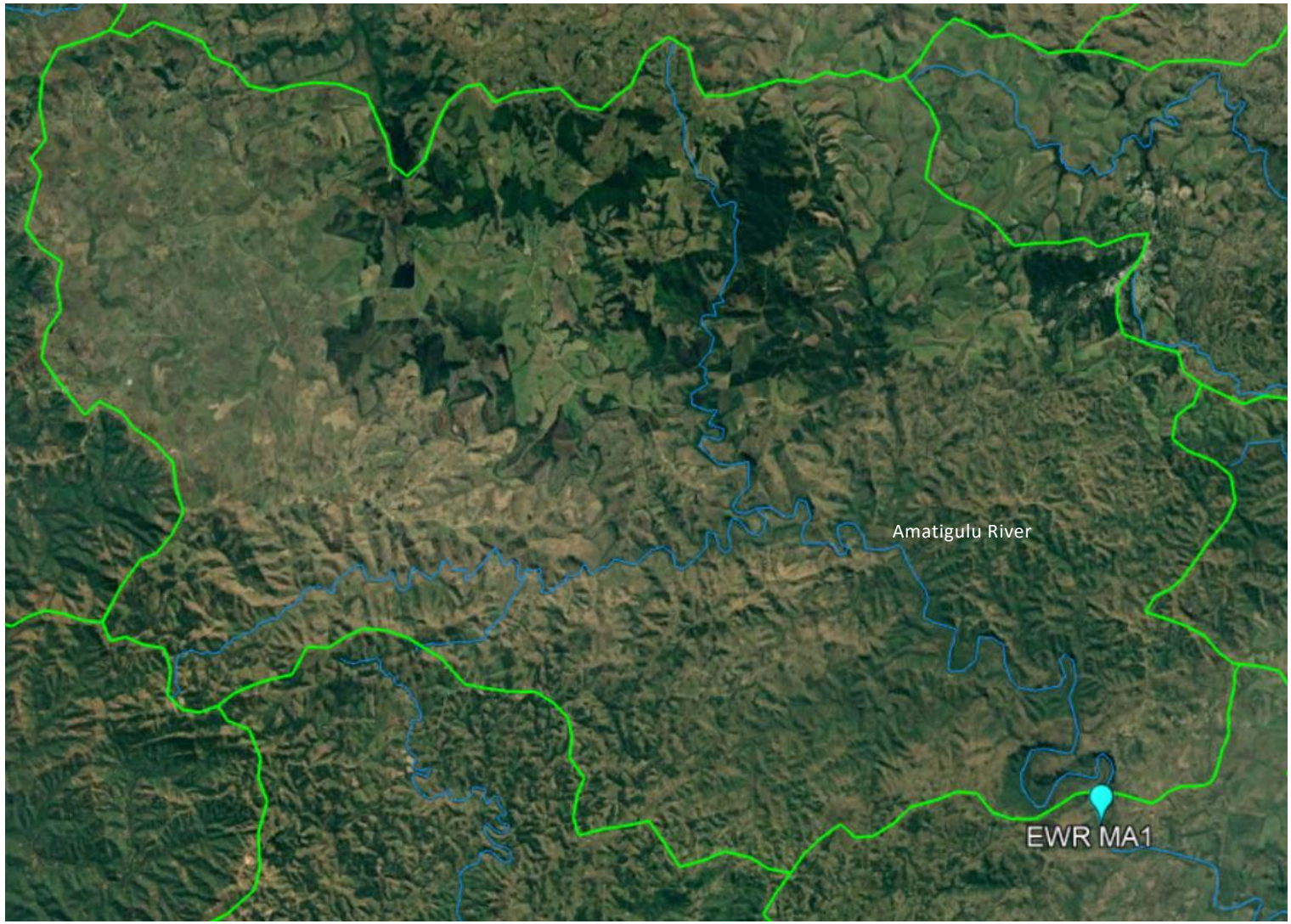


Figure 6-1: River EWR Site in the Amatigulu (MA1)

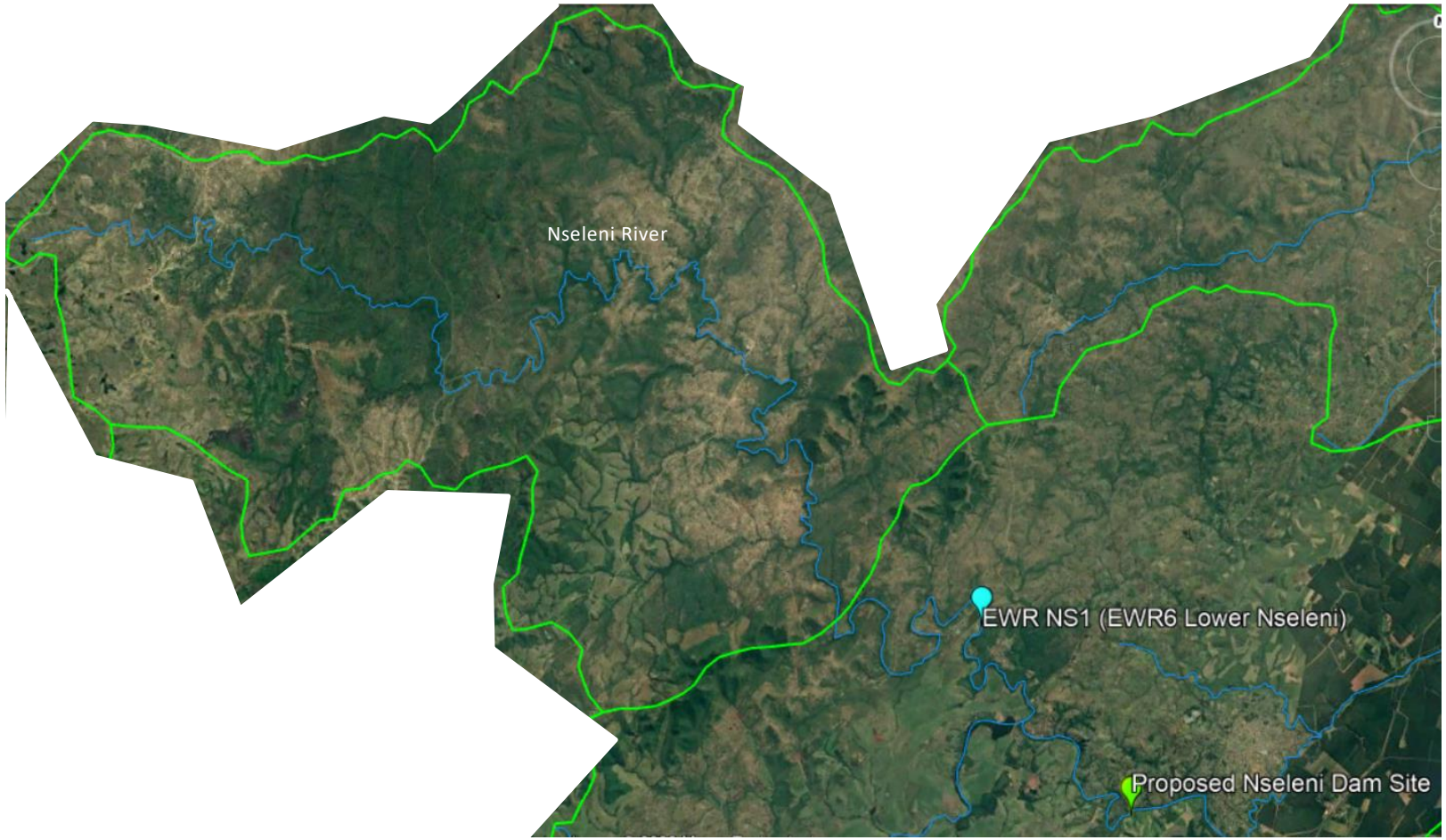


Figure 6-2: River EWR Site in the Nseleni (NS1)

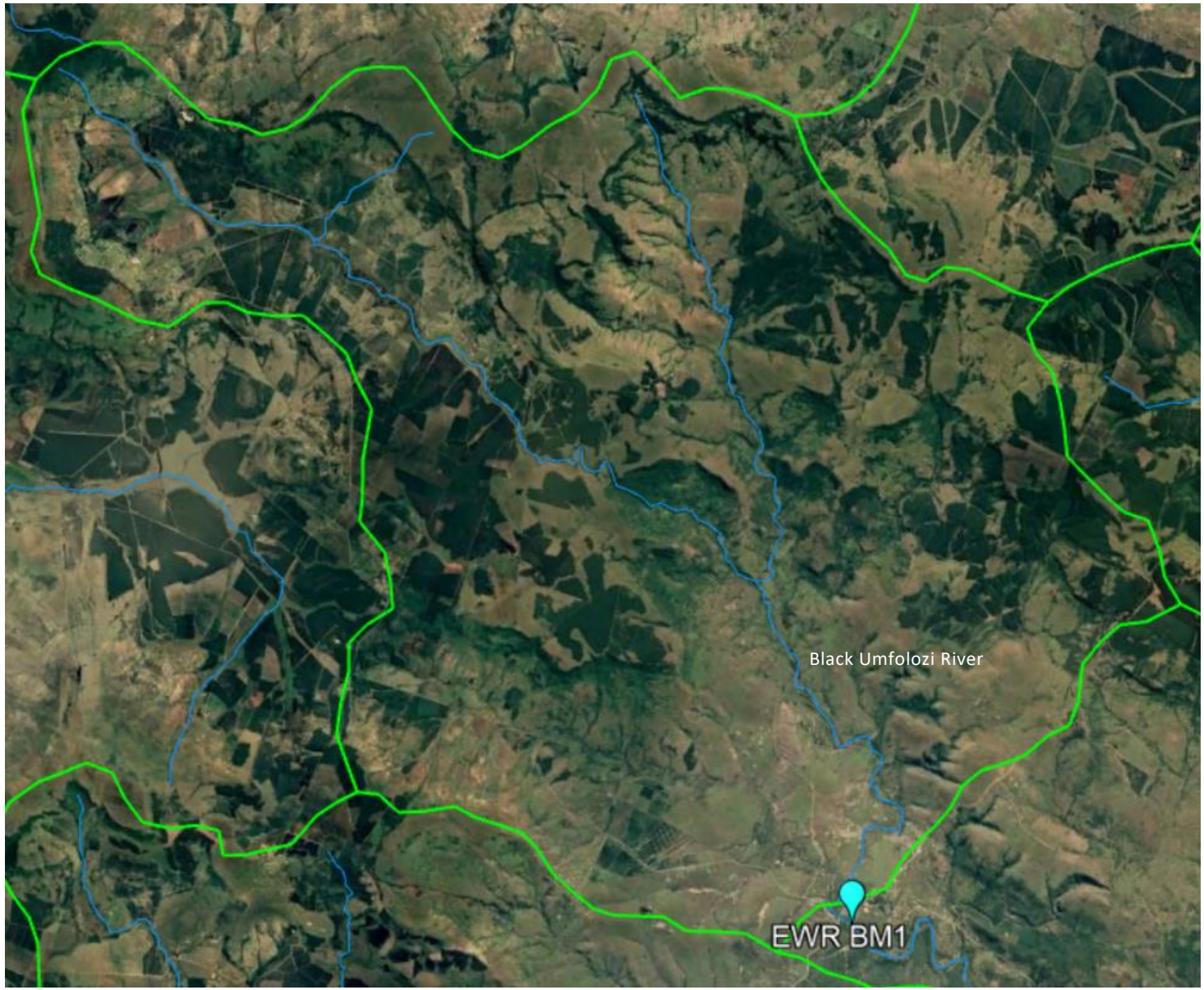


Figure 6-3: River EWR Sitein the Black Umfolozi (BM1)

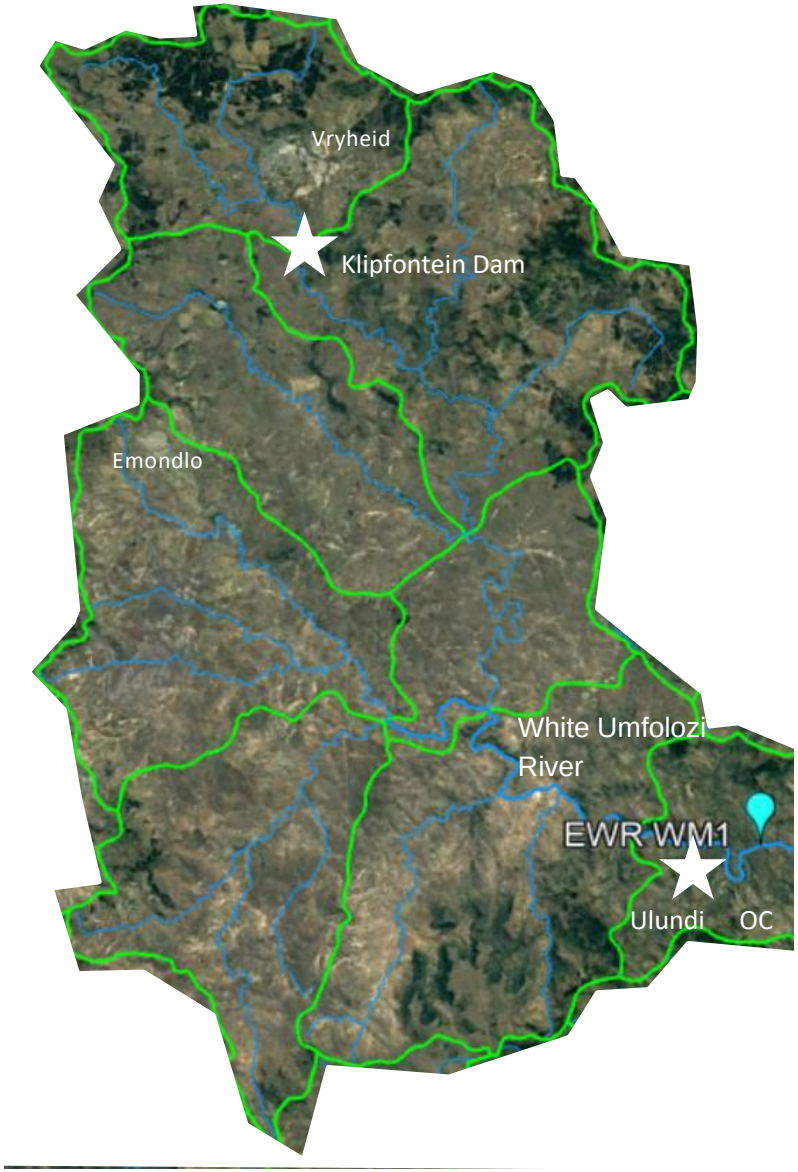


Figure 6-4: River EWR Site in the White Umfolozi (WM1)

Figure 6-5: River EWR Site in the Mkuze (MK1)

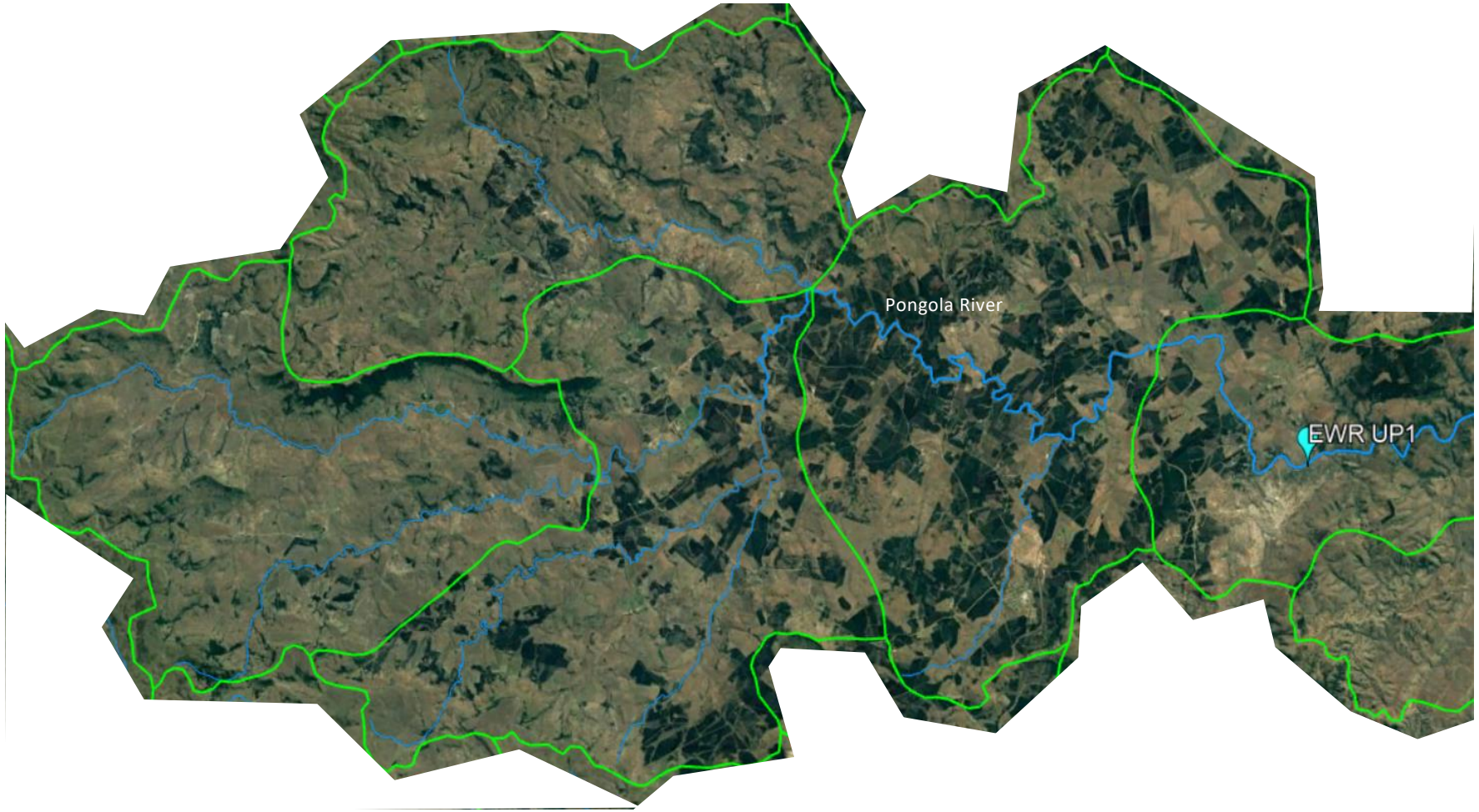


Figure 6-6: River EWR Site in the Pongola (UP1)

Figure 6-7: River EWR Site in the Assegaai (AS1)

Figure 6-8: River EWR Site Ngwempisi (NG1)

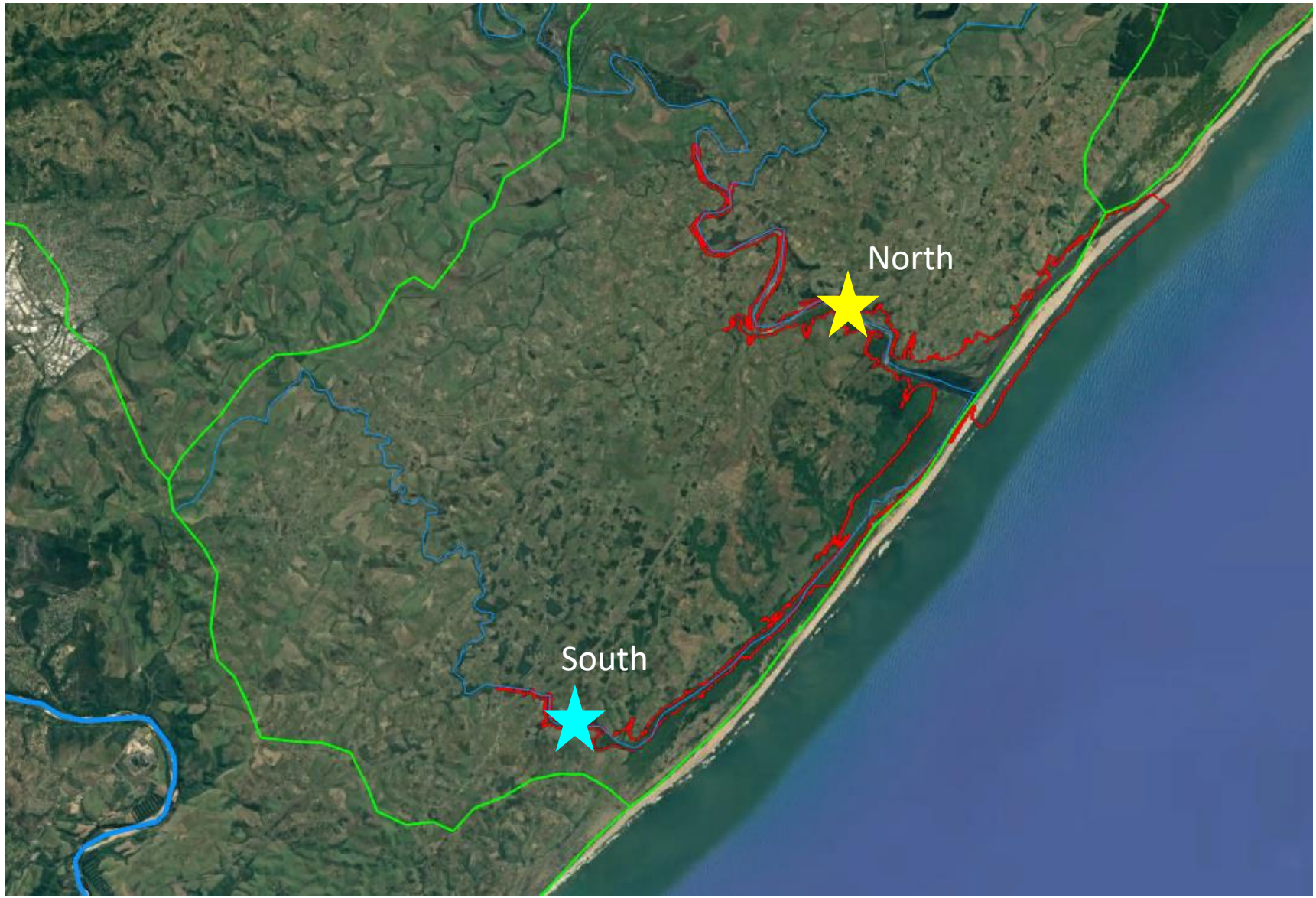


Figure 6-9: Amatigulu Estuary

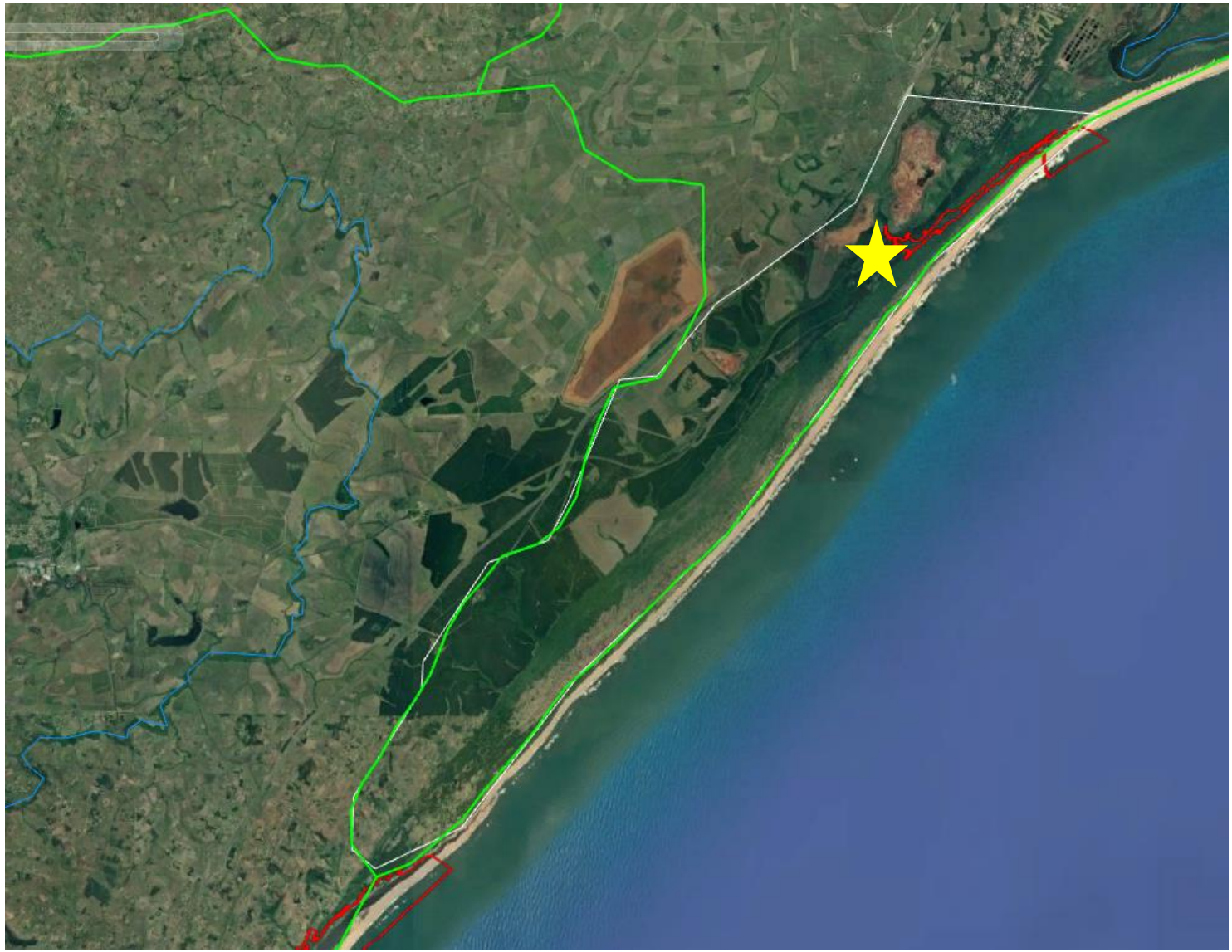


Figure 6-10: Siyaya Estuary

Figure 6-11: Mlalazi Estuary

Figure 6-12: Mhlathuze Estuary

Figure 6-13: Nhlabane Estuary

7 APPENDIX B: EWR FLOWS INCLUDED IN SCENARIOS

REC & PES EWR for Site WM1, Class B/C (units m^3/s)

Oct	Oct	Nov	Nov	Dec	Dec	Jan	Jan	Feb	Feb	Mar	Mar
Natural	EWR	Natural	EWR	Natural	EWR	Natural	EWR	Natural	EWR	Natural	EWR
00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000
00.943	00.721	01.022	00.706	01.043	00.902	01.126	00.918	01.326	00.942	01.346	00.933
01.139	00.833	01.347	00.938	01.525	01.063	01.696	01.167	02.066	01.262	02.018	01.446
01.272	00.903	01.497	01.032	01.785	01.206	01.911	01.324	02.452	01.439	02.268	01.576
01.336	00.974	01.688	01.178	01.878	01.365	02.179	01.552	02.685	01.699	02.507	01.804
01.453	01.101	01.894	01.396	02.047	01.569	02.508	01.879	02.898	01.979	02.756	02.091
01.667	01.292	02.061	01.551	02.302	01.794	02.693	02.070	03.266	02.257	03.192	02.433
01.827	01.407	02.360	01.690	02.590	01.915	03.355	02.264	04.471	02.539	03.961	02.531
02.006	01.542	02.605	01.838	03.379	02.267	04.099	02.599	05.261	02.825	04.720	02.816
02.327	01.595	03.257	02.098	05.108	02.849	05.187	02.947	06.038	03.073	05.421	03.094
02.864	01.919	06.270	02.826	07.442	03.106	06.870	03.074	10.253	03.247	06.773	03.106
99.999	01.919	99.999	02.826	99.999	03.106	99.999	03.074	99.999	03.247	99.999	03.106

Apr	Apr	May	May	Jun	Jun	Jul	Jul	Aug	Aug	Sep	Sep
Natural	EWR	Natural	EWR	Natural	EWR	Natural	EWR	Natural	EWR	Natural	EWR
00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000
01.350	01.181	01.266	00.941	01.169	00.833	01.075	00.758	01.053	00.724	00.910	00.640
02.041	01.385	01.643	01.140	01.408	01.011	01.296	00.952	01.176	00.844	01.084	00.773
02.279	01.464	01.953	01.324	01.637	01.098	01.419	01.001	01.323	00.938	01.196	00.839
02.540	01.743	02.203	01.561	01.806	01.270	01.564	01.132	01.400	01.016	01.285	00.916
02.753	02.029	02.393	01.813	02.114	01.523	01.684	01.262	01.445	01.090	01.346	01.001
03.044	02.263	02.706	02.056	02.265	01.677	01.762	01.378	01.534	01.165	01.462	01.105
03.543	02.324	03.032	02.101	02.355	01.721	01.949	01.510	01.661	01.258	01.586	01.212
04.360	02.631	03.398	02.288	02.635	01.855	02.259	01.673	01.859	01.415	01.736	01.324
05.000	02.801	03.958	02.491	03.075	01.967	02.614	01.759	02.162	01.505	02.155	01.453
05.551	02.805	05.167	02.626	04.421	02.312	03.286	01.962	02.686	01.671	02.654	01.591
99.999	02.805	99.999	02.626	99.999	02.312	99.999	01.962	99.999	01.671	99.999	01.591

REC & PES EWR for Site AS1, Class C (units m^3/s)

Oct	Oct	Nov	Nov	Dec	Dec	Jan	Jan	Feb	Feb	Mar	Mar
Natural	EWR	Natural	EWR	Natural	EWR	Natural	EWR	Natural	EWR	Natural	EWR
00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000
00.899	00.204	01.050	00.244	01.147	00.303	01.578	00.515	01.950	00.610	01.802	00.573
01.160	00.226	01.637	00.319	01.967	00.446	02.588	00.615	03.137	00.695	03.094	00.686
01.361	00.265	01.861	00.364	02.482	00.544	03.176	00.756	03.786	00.817	03.686	00.791
01.571	00.307	02.066	00.414	02.847	00.619	03.909	00.917	04.403	00.948	04.002	00.919
01.732	00.350	02.364	00.476	03.118	00.693	04.466	01.036	05.239	01.101	05.052	01.085
01.928	00.417	02.663	00.580	04.096	00.921	05.261	01.254	05.981	01.286	05.249	01.226
02.134	00.570	03.245	00.844	05.076	01.307	06.266	01.586	06.862	01.540	05.701	01.443
02.409	00.918	04.215	01.404	06.139	01.820	06.815	02.295	07.457	01.906	06.450	01.860
02.993	01.602	04.961	02.217	08.147	03.306	07.943	02.703	08.527	02.344	07.691	02.982
04.159	02.809	08.064	03.583	10.117	03.580	09.424	04.160	13.137	02.922	11.007	03.399
99.999	02.809	99.999	03.583	99.999	03.580	99.999	04.160	99.999	02.922	99.999	03.399

Apr	Apr	May	May	Jun	Jun	Jul	Jul	Aug	Aug	Sep	Sep
Natural	EWR	Natural	EWR	Natural	EWR	Natural	EWR	Natural	EWR	Natural	EWR
00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000
02.147	00.586	01.549	00.491	01.392	00.378	01.204	00.283	00.960	00.236	00.894	00.179
02.871	00.673	02.300	00.529	01.729	00.379	01.417	00.291	01.207	00.240	01.117	00.202
03.549	00.796	02.579	00.573	02.042	00.402	01.588	00.314	01.358	00.260	01.278	00.234
03.958	00.893	03.045	00.666	02.269	00.452	01.714	00.343	01.490	00.289	01.424	00.264
04.367	00.960	03.368	00.744	02.505	00.518	01.911	00.394	01.682	00.338	01.559	00.302
04.919	01.083	03.648	00.819	02.836	00.596	02.065	00.448	01.762	00.380	01.752	00.356
05.258	01.294	03.927	01.046	03.075	00.788	02.398	00.637	01.906	00.516	01.856	00.476
05.702	01.739	04.697	01.538	03.505	01.206	02.701	01.004	02.181	00.828	02.043	00.763
06.802	02.417	05.243	02.266	04.050	01.956	03.004	01.657	02.400	01.403	02.270	01.243
08.712	03.620	06.072	03.393	04.948	02.916	03.645	02.297	03.077	01.954	02.859	01.986
99.999	03.620	99.999	03.393	99.999	02.916	99.999	02.297	99.999	01.954	99.999	01.986

REC & PES EWR for Site NG1, Class B/C (units m^3/s)

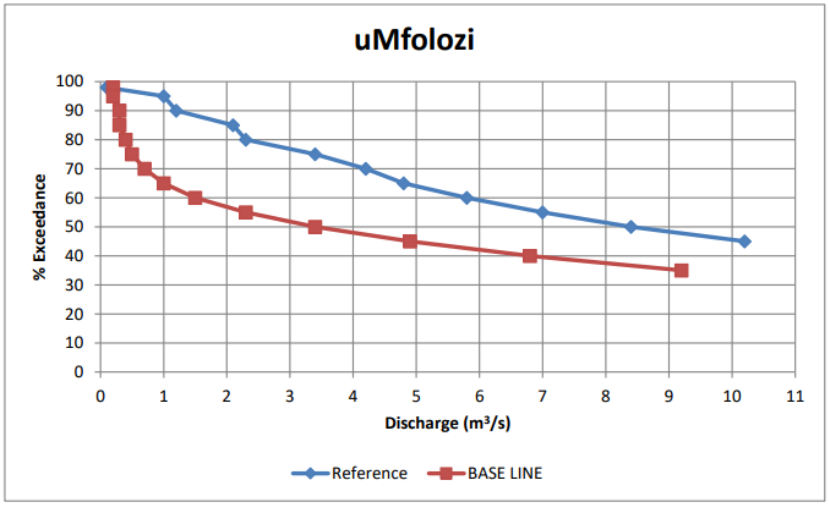
Oct	Oct	Nov	Nov	Dec	Dec	Jan	Jan	Feb	Feb	Mar	Mar
Natural	EWR	Natural	EWR	Natural	EWR	Natural	EWR	Natural	EWR	Natural	EWR
00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000
00.408	00.085	00.483	00.135	00.507	00.212	00.772	00.495	00.918	00.434	00.956	00.382
00.530	00.120	00.728	00.187	00.868	00.288	01.106	00.513	01.402	00.604	01.407	00.494
00.610	00.166	00.816	00.234	01.103	00.384	01.562	00.642	01.777	00.694	01.568	00.646
00.667	00.216	00.897	00.302	01.387	00.550	01.815	00.805	02.065	00.819	01.769	00.754
00.731	00.277	01.107	00.431	01.615	00.710	02.046	00.972	02.357	01.003	02.123	00.977
00.783	00.371	01.254	00.601	01.875	00.970	02.204	01.193	02.653	01.301	02.469	01.258
00.912	00.523	01.511	00.850	02.191	01.321	02.586	01.563	03.220	01.778	02.873	01.752
01.005	00.649	01.817	01.269	02.501	01.836	03.455	02.470	03.627	02.371	03.383	02.436
01.320	01.065	02.043	01.591	03.479	02.454	04.034	02.891	04.800	02.974	04.194	02.886
01.665	01.271	02.993	02.095	04.363	02.807	05.638	03.493	06.683	03.494	05.954	03.416
99.999	01.271	99.999	02.095	99.999	02.807	99.999	03.493	99.999	03.494	99.999	03.416

Apr	Apr	May	May	Jun	Jun	Jul	Jul	Aug	Aug	Sep	Sep
Natural	EWR	Natural	EWR	Natural	EWR	Natural	EWR	Natural	EWR	Natural	EWR
00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000	00.000
00.800	00.192	00.567	00.099	00.490	00.110	00.442	00.085	00.395	00.071	00.381	00.061
01.206	00.426	00.923	00.206	00.677	00.161	00.629	00.124	00.564	00.101	00.502	00.086
01.511	00.591	01.137	00.351	00.857	00.235	00.690	00.149	00.632	00.123	00.578	00.134
01.769	00.726	01.412	00.430	01.027	00.287	00.759	00.180	00.668	00.143	00.621	00.154
01.939	00.865	01.592	00.563	01.158	00.338	00.848	00.205	00.728	00.168	00.698	00.185
02.180	01.137	01.732	00.661	01.285	00.386	00.986	00.254	00.775	00.198	00.745	00.224
02.644	01.555	02.008	00.820	01.450	00.457	01.083	00.300	00.873	00.253	00.816	00.245
02.997	02.127	02.244	00.959	01.655	00.570	01.212	00.354	00.988	00.279	00.870	00.296
03.797	02.613	02.606	01.213	01.897	00.716	01.409	00.491	01.072	00.329	00.964	00.371
04.971	03.012	03.598	02.400	02.335	01.124	01.636	00.641	01.313	00.487	01.312	00.499
99.999	03.012	99.999	02.400	99.999	01.124	99.999	00.641	99.999	00.487	99.999	00.499

8 APPENDIX C: COMMENTS AND RESPONSES REGISTER

No.	Sect	Comment	From	Addressed?
1	General	Expand the Glossary to also include acronyms used in the report. It was reasonably evident that PD refers to "Present Day", but I had to read through a large section of the report before finding out that HFY refers to "Historic Firm Yield". The authors cannot assume that the readers understand terms and abbreviations without providing the explanations up front.	C Theron	Yes
2	Append A	The Google Earth Maps indicating the sites should also include the river names etc, and the figure captions should be expanded to more than just the site code.	C Theron	Yes
3	1.1	Editorial	K Makanda	Yes
4	General	I have a query regarding the St Lucia Estuary. I am aware that the scenarios are being run for EWR sites. The aforementioned report states that "Only scenarios that would potentially affect the flows at these sites have been defined". I am aware that an intermediate EWR study was conducted in 2016 for the St Lucia estuary. The 2016 DWS report states "No Environmental Water Requirement (EWR) scenarios (hypothetical scenarios not considered by DWS but constructed to explore greater extremes or options such as increased runoff) were evaluated as part of this study. This is considered to be an important shortcoming as this does not allow for the	R Pillay	1) Renelle is correct, while St Lucia EWR Report is a very detailed study based on the best available information (then and now), the EWR Assessment Report was signed off without a clear recommended flow scenario. 2) While the consultant states their reason (i.e. very low confidence in the hydrology used to drive the DRIFT model), I have never seen an Estuary EWR report being signed off before by the department without a 'Recommended Flow Scenario', albeit of very low confidence. Our methods require us to provide you with guidance and allows us to follow a precautionary approach in flow allocation - rather than not setting guidance on flows for the environment. 3) The report is also not that clear on the REC. The overarching recommendation is an A or 'Best Attainable State'. Part of the report indicate a REC= C+ (B/C) (~72), while other sections (Chapter 7 (page 233) & Appendix A) indicate that a B Category is achievable and thus the BAS. 4) The DFFE Ministerial Panel also advocate for a REC = B Category. 5) The main DWS 2016 EWR report clearly states that the total present flow from both the Mfolozi and the St Lucia rivers are needed to achieve the C category, i.e. any flow scenario that would involve flow reduction from Present will not meet the REC. Less than 1% change can be made to Mfolozi flows, but that flow needs to be reallocated to the EWR of the St Lucia Rivers to ensure that the system remain in a C category (and not decline during droughts).

No.	Sect	Comment	From	Addressed?
		identification of a Recommended Ecological Scenario (REC)". I might have missed something in the earlier meetings but are there any scenarios that should be or are being considered for the St Lucia estuary, such as the climate change scenario or how will St Lucia estuary be addressed within the context of the Classification study as a whole?		This is considered a critical omission from an environmental flow assessment of this nature. While flow in the uMfolozi is critically important for keeping the mouth of the Lake St Lucia system open, flow from the rivers feeding directly into the Lakes is also critically important for maintaining water levels in these lakes (preventing them from drying out) and also for minimising the risks of the Lakes from becoming hypersaline. Maintaining a proper balance between flows in the two "sides" of the system (uMfolozi vs. direct inflow to the Lakes) is thus critically important. Minimising flow reduction in the uMfolozi River is very important as it ensures that the combined mouth remains open as much as possible (and hence provides a means for marine fish and invertebrates to recruit into and exit from the system) this also increases seawater inputs to the system and can lead to the development of hypersaline conditions in the St Lucia Lakes if adequate flows are not maintained in the smaller rivers feeding directly into the Lakes. This is clearly evident in the results from this study where the 6) Appendix A, (done by a different consultant using a different flow model) provides clear additional minimum flow criteria against which scenarios can be screened to achieve a REC = B. These will require abstraction reductions in both the Mflozi and the main St Lucia Rivers to achieve REC = B category. The information in Appendix A chapter should have been used to guide the development of a 'Recommended Flow Scenario', I am at a loss why it is not in place. See examples below of recommendations: in the modelling. However, due to uncertainties, especially in low flow measurement accuracy, a Baseline discharge > 3 m3/s is recommended as the minimum flow required to maintain an open mouth. Based on Figure 9.9 and Table 9.2, discharge of 3 m3/s in the uMfolozi River is exceeded 52% of the time under Present Day conditions, while the discharge for the same exceedance was 7.9 m3/s - under Reference conditions a reduction of 4.9 m3/s. If one takes drought flow conditions as to be 80% flow exceedance, then the

No.	Sect	Comment	From	Addressed?
				 **Figure 9.9 uMfolozi River downstream of the bifurcation flow duration graph (1962 to 2010 daily data).** Table 9.5 indicates the additional water volume required to maintain the Lake level at a point where TDS concentrations at Lister's Point and the Northern Lake do not exceed an ecological critical TDS value of 70000 mg/l. (Note that based on the results of the ecological assessment (DWS 2016), it is anticipated that this would ensure that the health of the St Lucia system improves from a current category C to a category B). This estimate was obtained from the daily Lake volume difference calculations, but it is recommended thatthe effect of adding additional runoff in rivers should still be evaluated by hydrodynamic modelling. Under Present Day conditions, the Lake requires an additional 5.2 m3/s during drought periods. For possible future development scenarios, the Lake thus requires additional inflows of 5.5 to 6.6 m3/s during droughts. 7) Using the DWS 2016 EWR report as a guide to achieve an REC = B, the recommend way forward thus is to screen all operational flow scenarios against the Present flows + the additional flow requirements stated in Appendix A, e.g. cap minimum discharge in the Mfolozi at 3 m3/s to maintain an open mouth, an additional combine Mfolozi/Mkuze drought discharge of 5 m3/s (including an additional 1.6 m3/s in Mkuze). This should provide us with an 'optimum flow

No.	Sect	Comment	From	Addressed?
				configuration'. Given the large accumulation of muddy sediments in the St Lucia mouth at present and the lack of data on its extent and consistency, flow should not be set at the lowest thresholds. I also recommend that Prof Basson be asked to comment/consult on the recommend flow configuration given that Appendix A provides the clearest recommendation towards achieving a Category B from a flow perspective. 8) From the above it is quite clear that any further water resource development will further negative impact on St Lucia, regardless of scope as all flow matter to this system.