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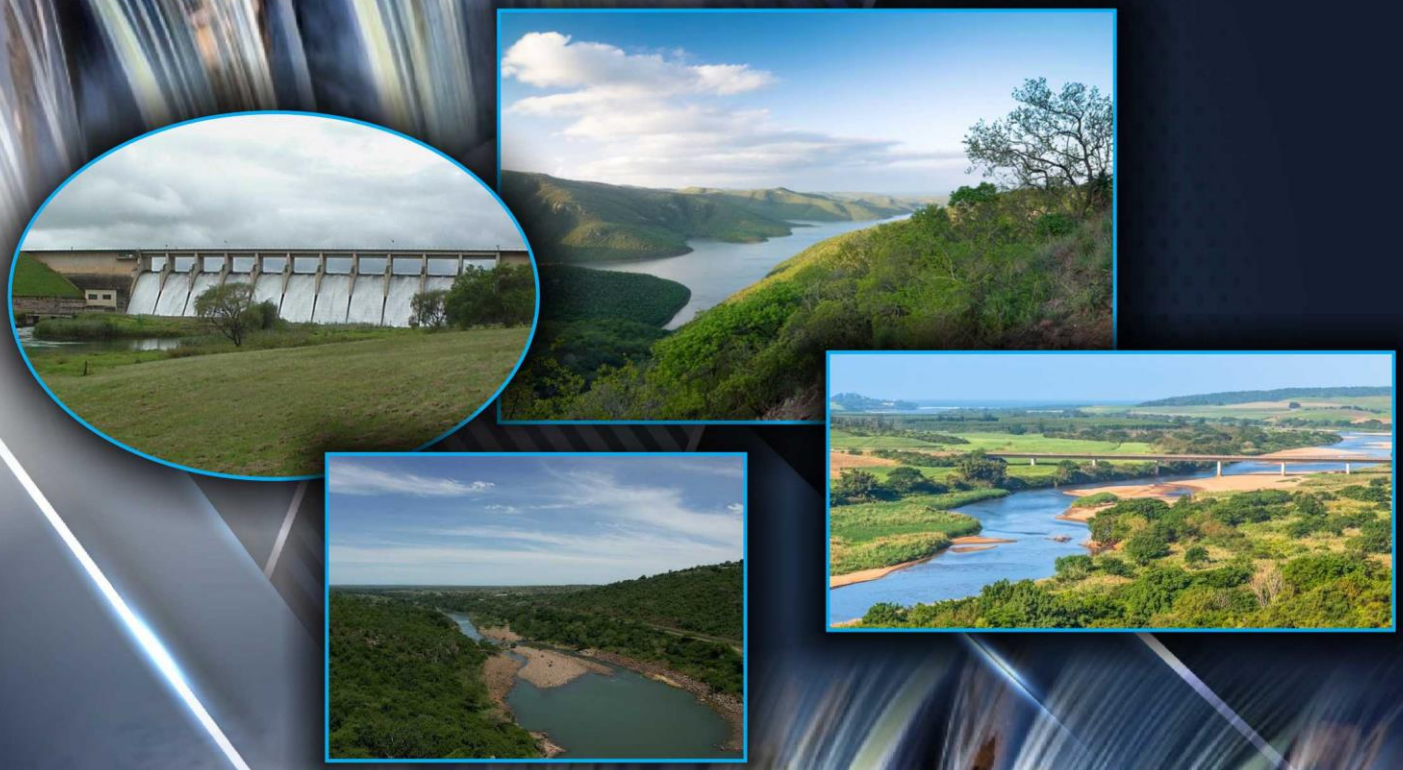
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

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

RESOURCE QUALITY OBJECTIVES REPORT, VOLUME 2: ESTUARIES



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Chief Directorate: Water Ecosystems Management

PROJECT NUMBER**:** WP 11387

Resource Quality Objectives Report
Volume 2: Estuaries

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

JANUARY 2024

REFERENCE

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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 Determination of 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 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**
3	WEM/WMA3/4/00/CON/CLA/0322	Classification of Significant Water Resources and Determination of 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 Determination of 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 Determination of 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 Determination of 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 Determination of 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 Determination of 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 Determination of 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 Determination of 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 Determination of 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 Determination of 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 Determination of 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 Determination of Resource Quality Objectives for Water

Index Number	DWS Report Number	Report Title
		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 Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Ecological Consequences Report, Volume 2: Estuaries**
15	WEM/WMA3/4/00/CON/CLA/0323	Classification of Significant Water Resources and Determination of 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 Determination of 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 Determination of 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 Determination of 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 Determination of 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 Determination of 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 Determination of 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 Determination of 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 Determination of 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 Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: **Close out Report**

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APPROVAL

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Report Title:	***Resource Quality Objectives Report: Volume 2: Estuaries***
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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 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 several 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 document the Resource Quality Objectives for estuaries. The results form part of Task 6: Determine Resource Quality Objectives (RQO) (narrative and numerical limits) and provide implementation information.

RESULTS

As per the DWS methodology, estuaries are sufficiently different in terms of state, functioning and management to form individual RUs. RQOs are set for the short to medium term (5 to 10-year period) for the following components:

- Quantity, pattern and timing of instream flow (hydrology).
- Mouth state (hydrodynamics).
- Water quality.
- Characteristics and condition of primary producers (e.g. macrophytes).
- Characteristics and condition of biota (e.g. fish).

The RQOs for the estuaries were derived from the EcoSpecs and Thresholds of Potential Concern (TPCs) set for systems that were assessed as part of EWR studies. For the uMgobezeleni Estuarine Lake system, the RQOs were based on the 2018 National Biodiversity Assessment and field studies.

In terms of RQOs for recreational use (water quality), the recommended targets proposed for South Africa's coastal marine waters were applied as summarised in **Table 1**.

Table 1 RQOs for recreational use in estuaries are specified as risk-based ranges for intestinal enterococci and *E. coli* (microbiological indicator organisms) (DEA, 2012)

Category	Estimated Risk per Exposure	Enterococci (Count per 100 ml)	*E. coli* (Count per 100 ml)
Excellent	2.9% gastrointestinal (GI) illness risk	≤ 100 (95 percentile)	≤ 250 (95 percentile)
Good	5% GI illness risk	≤ 200 (95percentile)	≤ 500 (95 percentile)
Sufficient or Fair (minimum requirement)	**8.5% GI illness risk**	**≤ 185 (90 percentile)**	**≤ 500 (90 percentile)**
Poor (unacceptable)	>8.5% GI illness risk	> 185 (90 percentile)	> 500 (90 percentile)

In South Africa, the minimum requirement for recreational use is the "Sufficient or Fair" category, thus also representative of the RQOs for estuaries used for full-contact recreation.

Ecological Categories for the eight estuaries represented below summarise the numerical and narrative RQOs in **Table 2** (as per DWS estuarine methods).

Table 2 Generic numerical and narrative RQOs associated with Ecological categories for Estuaries

	aMatigulu/iNyoni	iSiyaya	uMlalazi	uMhlathuze	iNhlabane	uMgobezeleni	Kosi	St Lucia/ uMfolozi
PES (trajectory)	B/C ↓	D/E↓	B/C ↓	D↓	E↓	B↓	A/B↓	D ↓↑
REC	B	C	B	D	D	A	A	B
TEC	B	D (short term) C (long term)	B	D	D	A/B	A	C (short term) B (long term)
Hydrology	C	B/C↑	C	C	D	B	A	C
Hydrodynamics	B	D ↑	B/C	D/E	C/D	B	A	C
Physical habitat (sediments)	B	B	B	D	E→D	A/B	A	C
Water quality (salinity)	A	B	B	C/D	E→D	A/B	A	D ↑
Water quality (general)	C	D ↑	C	D	D	B	A/B	D ↑
Microalgae	B	C	C	D	D	B	A	D ↑
Macrophytes	B	D→C	B/C	D	C/D	B	A/B	B
Invertebrates	B	D→C	B	E→D	E→D	A/B	B↑	D
Fish	B/C	D→C	B	D	E→D	B	B↑	C
Birds	B	D→C	B	C	D	A	A/B	C

X (short term; <5 years)→Y (long term; 5-10 years) - indicate the expected long-term trajectory of change to meet long-term TEC/RQO.
↓↑ - indicate that the trajectory of change is not stable.
↑ - indicate an improvement within a category (mostly associated with degraded components) and thus a focus for restoration.

THE WAY FORWARD

The proposed Classes and Catchment Configuration have been documented and concludes the National Water Resource Classification phase of this study.

The information leads to the final phase, i.e., the determination of Resource Quality Objectives. All TEC at high-priority RUs will be defined in terms of flow, water quality, habitat and riparian biota and habitat. In addition to this quantitative information, a suggested monitoring programme with ecological specifications to achieve and maintain the RQOs (and TEC) will also be provided. This will also form part of information that will/can be input into an implementation plan.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

TERMINOLOGY AND ACRONYMS

CD: WEM	Water Ecosystems Management
CSIR	Council for Scientific and Industrial Research
CWAC	Coordinated Waterbird Counts
DFFE	Department of Forestry, Fisheries and the Environment
DIN	Dissolved Inorganic Nitrogen
DIP	Dissolved Inorganic Phosphate
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EFZ	Estuary Functional Zone
EWR	Ecological Water Requirement
GBF	Global Biodiversity Framework
GI	Gastrointestinal
Hab	Harmful Algal Bloom
ICM	Integrated Coastal Management
IUA	Integrated Unit of Analysis
MPA	Marine Protected Area
MPB	Microphytobenthos
MSL	Mean Sea Level
NBA	National Biodiversity Assessment
NEMP	National Estuarine Management Protocol
NTU	Nephelometric Turbidity unit
NWA	National Water Act
NWRC	National Water Resource Classification
NWRCS	National Water Resource Classification System
PES	Present Ecological State
RQO	Resource Quality Objective
RU	Resource Units
Sc	Scenario
TEC	Target Ecological Category
WIO	West Indian Ocean
WMA	Water Management Area
WRCS	Water Resource Classification System

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	
uMfolozi/uMsunduze Estuary	
St Lucia Estuary	
uMgobezeleni Estuary	
i	uMfolozi/uMsunduze Estuary
St Lucia 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	

The names adopted in the estuaries report are the official names assigned to the systems in the 'South African National Ecosystem Classification System' (and the KwaZulu-Natal Department of Economic Development and Environmental Affairs) (Dayaram *et al.,* 2021).

GLOSSARY

Basic Human Needs	Water needs to be set aside for basic human needs such as drinking, food preparation, and health and hygiene purposes. This is referred to as the Basic Human Needs Reserve (BHNR).
EcoClassification	The term used for the Ecological Classification process - refers to the determination and categorisation of the Present Ecological State (PES; health or integrity) of various biophysical attributes of rivers relative the natural or close to the natural reference condition. The purpose of the EcoClassification process is to gain insights and understanding into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition. This provides the information needed to derive desirable and attainable future ecological objectives for the river.
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.
Ecosystem services	The benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth.
Euhaline	Generally, refers to a salinity range between 30 to 35.
Fresh	Generally, refers to a salinity less 0.5.
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.
Mesohaline	Generally, refers to a salinity range between 5 to 18.
Oligohaline	Generally, refers to a salinity range between 0.5 to 5.0.
Polyhaline	Generally, refers to a salinity range between 18 to 30.
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).
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) 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 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 following 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 the 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 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 several 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 include the World Heritage Site and the St Lucia/iMfolozi Estuarine Lake Complex. 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 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.

River Ecological Water Requirements (EWR) sites are shown in **Figure 1.1**.

[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.

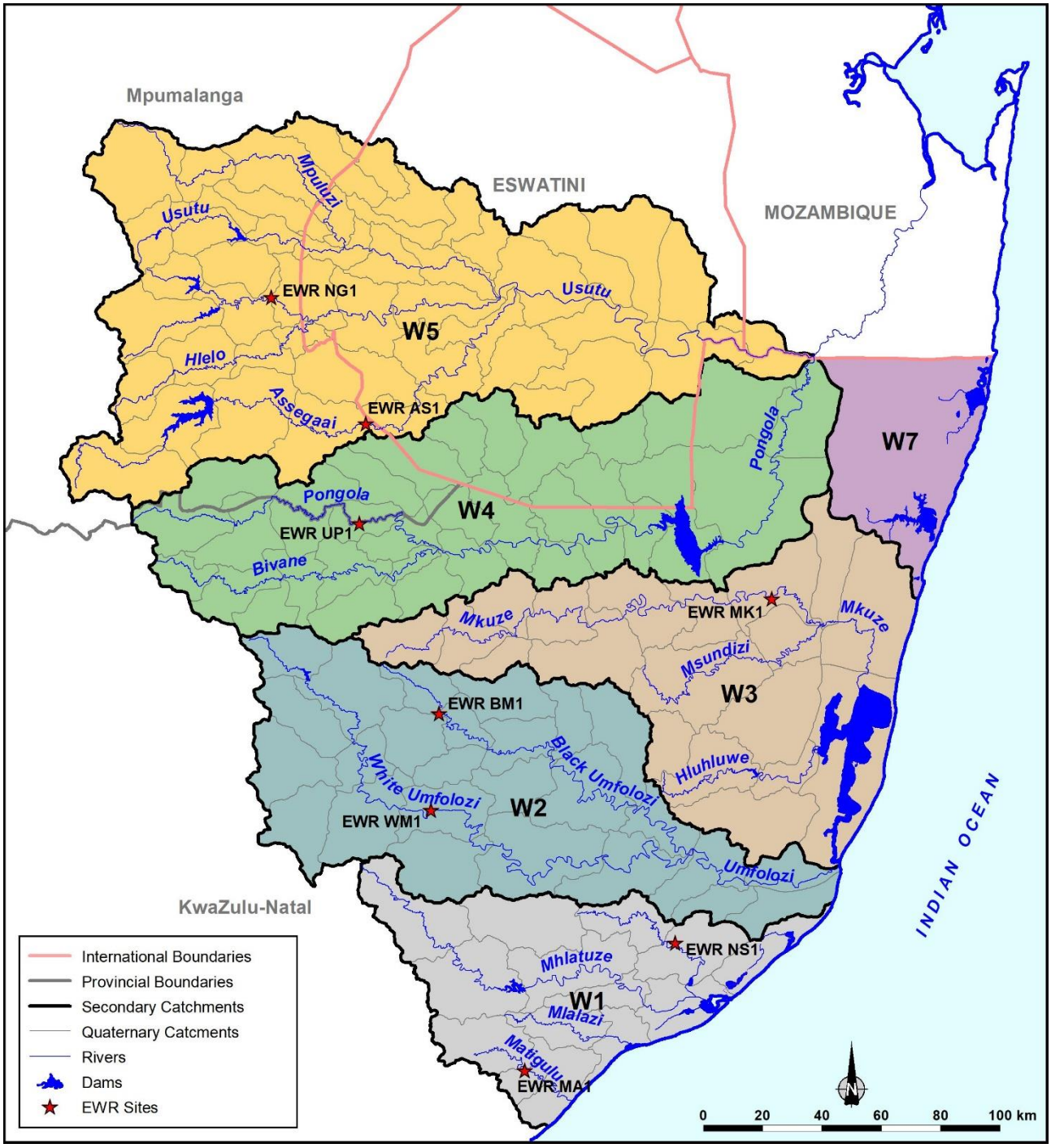

Figure 1.1 Locality Map of the Study Area

1.3 PURPOSE OF THIS REPORT

The purpose of this report is to document the Resource Quality Objectives for estuaries. The results form part of Task 6: Determine Resource Quality Objectives (RQO) (narrative and numerical limits) and provide implementation information (**Figure 1.2**).

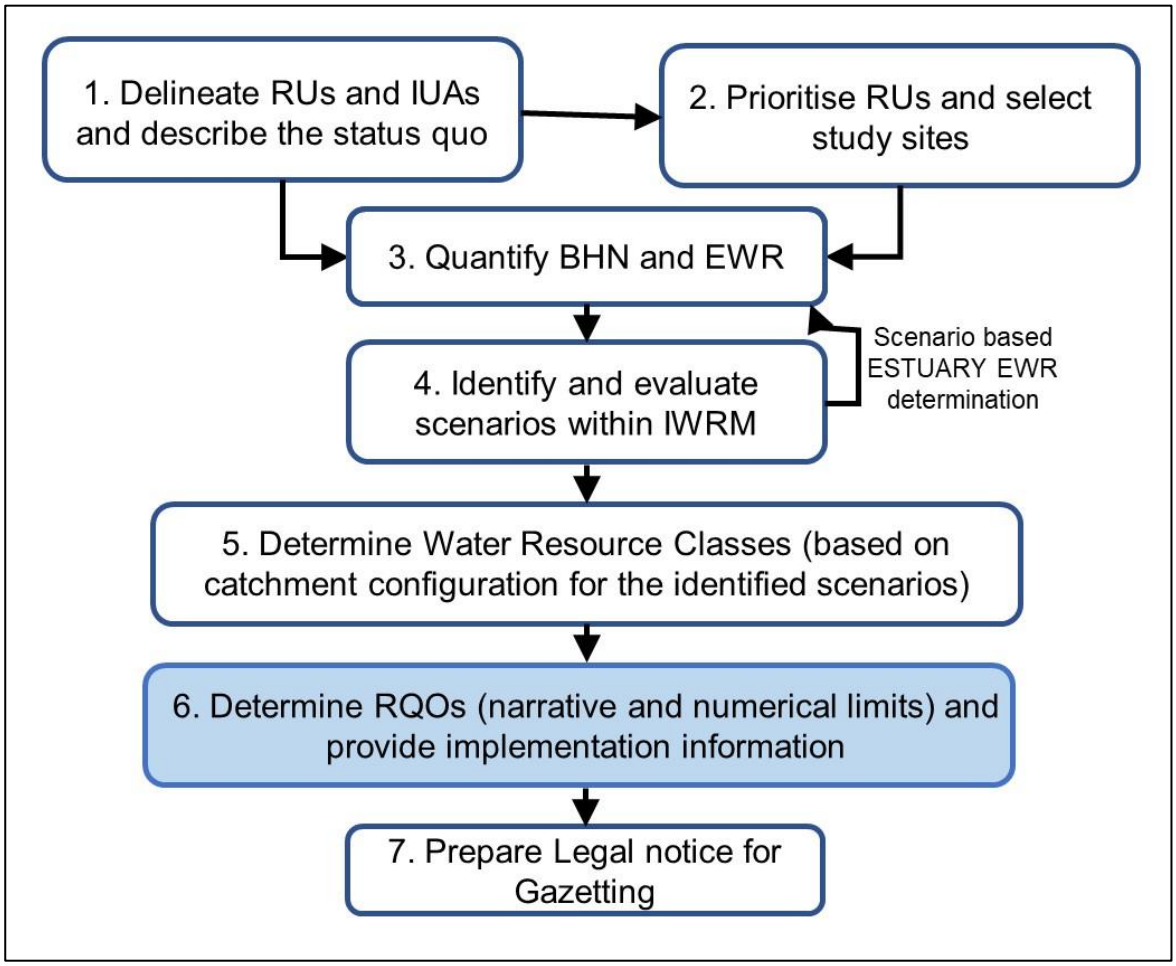

Figure 1.2 Project Plan for the Usutu-Mhlathuze Classification Study

1.4 INTRODUCTION TO RESOURCE QUALITY OBJECTIVES

RQOs are numerical and/or descriptive statements about the biological, chemical and physical attributes that characterise a resource for the level of protection defined by its Class. The *National Water Resource Strategy* (NWRS) stipulates that "Resource Quality Objectives might describe, among other things, the quantity, pattern and timing of instream flow; water quality; the character and condition of riparian habitat, and the characteristics and condition of the aquatic biota".

1.5 OPERATIONAL SCENARIOS, WATER RESOURCE CLASS AND RQOS

Operational scenarios, Water Resource Classes and RQOs are inherently linked as operational scenarios (Sc) to inform the Water Resource Class, and RQOs define and/or describe the Water Resource Class (**Figure 1.3**).

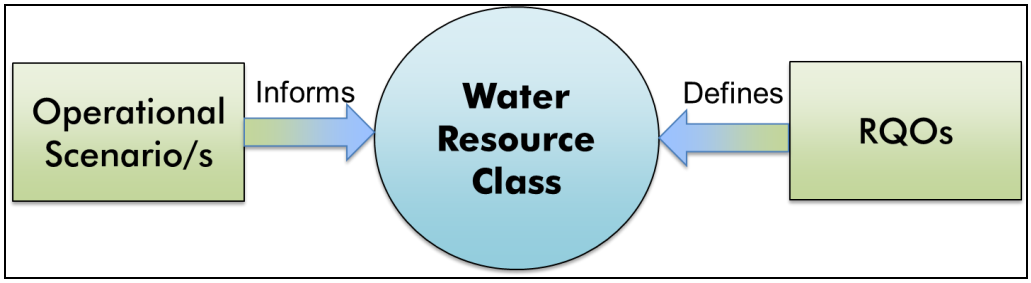

Figure 1.3 Links between RQOs and the Water Resource Class and operational scenarios

1.6 REPORT OUTLINE

The report outline is as follows:

- **Chapter 1** provides general background information on the study area and the Project Plan.
- **Chapter 2** outlines the legislative context for RQOs in estuaries.
- **Chapter 3** details the approach followed in setting estuary RQOs estuaries.
- **Chapter 4** summarises the RQOs of the individual estuaries in the Water Management Area (WMA).
- **Chapter 5** lists the references used in the report.
- **Chapter 6** is an Appendix that outlines key estuary habitats.

2 LEGISLATIVE CONTEXT FOR RQOs IN ESTUARIES

2.1 ESTUARY MANAGEMENT

Government response to mitigating the deterioration of South Africa's estuaries is manifested in two pieces of key legislation, namely the National Water Act (Act 36 of 1998) and the National Environmental Management: Integrated Coastal Management (ICM) Act (Act 24 of 2008).

- South Africa's National Water Act (1998) recognises the right to water for aquatic ecosystems, only second to the right to water for basic human needs. The estuary freshwater requirements and RQOs are determined as part of the National Water Classification System provided for under this act.
- More recently, the ICM Act (2008) set out specific requirements for the development of a National Estuarine Management Protocol (NEMP) for South Africa, as well as the development of individual estuarine management plans.

South Africa's estuaries have a diversity of management requirements, often unique to individual systems, and are governed by a variety of authorities, from national to local level (Van Niekerk *et al*., 2019). Therefore, estuary management must allow for a dynamic process that facilitates integrated cross-sectorial planning and implementation including stakeholders involved in land-use planning, and management of freshwater and marine resources, amongst others. Consequently, it was necessary to develop a flexible, but legally defensible NEMP guiding estuarine managers at all levels to develop sound management plans to suit individual systems. South Africa's NEMP was published in May 2013 and recently revised in 2021. The NEMP (as set out in the ICM Act) sets out to:

- Determine a strategic vision and objectives for achieving effective integrated management of estuaries;
- Set standards for the management of estuaries;
- Establish procedures or guide how estuaries must be managed and how the management responsibilities are to be exercised by different organs of state and other parties;
- Establish minimum requirements for estuarine management plans;
- Identify who must prepare estuarine management plans and the process to be followed in doing so; and
- Specify the process for reviewing estuarine management plans to ensure that they comply with the requirements of the ICM Act.

While the specific requirement for the development and implementation of estuarine management plans is stipulated in the NEMP (following the ICM Act), there are numerous existing management initiatives promulgated under other Acts that are also taking place in South Africa's estuaries. Key management initiatives to consider in individual estuarine management planning include:

- Biodiversity management plans (NEM: Biodiversity Act as articulated in the National Biodiversity Assessment (NBA) 2011 and future updates);
- Integrated Development Plans and Spatial Development Frameworks (Municipal Systems Act);
- Classification of water resources, including estuaries (National Water Act);
- Living resources management plans (Marine Living Resources Act); and
- Biodiversity targets and incorporation of the DWS water resource classification process.

2.2 BIODIVERSITY PROTECTION

In the NBA 2011 (Van Niekerk and Turpie, 2012) estuary biodiversity targets are defined in terms of achieving representation of ecosystem types, habitats and species, as well as meeting population targets that ensure their viability. The overall target was to protect a minimum of 20% of the total estuarine area. Targets for ecosystem type are sometimes used as a surrogate for biodiversity for which data are lacking. In NBA 2011, estuary ecosystem type was defined on the basis of mouth state, salinity structure, freshwater type and size, to align with the estuary ecosystem types used for the assessment of threat status and protection level in the NBA (see Van Niekerk and Turpie, 2012). Historically targets were set at 20% of the total area of each estuary type.

However, the Global Biodiversity Framework (GBF), signed by 196 nations on 19 December 2022 highlights the need to "take urgent action to halt and reverse biodiversity loss" by 2030. The GBF consists of four overarching global goals to protect nature, including: halting human-induced extinction of threatened species; sustainable use and management of biodiversity; fair sharing of the benefits from the utilization of genetic resources; and that adequate means of implementing the GBF be accessible to all Parties. The GBF targets include: Effective conservation and management of at least 30% of the world's land, coastal areas and oceans (Target 3); Restoration of 30 % of terrestrial and marine ecosystems (Target 2); and Climate change mitigation and adaptation including a focus on Blue Carbon (Target 8); and Restore, maintain and enhance nature's contributions to people, including ecosystem functions and services (Target 11). South Africa has committed to demonstrating progress towards meeting the 23 GBF targets by 2030, with the protection and restoration of key estuaries activity contributing towards these targets if they can be managed in a natural or near natural state (Department of Forestry, Fisheries and the Environment (DFFE) Reaching Target 3 of the Global Biodiversity Framework National Workshop[2] proceedings, 6 – 8 June 2023).

In response, many conservation agencies are now revisiting their existing conservation/biodiversity plans to include adjacent areas to meet higher expansion targets. The aMatigulu/iNyoni, iSiyaya, uMlalazi, uMhlathuze, uMgobezeleni and St Lucia/uMfolozi estuaries form part of this commitment to increased protection by 2030.

In addition to the global call for a 30% protection target for all ecosystem types, South Africa has also been identifying Critical Biodiversity Areas with the intent to sustain and protect coastal and estuarine biodiversity (Harris *et al*., 2023). As part of the spatial biodiversity planning process ecosystem type targets were set between 30 and 50% (with higher targets for rare types) and estuarine habitat targets (mangroves, salt marsh, submerged macrophytes and swamp forest) were all set at 100% to support climate protection and ecosystem services. The habitat that supports functional processes like fish nursery areas was also included with targets between 40 and 80% (with important nursery areas given higher targets), e.g. aMatigulu/iNyoni, uMlalazi, uMhlathuze, Kosi and St Lucia/uMfolozi. All the above will be considered in South Africa's drive to increase protection levels (GBF Target 3) and identify restoration areas in support of GBF Targets 2 and 3.

It should also be noted that because the Estuary Realm is the most degraded in South Africa (Van Niekerk *et al*., 2019), in many cases achieving the required protection levels (GBF Target 3) requires intensive restoration (GBF Target 2). Increased representative protection cannot be achieved without investment in restoration.

[2] https://www.dffe.gov.za/sites/default/files/docs/discussiondocument30.30workshop.pdf.

In the case of estuaries, protection is not only affected by localised management actions but also through ensuring adequate quantity and quality of freshwater flows into the estuary. Future flows into an estuary will be decided based on its Target Ecological Categories (A, B, C or D) determined under the National Water Resources Classification System (Dollar *et al*., 2010).

Note: Ideally, the outcome of the Water Resource Classification process should inform and support other estuary planning initiates and products developed as part of this process and aligned as much as possible with other management initiatives. However, water sector responses may diverge from other estuary management processes with the Water Resource Classification process planning processes at times not aligning/supporting long-term estuary management or estuary protection objectives. This may result in Estuary Management Plans, Protected Areas Plans (e.g. Park Plans) and/or Biodiversity Plans requiring higher condition categories than those indicated in the Target Ecological Category (TEC) to achieve biodiversity and fisheries management objectives.

3 APPROACH FOR DETERMINING RQOs FOR ESTUARIES

3.1 GENERAL APPROACH

Once the Integrated Unit of Analysis (IUAs) have been defined, Resource Units (RUs) and biophysical nodes must be identified for different levels of Ecological Water Requirement (EWR) assessment and the setting of RQOs. RUs are sections of a river system that frequently have different natural flow patterns, react differently to stress according to their sensitivity, and therefore require individual specifications of the Reserve appropriate for that reach. Management requirements (DWAF, 1999, volume 3) also play a role in the delineation. An example could be where large dams and/or transfer schemes occur. Furthermore, the type of disturbance/impact on the system also plays a role in selecting homogenous reaches from a biophysical basis under present circumstances.

Each estuary is sufficiently different in terms of state, functioning and management to form individual RUs. RU priority is based on the outcome of the Status Qua assessment (Step 1 of the integrated steps for the National Water Resource Classification (NWRC); DWA (2007) as well as available information. **All estuaries were prioritised for the development of RQOs. RQOs were developed as comprehensively as possible for all systems based on available information. The benefit of this is that it allows for alignment between legislation and the incorporation of the RQOs in the estuary management planning process under the ICM Act.**

Priority estuaries for evaluating RQOs against monitoring results:

- aMatigulu/iNyoni Estuary;
- iSiyaya Estuary;
- uMlalazi Estuary;
- uMhlathuze Estuary;
- iNhlabane Estuary;
- uMgobezeleni Estuary;
- Kosi Estuary; and
- St Lucia/uMfolozi Estuary.

3.2 ECOSPECs, TPCs AND RQOs

For the purpose of RQO determination, the following differentiation is made between EcoSpecs and RQOs (DWS, 2015).

EcoSpecs are associated with the Ecological Reserve process and are usually provided per estuary. EcoSpecs are seen as detailed or numerical RQOs as they are quantifiable, measurable, verifiable and enforceable to ensure the protection of all components of the resource, which make up ecological integrity (DWA, 2009a). Therefore, EcoSpecs are numerical and can be used for monitoring. TPCs are upper and lower levels along a continuum of change in selected environmental indicators and are used and interpreted according to the following guidelines (Rogers and Bestbier, 1997) and are linked to EcoSpecs. When setting EcoSpecs, the work is usually based on fieldwork that has been undertaken, a monitoring baseline is therefore available and monitoring to determine whether the specifications are being achieved (or Ecological Category) can be undertaken.

Where limited data is available RQOs are usually determined rather than EcoSpecs as the requirements for RQOs are broader or less detailed. This is inherently the case where detailed fieldwork has not been undertaken or historical data is not available. Where a monitoring baseline

is not available, EcoSpecs cannot be determined. Unlike EcoSpecs, RQOs also consider user requirements such as recreational water quality.

If sufficient data is not available to set specifications, broad objectives for the EC are provided only. RQOs in this format cannot be used in monitoring as is. Monitoring must be undertaken so that the objectives can be translated into EcoSpecs based on field surveys and the findings of the baseline monitoring.

3.3 FORMAT OF RQO COMPONENTS

RQOs are set for the short term (<5 years) for the following components:

- Quantity, pattern and timing of instream flow (hydrology);
- Hydrodynamics (e.g. mouth state);
- Water quality;
- Characteristics and condition of primary producers (e.g. microalgae and macrophytes); and
- Characteristics and condition of biota (e.g. fish and birds).

Hydrological RQOs are provided as a flow regime (described using a flow duration table) associated with the TEC for estuaries of the WMA. Groundwater driven systems were indicated as a percentage of natural inputs and Groundwater stress index value.

Water quality RQOs were set for all estuaries based on environmental requirements and national guidelines or standards. The water quality component is discussed in **Section 3.4.3**.

Habitat and biota are described as the habitat and biota associated with a TEC. The format of the RQOs is as follows:

- PES;
- Overall TEC; and
- Ecological objectives for components.

Detailed RQOs were developed for the estuaries of the region for the TEC. Where the RQOs do not meet the TEC a "↑" was used to indicate which individual components should improve to achieve the TEC. "X ➔Y" indicates the expected trajectory of change from the short-term RQO to meet the long-term TEC. A negative trajectory of change is indicated by a "**↓",** while "**↓↑"** indicates that the trajectory of change is not stable as is the case for the St Lucia/uMfolozi system.

3.4 APPROACH FOLLOWED IN DEVELOPING ESTUARY RQOs

3.4.1 Hydrodynamics

Ezemvelo KZN Wildlife weekly observational data on estuary mouth conditions along the KwaZulu-Natal coastline was collated for this study. The average percentage of time an estuary was open was derived from this data set. This formed the baseline for this project assessment and was used as the starting point for many of the hydrodynamics RQOs.

Where a detailed study was conducted and the mouth state information matches the observed information, RQOs are based on the selected scenario. If an estuary is very sensitive to flow modification (e.g. very small or shallow), in a protected area and/or in an A or B Category, a ±5% variation was allowed over a 5-year period. However, if an estuary was deemed to be more robust (e.g. large size, mouth protected) from a flow perspective and/or in a C to F Category, a 10 - 20%

variance from the current data set was allowed for over a 5-year period. Where more information was available it was incorporated into the RQOs.

3.4.2 Salinity

Salinity RQOs were derived from measured data, published information, extrapolated for similar systems or derived from the modelled condition in the EWR assessment. Key determining estuarine features used in setting the salinity RQOs were: estuary size, estuary depth, % mouth open and mouth position (i.e. perched/not perched). Historical data sets used include CSIR Harrison observations and DWS data sets.

3.4.3 Water Quality

For estuaries, unlike rivers, there are no official, numerical water quality RQOs specified for various health categories because of the diverse and site-specific nature of many of these variables in estuaries. However, for this study, where water quality RQOs had to be proposed for a large number of estuaries at a desktop level, it was necessary to develop a generic approach to derive such RQOs. Based on a general understanding of water quality characteristics in estuaries along this part of the KwaZulu-Natal (KZN) coast, as well as expert knowledge, target ranges were proposed for various water quality health categories as listed in **Table 3.1**.

Table 3.1 Proposed RQOs for water quality associated with ecosystem health for the estuaries

Variable	Health Category					
	A	B	C	D	E	F
Dissolved oxygen	Average in estuary ≥ 6 mg/l		Average in estuary ≥4 mg/l	Average in lower estuary ≥4 mg/l		
Turbidity	Estuary: Clear (<10NTU) accept during high flows			Estuary: Mostly clear (<15NTU) accept during high flows		
Dissolved inorganic nitrogen (DIN) in river inflow	50%ile <0.1 mg/l	50%ile <0.2 mg/l	50%ile <0.3 mg/l	50%ile <0.5 mg/l		
Dissolved inorganic phosphate (DIP) in river inflow	50%ile <0.01 mg/l	50%ile <0.015 mg/l	50%ile <0.025 mg/l	50%ile <0.125 mg/l		
Toxic substances	▪ RQOs for water are based on national guidelines issued by the government, originally DWAF but since 2008 it is the responsibility of DFFE. Presently the official guidelines for coastal water quality in South Africa is still those published in 1995 (DWAF 1995) (see **Table A1** in **Appendix A**). In 2008, the protection of coastal waters (including estuaries) became the responsibility of DFFE under the ICM Act. DFFE is in the process of revising the 1995 guidelines in which case these RQOs may have to be adjusted, where necessary. ▪ South Africa currently does not have official sediment quality guidelines for coastal areas (including estuaries). As an interim we therefore propose that such RQOs be derived from guidelines for the Western Indian Ocean Region (which includes this study area) (UNEP/Nairobi Convention Secretariat and CSIR, 2009) (see **Table A2** in **Appendix A**). However, the WIO region guidelines also are currently being updated in which case these RQOs may have to be adjusted, where necessary.					

These target RQOs are not cast in stone but are considered most appropriate for the level of assessment. For this study, the water quality RQOs were equated to the corresponding TEC category allocated to an estuary. Where the PES category for water quality was below the TEC category, water quality was identified as a potential risk and the water quality RQOs equivalent to the TEC category were proposed. Where the WQ PES category was higher than the TEC, the RQOs for the WQ PES were maintained as a precautionary approach until monitoring showed a relation was appropriate.

In terms of RQO for recreational use, the recommended targets proposed for South Africa's coastal marine waters were applied as summarised in **Table 3.2** (DEA, 2012).

Table 3.2 RQOs for recreational use specified as risk-based ranges for intestinal enterococci and *E. coli* (microbiological indicator organisms) (DEA, 2012)

Category	Estimated Risk per Exposure	Enterococci	*E. coli*
		(Count per 100 ml)	(Count per 100 ml)
Excellent	2.9% gastrointestinal (GI) illness risk	≤ 100 (95 percentile)	≤ 250 (95 percentile)
Good	5% GI illness risk	≤ 200 (95percentile)	≤ 500 (95 percentile)
Sufficient or Fair (minimum requirement)	8.5% GI illness risk	≤ 185 (90 percentile)	≤ 500 (90 percentile)
Poor (unacceptable)	>8.5% GI illness risk	> 185 (90 percentile)	> 500 (90 percentile)

In South Africa, the minimum requirement for recreational use is the "Sufficient or Fair" category. Therefore, any estuary used for contract recreation had to meet this RQO.

3.4.4 Microalgae

The RQOs were set for each estuary based on literature, field data and/or expert opinion informed by first-hand knowledge of the region's estuaries. RQOs were established for different estuaries based on the main groups occurring in them. These RQOs should be further developed and refined as part of the monitoring requirements of individual systems.

3.4.5 Macrophytes

The RQOs were set for each estuary based on available data and recent field surveys and those data can be considered as high confidence. For uMhlathuze macrophyte RQOs are based on historical data and remote sensing and are considered to be of lower confidence. Expert opinion and Google images were used to make the assessments. RQOs were generally set to maintain the distribution of current macrophyte habitats (10 - 20% change in area), maintain the integrity of the riparian zone and floodplain habitat and prevent the spread of invasive plants in both the water column and riparian zone. Increased nutrient input (e.g. agricultural return flow) to estuaries will result in reed encroachment, algal blooms and floating aquatic invasives such as water hyacinths. Estuaries with important mangrove and swamp forest habitats were identified where present.

3.4.6 Invertebrates

The RQOs were set for each estuary based on literature, field data and/or expert opinion informed by first-hand knowledge of the region's estuaries. RQOs were established for different estuaries based on the taxa occurring in them. These RQOs should be further developed and refined as part of the monitoring requirements of individual systems.

3.4.7 Fish

The RQOs were set for each estuary based on analysis of available data and expert opinion informed by first-hand knowledge of the estuaries. Preliminary fish lists (% abundance and frequency of occurrence) based on Harrison *et al*. (2000), literature, field surveys and expert opinion were drawn for the estuaries. These fish lists were used to establish RQOs and the RQOs are expressed as requirements based on a sampling trip. For example, a requirement that 18 species should occur in an estuary implies that 18 species should be sampled during a single sampling trip. Over several

trips, more than 18 species would be expected to have been recorded in the system. These RQOs should be further developed and refined as part of the monitoring requirements of individual systems.

3.4.8 Birds

The RQOs were set for each estuary based on analysis of available data and expert opinion informed by first-hand knowledge of the estuaries. Preliminary bird lists based on Coordinated Waterbird Counts (CWAC) counts, literature, field surveys and expert opinion were drawn for the different estuaries. These lists were then used to establish RQOs. These RQOs should be further developed and refined as part of the monitoring requirements of individual systems.

4 ESTUARY RQOs

4.1 W1-AMATIGULU/INYONI ESTUARY

The aMatigulu/iNyoni Estuary is sub-divided into four distinct zones, primarily based on bathymetry and geomorphology (**Figure 4.1**).

Figure 4.1 Zonation of the aMatigulu/iNyoni Estuary

The RQOs for the aMatigulu/Inyoni Estuary, to achieve the TEC, are presented in **Table 4.1**.

Table 4.1 RQOs for the aMatigulu/Inyoni Estuary to achieve the TEC

PES:	B/C ↓	REC:	B	TEC:	B

The following non-flow interventions will result in halting the negative trajectory and achieving the TEC:

- Undertake restoration of estuarine floodplain (Estuary Functional Zone - EFZ) and reduce agriculture impacts in the supratidal area of the system.
- Control/manage the harvesting of Juncus and Phragmites to prevent over-exploitation (management plan in place).
- Curb/control illegal fishing activities (e.g., gill netting) to improve nursery function and prawn abundance (bycatch) and increase community educational and awareness.
- Control recreational activities in the lower reaches through zonation and improve compliance (e.g. development of an Estuary Management Plan and estuary zonation map).
- Improve protection levels through Contracted Conservation on the North Bank - part of the DFFE 30 x 30 Estuary Protection Priorities which include expanding uThukela Marine Protected Area (MPA).
- Promote tourism (e.g., bird guides) to reduce impacts and provide benefits to the community.
- Implement interventions (e.g., agricultural best practices, development of farm plans) within the catchment and institute a buffer of natural vegetation along length of the river to improve the nutrient status and help with sedimentation issues.
- Remove invasive aliens to improve baseflows.

Component/ indicator	TEC	RQO
Hydrology	C	Maintain TEC (>63%). Protect the flow regime to create the required habitat for birds, fish, macrophytes, microalgae and water quality: ▪ River inflow distribution patterns (flood components) should not differ by more than 10% (in terms of magnitude, timing and variability) from that of the Present State – (MAR = 113.77 x10^6 m^3)(DWS, 2023a). ▪ River inflow distribution patterns should not differ by more than 5% from that of the Present State (i.e. approved flow scenario for the aMatigulu/iNyoni). ▪ Monthly river inflow should not be < 0.75 m^3/s for more than 17% of the time. ▪ Monthly river inflow should not be < 10.0 m^3/s for more than 65% of the time.
Hydrodynamics	B	Maintain Target EC (>78%). Maintain mouth conditions to protect estuarine ecosystems and the associated habitat for birds, fish, macrophytes, microalgae and water quality (DWS, 2015a; 2023a): ▪ Mouth closure occurs less than 6 - 8 weeks in a year. ▪ Mouth closure occurs for less than 3 - 4 years out of ten. ▪ Mouth closure occurs between September and March. ▪ Changes in tidal amplitude at the tidal amplitude should be <20% from Present State (DWS, 2015a) (mouth in the northern position, if mouth moves south the average tidal amplitude is expected to increase by 30 - 50%.
Physical habitat (sediments)	B	Maintain the TEC (>78%). Protect estuarine sediment distributions suitable habitat for estuarine biota: ▪ River inflow distribution patterns (flood components) are <20% (in terms of magnitude, timing and variability) from that simulated for the present state (refer to DWS, 2015a). ▪ Suspended sediment concentration in river inflow not to deviate by more than 20% of sediment load-discharge relationship of the present state (refer to DWS, 2015). ▪ No deviation in sedimentation and erosion patterns in the estuary should occur from the present baseline (refer to DWS, 2015).
		Changes in sediment grain size distribution patterns not to cause exceedance tolerance of benthic invertebrates: ▪ Median bed sediment diameter should not deviate by more than a factor of two from levels of the present baseline (refer to DWS, 2015a). ▪ Sand/mud distribution in middle and upper reaches should change <20% from the present baseline (refer to DWS, 2015). ▪ Changes in tidal amplitude at the tidal gauge should change <20% from the present baseline (refer to DWS, 2015) as a result of sediment processes.
Water quality (salinity)	A	Maintain TEC (>93%). Salinity regime to maintain TEC for dependent biotic components (DWS 2015a; 2023a). ▪ Salinity values >5 in the upper reaches (End of Zone B/ beginning of Zone C) of the estuary. ▪ Salinity values >10 in middle reaches (Zone B) during the low flow season. ▪ Salinity values <5 in middle reaches (Zone B) and <15 in the lower reaches (Zone A) during closed mouth periods. ▪ Salinity values >5 in the iNyoni Arm about 1 km from the confluence. ▪ Salinities should not decrease by >20% in each of the reaches except during high flow freshwater dominated conditions. Salinities should not drop below 10 in the lower and middle reaches, except for short periods during the high flow freshwater state, to allow macrocrustacea larval development.

Water quality (general)	**C**	Maintain the TEC (>63%). Water quality to be suitable for maintaining the TEC for dependent biotic components (DWS, 2023a). River inflow: ▪ 7.5 < pH > 8.5 consistently over 2 months. ▪ DO >6 mg/l. ▪ Turbidity <15 NTU (low flow). ▪ Turbidity high flows naturally turbid ▪ Flows <5 m^3/s: NO_x-N <200 µg/l over 2 months (NO_x-N refers to Nitrate-N + Nitrite-N); NH_3-N<30 µg/l over 2 months; PO_4-P <50 µg/l over 2 months. ▪ Flows >5 m^3/s: Average DIN <300 µg/ℓ; Average DIP <50 µg/ℓ. ▪ Toxic substances (water): See **Table A1** in **Appendix A**. ▪ Toxic substances (sediment): See **Table A2 in Appendix A**. Estuary: ▪ Average turbidity <10 NTU (low flow). ▪ Turbidity high flow, naturally turbid. ▪ 6.0 < pH > 8.5 in a sampling survey (to be verified by sampling) ▪ Average DO >6 mg/ℓ in a sampling survey. ▪ River flow <5 m^3/s): Average NOx-N <200 µg/l; Average NH_3-N <30 µg/l; Average PO_4-P <50 µg/l in a sampling survey. ▪ River flow >5m^3/s): Average NOx-N <300 µg/l; Average NH_3-N <20 µg/l; Average PO_4-P <50 µg/l in a sampling survey. ▪ Toxic substances (water): See **Table A1** in **Appendix A**. ▪ Toxic substances (sediment): See **Table A2** in **Appendix A**. For recreational use areas in estuary (see details in DEA, 2012): ▪ Enterococci <185 counts per 100 ml (90 percentile), and ▪ *E. coli* <500 counts per 100 ml (90 percentile).
Microalgae	**B**	Maintain the TEC (>78%) through: Maintain the current composition, richness, and abundance of phytoplankton and benthic microalgal assemblages. No harmful algal bloom (HAB) species, unless constrained to Zone A during open mouth conditions (i.e., marine origin) (DWS, 2023a). **Phytoplankton:** ▪ 90^{th} percentile value (i.e., entire estuary) for phytoplankton biomass <10 µg Chl-*a* l^{-1}. ▪ No bloom conditions (represented by values >20 µg Chl-*a* l^{-1}); even isolated instances. ▪ No presence of potentially HAB-forming taxa. **Benthic Microalgae:** ▪ Average Microphytobenthos (MPB) biomass <50 mg Chl-*a* m^{-2}. ▪ Average benthic diatom diversity (H') >3. (Based on average values recorded throughout estuary).
Macrophytes	**B**	Maintain the TEC (>78%) through: ▪ Maintain the distribution of macrophyte habitats to present baseline, particularly the large Swamp Forest stands (>300 ha) and presence of submerged macrophytes (refer to **Appendix B** and DWS, 2023a). ▪ <10% change in the area covered by different macrophyte habitats, especially swamp forest and submerged macrophytes. ▪ Invasive plants (e.g. syringa berry, Brazilian pepper tree, lantana, *Chromolaena*, *Opuntia*) should be largely absent from the riparian zone. ▪ No unvegetated, cleared areas along the banks. ▪ Floating invasive aquatics should not be observed in the upper estuary reaches. ▪ Macroalgae cover should be <20% of estuarine water surface area. ▪ Sugarcane should not be present in the estuarine functional zone. ▪ There should not be extensive land cover change of natural land in the iNyoni and aMatigulu EFZ – less than 5% change from 2023.
Invertebrates	**B**	Maintain the TEC (>78%) through (DWS 2015a, 2023a): ▪ Maintain current zooplankton, zoobenthic and macrocrustacea abundance (including seasonal variation) and species richness in each of the estuary regions. <10% decrease in macrobenthic densities in terms of numbers per m^{-2} over estuarine area (at least Zones A - C). ▪ Polychaetes, amphipods and tanaids should numerically dominate during all seasons. However, abundance of all taxon groups should be higher during spring before summer high flow and decline during the winter, low flow periods. ▪ No increase in distribution and relative abundance of invertebrate alien species currently present. Invasive snail *Tarebia granifera* distribution should be limited to Zones C and D and present <20% of the abundance in any sample. No new alien species (especially molluscs in any reach, in any sample). ▪ No shift in prawn community from current balanced marine-freshwater assemblage in the middle reaches towards freshwater dominated assemblage. i.e. Carid prawns

		should not dominate in the Zone A and migrating species (e.g., *Macrobrachium* and *Varuna* should be present in Zones B - D). ▪ <20% decrease in abundance of zooplankton in terms of numbers per m^{-2} over entire estuarine area (from at least 3 sites) over 3 years ▪ Regionally endemic species to be retained; *Paratylodiplax blephariskios* present in annual samples from Zones A and B.
Fish	**B/C**	Maintain the TEC (>73%) through (DWS 2015a, 2023a): ▪ <20% decline in abundance (to be defined as an average with prediction limits) of marine estuarine-opportunist species and estuarine-dependent species as juveniles. ▪ Marine estuarine-opportunist species should occur throughout Zone A and into the lower reaches at least of Zones B and D. *Sillago sihama, Platycephalus indicus* and *Stolephorus* spp. should always occur. *Hilsa kelee, Bothus pantherinus* (or *Pseudorhombus arsius*), *Sphyraena* spp., *Thryssa* spp. *Amblyrhynchotes honckenii* should occur in at least one sampling session over a two consecutive year period. ▪ All zones of the estuary should function as high value nursery habitat to a diversity of marine estuarine-dependent species with all of the following species occurring in the estuary in two consecutive years: *Leiognathus equula, Acanthopagrus vagus, Pommadasys commersonnii, Terapon jarbua, Rhabdosargus sarba, Rhabdosargus holubi, Caranx* spp. Mullet should occur throughout the system (all zones) every year. *Pseudomyxus capensis, Mugil cephalus, Osteomugil cunnesius, Planiliza macrolepis, Chelon dumerilii* occur in all zones of the estuary at a full array of size classes. ▪ Permanent populations of estuarine resident species should occur throughout the system. *Ambassis ambassis* (or *Ambassis natalensis*) and *Glossogobius callidus* are all present and abundant in the estuary (except during floods). *Croilia mossambica* occurs in the estuary, being sampled at least once every two consecutive years. ▪ A good trophic basis must exist for predatory (piscivorous) marine estuarine-dependant and opportunist species. Piscivorous fishes (e.g. *Agyrosomus japonicus*, *Caranx* spp.) occur in the estuary. ▪ Freshwater fishes should be limited in their distribution through the system. *Oreochromis mossambicus* is the most abundantly occurring freshwater species and is limited to the Zone C and the upper reaches of Zones B and D in the low flow period. ▪ The species assemblage should comprise indigenous species only. No non-indigenous fishes should occur.
Birds	**B**	Maintain the TEC (>78%). Maintaining avifaunal community that includes representatives of all original groups as per present baseline (refer to DWS, 2015; 2023a). ▪ Resident pair of African Fish Eagle present and breed successfully. ▪ Cormorants and/or herons/egrets: No significant reduction in numbers (<20%). ▪ Migratory waders, especially of estuarine-dependent species: No significant reduction in numbers (<20%). ▪ Waterfowl (ducks and geese): No significant reduction in numbers (<20%). ▪ Whole waterbird community: No significant reduction in numbers (<20%). ▪ Tern and gull roost at mouth: No significant reduction in numbers (<20%).

4.2 W13-ISIYAYA ESTUARY

The iSiyaya Estuary is sub-divided into two distinct zones, primarily based on bathymetry and geomorphology (**Figure 4.2**).

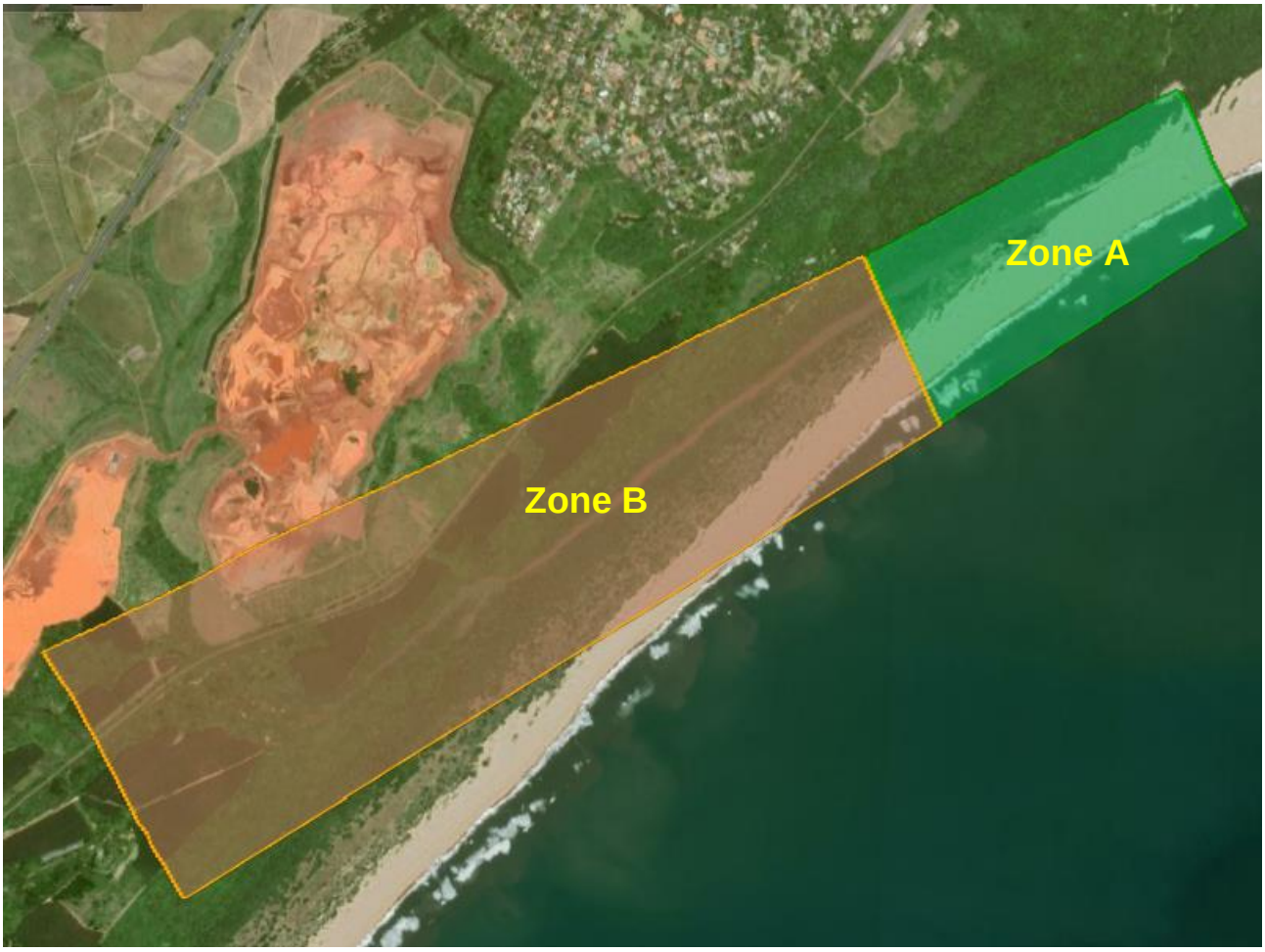

Figure 4.2 Zonation of the iSiyaya Estuary

This system is in a provincial park and forms part of the uThukela MPA and is on a negative trajectory. Regardless of the TEC, non-flow interventions need to address negative trajectory. The RQOs for the iSiyaya Estuary, to achieve the TEC, are presented in **Table 4.2**.

Table 4.2 RQOs for the iSiyaya Estuary to achieve the TEC

PES:	**D/E↓**	**REC:**	**C**	**TEC:**	**D (Short term)** **C (Long-term**

The following interventions will result in halting the negative trajectory and achieving TEC:

An Ecosystem-based adaptation restoration project embedded in an Estuary Management Plan is needed to restore the iSiyaya Estuary's functionality. In the short term (<5 years) several mechanical interventions are needed to restore estuarine functionality:

- Remove accumulated organic sludge through dredging of the bottom substrate to improve water quality, i.e., increase oxygen in the water column. This is a once-off intervention but may need to be repeated every 10 - 20 years if marine connectivity and water quality do not improve.
- Mechanical removal of reeds in lower reaches to increase open water area (once-off).
- When the mouth has been closed for long periods, it may require mechanical removal of sediment that build up at the mouth to allow for overwash recruitment and breaching. This may also require deepening the estuarine channel and /or bringing the openwater area forward by removing marine sand at the mouth. Given that the removal of 5 m^3 of sediment at an estuary triggers the Environmental Impact process (National Environmental Management Act No. 107 of 1998), removal of organic sludge and skimming/reshaping of the berm will require the development of an Estuary Mouth/Maintenance Plan to guide the management authority on when such an action is needed. The plan also needs to consider the location of submarine cable to the north of the system.

- Revegetate the dune at the mouth.

In the long-term (5 - 10 years), a “catchment-to-coast” approach needs to be taken given this is a small river basin including:

- Mitigate the impacts of mining by ensuring a 1 km buffer zone of riparian vegetation around the estuary to reduce the turbidity signal and sediment input from mining. Note: Forestry in and around the EFZ has removed the natural buffer capacity riparian vegetation provides.
- Reduce the direct impact of forestry on the estuary by instituting buffer zones around the estuary (e.g., 1 km zone), while over longer time scales baseflows should be restored by an overall reduction in forested areas in the catchment.
- Pioneer different footpaths to the beach further north to reduce the disturbance of birds.
- Increase fishing compliance as fishing pressure will escalate if fish communities recover under restoration actions.
- Restore the upstream riparian zone and remove alien vegetation to assist with restoring baseflows and act as turbidity and nutrient filters.
- Develop a groundwater-surface water model to direct the use of groundwater resources and ensure the protection of estuary functionality and guide management of the plantations and woodlots. Note that a reduction of community woodlots may require the establishment of alternative livelihoods.

Component/ indicator	TEC	RQO
Hydrology	**B/C↑**	Maintain TEC (>63%). Protect the flow regime to create the required habitat for birds, fish, macrophytes, microalgae and water quality: River inflow patterns should not: ▪ Differ by more than 5% from that of Present State - (MAR = 3.39 x10^6 m^3) (2022) (DWS, 2023b). ▪ Monthly river inflow <0.05 m^3/s for more than 10% of the time. ▪ Monthly river inflow <0.5 m^3/s for more than 87% of the time.
Hydrodynamics	**D↑**	Maintain TEC (>43%). Maintain an open mouth conditions to protect estuarine ecosystems and the associated habitat for birds, fish, macrophytes, microalgae and water quality: ▪ Mouth closure occurs for <3%. ▪ Changes in tidal amplitude at the tidal amplitude of <20% from Present State (2022) (DWS, 2023b).
Physical habitat (sediments)	**B**	Maintain the TEC (>78%). Protect estuarine sediment distribution suitable habitat for estuarine biota (DWS, 2023b): ▪ River inflow distribution patterns (flood components) should differ by <20% (in terms of magnitude, timing and variability) from that of the Present State (2021). ▪ Suspended sediment concentration from river inflow should deviates by <20% of the sediment load-discharge relationship to be determined as part of baseline studies (Present State 2015). ▪ Findings from the bathymetric surveys undertaken as part of a monitoring programme should not indicate changes in the sedimentation and erosion patterns in the estuary have occurred (± 0.5 m).
		Changes in sediment grain size distribution patterns not to cause exceedance tolerance of benthic invertebrates (DWS, 2023b): ▪ The median bed sediment diameter should deviate by less than a factor of two from levels to be determined as part of baseline studies (Present State 2021). ▪ Sand/mud distribution in the middle and upper reaches change should be <20% from Present State (2022). ▪ Changes in tidal amplitude at the tidal gauge should be <20% from Present State (2022).
Water quality (salinity)	**B**	Maintain TEC (>78%). Salinity regime to maintain TEC for dependent biotic components (DWS, 2023b). ▪ Surface Salinity values >4 in the Lower reaches (Zone A) for more than 90% of the time (develop under persistent close mouth conditions). ▪ Bottom Salinity values between 5 - 10 should not occur in the Lower reaches (Zone A) for more than 90% of the time (develop under persistent close mouth conditions).
Water quality (general)	**D↑**	Maintain the TEC (>43%). Water quality to be suitable for maintaining the TEC for dependent biotic components (DWS, 2023b). **River Inflow and Estuary:** ▪ 7.5< pH >8.5. ▪ Turbidity <5 NTU. ▪ DO >6 mg/l (surface), >4 mg/l (bottom, when stratified). ▪ DIN <100 ug/l. ▪ DIP <10 ug/l. ▪ Toxic substances (water): See **Table A1** in **Appendix A**. ▪ Toxic substances (sediment): See **Table A2** in **Appendix A**.

		For recreational use areas in estuary (see details in DEA, 2012): ▪ Enterococci <185 counts per 100 ml (90 percentile), and ▪ *E. coli* <500 counts per 100 ml (90 percentile).
Microalgae	**C**	Maintain the TEC (>63%). Maintain phytoplankton and benthic microalgal assemblages and ensure no harmful algal bloom (HAB) species. **Phytoplankton:** ▪ 90th percentile value (i.e., entire estuary) for phytoplankton biomass <15 µg Chl-a l^{-1}. ▪ No presence of bloom conditions (represented by values >20 µg Chl-a l^{-1}); even isolated instances. ▪ No presence of potentially HAB-forming taxa. **Benthic Microalgae**: ▪ Average MPB biomass & <50 mg Chl-a m^2. ▪ Average benthic diatom diversity (H') >2.5. (*Based on average values recorded throughout estuary.
Macrophytes	**D➔C**	Maintain the TEC (>43%) through (DWS 2023b): ▪ Maintain the distribution of macrophyte habitats. Less than 10% change in the area covered by different macrophyte habitats (**Appendix B**; DWS (2023b)). ▪ Maintain the integrity of the riparian zone. No development in estuarine functional zone. No plantations or agriculture (e.g. sugarcane) in the estuarine functional zone. ▪ Invasive plants (e.g. syringa berry, Brazilian pepper tree, lantana, *Chromolaena*, *Opuntia*) are largely absent from the riparian zone. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth.
Invertebrates	**D➔C**	Maintain the TEC category (>43%) through: ▪ Species richness and invertebrate diversity should not decline further from site and seasonal averages: <10% change in plankton or benthic invertebrate community metrics in Zones A and B. ▪ A minimum of ten core of estuarine taxa should always be present in the system including Peracarida and Mollusca representatives, especially *Ceratonereis, Grandidierella, Americorophium, Iphinoe, Halmrapseudes, Melanoides* spp. In Zone A. ▪ Macrocrustacea (*Macrobrachium* and *Kraussillichirus*) reproduction occurs (salinities >5 in the lower and middle reaches, Zone A) and both taxa are consistently present. ▪ The open mouth state allows for recruitment of larger macrocrustaceans into the system and importantly adult *Varuna* emigration during summer and larval immigration in autumn (April/May). ▪ Chironomidae and Oligochaeta should not dominate a site (tolerant of low oxygen, especially <4 mg/l). ▪ Invasive snail *Tarebia granifera* distribution limited to Zone B, with no increase in distribution and relative abundance of invertebrate alien species. *T. granifera* to not outnumber collective abundance of resident estuarine species.
Fish	**D➔C**	Maintain the TEC category (>43%) through: ▪ <20% decline in abundance (to be defined as an average with prediction limits) of estuarine-dependent species as juveniles. ▪ All zones of the estuary should function as nursery habitat for a diversity of marine estuarine-dependent species. The greatest diversity and abundance of marine estuarine-dependent species occurs in the lower reaches of Zone A. *Rhabdosargus holubi* and several species of *Mugillidae* dominate the assemblage. All of the following species occurring in the estuary in two consecutive years: *Planiliza alata*, *Planiliza macrolepis* and *Pseudomyxus capensis*, *Mugil cephalus*, *Osteomugil cunnesius*, *Rhabdosargus holubi*, *Terapon jarbua*. ▪ Connectivity down the full length of the historic estuary and into the marine environment is maintained. Three species of mullet occur throughout the whole system (all zones) in all size classes. ▪ Permanent populations of estuarine resident species should occur throughout the system. *Ambassis* spp. *Gilchristella aestuaria and Glossogobius callidus* are all present in the estuary (except during floods). ▪ Freshwater species should be dominated by euryhaline forms. Freshwater estuarine-opportunist species also occur throughout, dominated by *Oreochromis mossambicus*. Freshwater stenohaline fishes are restricted to the upper reaches of Zone B. ▪ The species assemblage should comprise indigenous species only. No non-indigenous fishes should occur.
Birds	**D➔C**	Maintain the TEC (>43%) through: ▪ Given limited species richness and abundance of waterbirds, all species should be present and assessed. ▪ Tern/gull should be roosting at the mouth and threatened specialized waterbirds, e.g. African Finfoot and White-backed Night Heron, present in the system. ▪ No sustained loss of key species, especially any threatened specialized waterbird species.

4.3 W13-UMLALAZI ESTUARY

The uMlalazi Estuary is sub-divided into four distinct zones, primarily based on bathymetry and geomorphology (**Figure 4.3**).

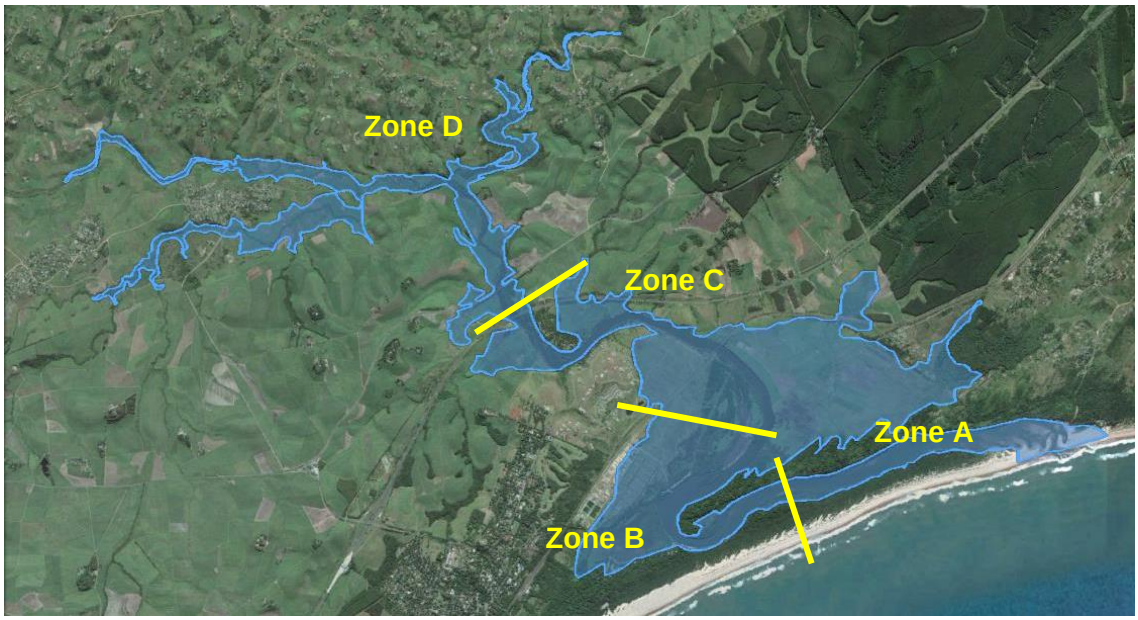

Figure 4.3 Zonation of the uMlalazi Estuary

The RQOs for the uMlalazi Estuary, to achieve the TEC, are presented in **Table 4.3**.

Table 4.3 RQOs for the uMlalazi Estuary to achieve the TEC

PES:	B/C🡻	REC:	B	TEC:	B

Components that require interventions to halt the negative trajectory and achieve TEC:

- Deteriorating water quality represents a significant threat to the ecological functioning of the system, the risk is especially high during the closed state. No wastewater should be discharged into the system RP and agricultural best practices should be implemented through farm plans to reduce nutrient-rich agriculture return flow. Address diffuse runoff from housing not on formal reticulation systems (supported through the Provincial Growth and Development Strategy). Look into innovative ways to manage wastewater in this area, e.g., artificial reed beds.
- Where possible, i.e. not build up, create interventions (e.g. replanting of natural vegetation, artificial wetlands, managing grazing) within a 500 m buffer zone around the EFZ to improve the nutrient status and reduce sediment inputs.
- Curb illegal fishing (i.e. gill netting) impacting nursery function and prawns (part of the bycatch).
- Undertake restoration of the uMlalazi EFZ and reduce agriculture impacts in the supratidal area of the system. Rewild banks and restore gentle slopes where possible along the banks of the estuary (investigate the option to remove hard structures of aquaculture facilities).
- Manage/control the harvesting of *Juncus* and *Phragmites* (refinement of existing plan).
- Curb recreational activities in the lower reaches through zonation and improved compliance (i.e. development of an Estuary Management Plan).
- Realign the protected area delineation with the EFZ to increase protection levels, including options for Stewardship/Contracted Conservation being undertaken on the North Bank. The system is a DFFE 30 x 30 priority targeted as part of uThukela MPA expansion.
- Manage disturbance to birds (e.g. closed areas, boating controls such as speed zones), including control of vehicle access at the mouth and promoting tourism (bird guides etc.) to reduce impacts and ensure the flow of benefits to the community.
- Remove/prevent sand-mining in the upper reaches of the system.
- Maintain hydrological connectivity by ensuring that roads and bridges do not impact tidal and river flows.
- Manage and control fires of riparian vegetation to protect mangroves.
- Remove invasive alien plants in the catchment to safeguard base flows to prevent mouth closure for periods longer than six to eight weeks and also prevent the water levels from going beyond 4m mean sea level (indicative of long closures).

Component/ indicator	TEC	RQO

Hydrology	C↑	Maintain TEC (>63%). Protect the flow regime to create the required habitat for birds, fish, macrophytes, microalgae and water quality (DWS, 2023c). River inflow patterns should not: ▪ Differ by more than 5% from that of Present State (MAR = 99.55 x10^6 m^3) (2022). ▪ Monthly river inflow <0.25 m^3/s for more than 1% of the time. ▪ Monthly river inflow between 0.25 - 0.5 m^3/s for more than 2% of the time. ▪ Monthly river inflow between 0.5 - 1.0 m^3/s for more than 29% of the time. ▪ Monthly river inflow between 1.0 - 15.0 m^3/s for less than 64% of the time. ▪ Monthly river inflow >15.0 m^3/s for less than 3% of the time.
Hydrodynamics	B/C	Maintain TEC (>73%). Maintain open mouth conditions to protect estuarine ecosystems and the associated habitat for birds, fish, macrophytes, microalgae and water quality (DWS 2015b; 2023c): ▪ Mouth closure occurs less than 2 - 4 weeks at a water level > 1.5 m mean sea level. ▪ Mouth closure occurs for less than 2 years out of ten. ▪ Mouth closure occurs between September and March. ▪ No changes in tidal amplitude at the tidal gauge of more than 20% from Present State (2015).
Physical habitat (sediments)	B	Maintain the Target EC (>78%). Protect estuarine sediment distribution suitable habitat for estuarine biota: ▪ River inflow distribution patterns (flood components) should differ by <20% (in terms of magnitude, timing and variability) from that simulated for the present state (refer to DWS, 2015b). ▪ Suspended sediment concentration in river inflow should deviate by <20% of the sediment load-discharge relationship of the present state (refer to DWS, 2015b). ▪ No deviation in sedimentation and erosion patterns in the estuary to occur from the present baseline (refer to DWS, 2015b).
		Changes in sediment grain size distribution patterns not to cause exceedance tolerance of benthic invertebrates: ▪ Median bed sediment diameter should not deviate by more than a factor of two from levels of the present baseline (refer to DWS, 2015b). ▪ Sand/mud distribution in the middle and upper reaches should change by <20% from the present baseline (refer to DWS, 2015b). ▪ Changes in tidal amplitude at the tidal gauge should be <20% from the present baseline (refer to DWS, 2015b) as a result of sediment processes.
Water quality (salinity)	B	Maintain TEC (>78%). Salinity regime to maintain TEC for dependent biotic components (DWS, 2023c). **Estuary open:** ▪ Salinity values <5 in the upper reaches (End of Zone C / beginning of Zone D) of the estuary. ▪ Salinity values <30 in middle reaches (Zone C) during the low flow season. **Estuary Closed:** ▪ Salinity values <10 in the upper reaches (End of Zone C/ beginning of Zone D) of the estuary. ▪ Salinity values >10 in middle reaches (Zone C). ▪ Salinity values >15 in the lower reaches (Zone A & B). **Average estuary salinity:** ▪ Salinity values >23 in Zone A. ▪ Salinity values <16 in Zone B. ▪ Salinity values <11 in Zone C. ▪ Salinity values <3 in Zone D.
Water quality (general)	C	Maintain the TEC (>63%). Water quality to be suitable for maintaining the TEC for dependent biotic components (DWS, 2023c). **River inflow:** ▪ 6 < pH > 8.5 consistently over 2 months. ▪ DO >6 mg/l. ▪ Turbidity: <15 NTU (low flow). ▪ Turbidity: High flows naturally turbid. ▪ Flow <5 m^3/s (closed states): Measured DIN <100 µg/l; Measured DIP <20 µg/l. ▪ Flow >5 m^3/s (open states): Measured DIN <130 µg/l; Measured DIP <20 µg/l. ▪ Toxic substances (water): See **Table A1** in **Appendix A**. ▪ Toxic substances (sediment): See **Table A2** in **Appendix A**. **Estuary:** ▪ Average turbidity <10 NTU (low flow). ▪ Turbidity high flow, naturally turbid. ▪ 6.0 < pH > 8.5. ▪ Average DO >5 mg/l in a sampling survey in surface water.

		▪ Flow <5 m^3/s (closed states): Measured DIN <20 µg/l (should be depleted as limiting nutrient); Measured DIP <50 µg/ℓ (may reflect some accumulation). ▪ Flow >5 m^3/s (open states): Measured DIN <100 µg/l; Measured DIP <20 µg/l. ▪ Toxic substances (water): See **Table A1** in **Appendix A**. ▪ Toxic substances (sediment): See **Table A2** in **Appendix A**. **For recreational use areas in estuary (see details in DEA, 2012):** ▪ Enterococci <185 counts per 100 ml (90 percentile), and ▪ *E. coli* <500 counts per 100 ml (90 percentile).
Microalgae	**C**	Maintain the TEC (>63%) through (DWS, 2023b): Maintaining the current composition, richness, and abundance of phytoplankton and benthic microalgal assemblages. No harmful algal bloom (HAB) species, unless constrained to Zone A during open mouth conditions (i.e., marine origin). **Phytoplankton:** ▪ 90^{th} percentile value (i.e., entire estuary) for phytoplankton biomass <15 µg Chl-*a* l^{-1}. ▪ No presence of bloom conditions (represented by values >20 µg Chl-*a* l^{-1}); even in isolated instances. ▪ No presence of potentially HAB-forming taxa (except during open mouth conditions and constrained to Zone A?). **Benthic Microalgae:** ▪ Average MPB biomass <50 mg Chl-*a* m^2. ▪ Average benthic diatom diversity (H') >3. (Based on average values recorded throughout estuary)
Macrophytes	**B/C**	Maintain the TEC (>73%) through: ▪ Maintain the distribution of macrophyte habitats to present baseline, particularly the large Swamp Forest stands (> 159 ha) and the presence of submerged macrophytes. (refer to **Appendix B** and DWS, 2023c). ▪ Less than 10% change in the area covered by different macrophyte habitats, especially mangroves, Swamp Forest and submerged macrophytes. ▪ Invasive plants (e.g. syringa berry, Spanish reed, black wattle, Brazilian pepper tree) are largely absent from the riparian zone. ▪ No unvegetated, cleared areas along the banks. ▪ Floating invasive aquatics observed in the upper estuary reaches. Macroalgae cover <20% of estuarine water surface area. ▪ No extensive land cover change in EFZ. ▪ **No additional** Sugarcane is present in the EFZ (2022) (Appendix A).
Invertebrates	**B**	Maintain the TEC (>78%) through (DWS, 2015b; 2023c): ▪ Maintain current zooplankton, zoobenthic and macrocrustacea abundance (including seasonal variation) and species richness in each of the Zones A - D. No decrease in abundance of zooplankton (<20%) in terms of numbers per m^2 from at least 3 sample sites, over 3 years, or for macrobenthos <15% change in numbers per m^2 from at least 5 sample sites, over 2 years. ▪ Species to include primarily estuarine affiliates but also freshwater representatives in the upper reaches and marine species at the mouth. ▪ Endemic or species with limited biogeographical distribution are maintained. No decrease in densities of *Paratylodiplax blephariskios* (<15% change in annual sample). To be targeted in Zone B, which is the limited habitat of this species. ▪ Abundance of all taxon groups are higher during spring before summer high flow periods and decline during the winter, low flow period. Macrofauna diversity seasonal ranges are 15 species (summer) to 40 species (winter). Zooplankton diversity ranges are 12 species (summer) to 20 (winter). Macrocrustaceans species ranges 8 - 15, indicating seasonal changes and recruitment to appropriate zones. ▪ Mouth to be open during peak recruitment periods for species with a life cycle dependent on an annual estuarine-marine link for larval and postlarval recruitment (mostly spring) for Penaeidae prawns and multiple Decapoda. ▪ Invasive snail *Tarebia granifera* distribution is limited to upper reaches with no occurrence outside of Zone D and <20% increase in abundance at any time of year. ▪ No shift in prawn community from marine dominated towards freshwater dominated assemblage. <20% decrease in relative abundance of estuarine dependent marine macrocrustaceans in Zones B - C, and no loss of marine species.
Fish	**B**	Maintain the TEC (>78%) through (DWS, 2015b; 2023c): ▪ Declines of <20% abundance (to be defined as an average with prediction limits) of marine estuarine-opportunist species and estuarine species as juveniles. ▪ Healthy transitional marine-estuary waters are maintained with good connectivity down the full length of the historic estuary and into the marine environment. Mullet do not occur throughout the system (all zones). All of the following mullet species occur in the system, *Pseudomyxus capensis, Mugil cephalus, Planiliza alata* (dominant in the upper reaches), *Osteomugil cunnesius, Planiliza macrolepis, Chelon dumerilii* (dominant in the lower reaches) at a full array of size classes.

		▪ Marine estuarine-opportunist species should occur throughout Zone A and into the lower reaches at least of Zones B. The following species occur in these reaches: *Bothus pantherinus* (or *Pseudorhombus arsius*), *Caranx* spp., *Chelonodon laticeps, Drepane longimana, Hilsa kelee, Platycephalus indicus, Pomadasys kaakan, Sillago sihama, Sphyraena jello, Stolephorus* spp, *Thryssa* spp. ▪ All zones (A - D) of the estuary should function as high value nursery habitat to a diversity of marine estuarine-dependent species. All of the following species (in addition to the mullet above) occur in the estuary in under normal (non-flood) flow conditions: *Leiognathus equula, Acanthopagrus vagus, Pommadasys commersonnii, Terapon jarbua, Rhabdosargus holubi, Caranx* spp., *Gerres filamentosus, Gerres methueni. Monodactylus argenteus, Pegusa nasuta.* ▪ Permanent populations of estuarine resident species should occur throughout the system. All three species of Ambassid occur (*Ambassis ambassis, Ambassis natalensis* and *Ambassis dussumieri*). At least three species of estuarine goby occur excluding mudskipper *Periophthalmus* spp. *Gilchristella aestuaria* occurs. ▪ Freshwater species are limited in their distribution to the upper reaches of the estuary. *Oreochromis mossambicus* distribution does not extend into Zone B and A for more than two consecutive years. ▪ A good trophic basis must exist for zooplanktivores (including several Clupeid species), benthivores, fishes that specialise in feeding on larger crustaceans and piscivores. Shifts if relative abundance of <20% (to be defined as an average with prediction limits) of *Gilchristella aestuaria* and other zooplanktivorous species (*Thryssa* spp. and *Stolephorus* spp.), benthivores (e.g. *Gerres* spp. and *Leiognathus equula*), fishes that specialise in feeding on larger crustaceans (e.g. *Pomadasys commersonnii*) and piscivores (*Agyrosomus japonicus*, *Caranx* spp.). ▪ The species assemblage should comprise indigenous species only. No non-indigenous fishes occur.
Birds	**B**	Maintain the TEC (>78%). Maintaining avifaunal community that includes representatives of all original groups as per present baseline (refer to DWS, 2015b; 2023c): ▪ Resident pair of African Fish Eagle present and breed successfully. ▪ Rare and highly specialized species, i.e. White-backed Night Heron, African Finfoot and Mangrove Kingfisher: No significant reduction in numbers (<20%). ▪ Cormorants and/or herons/egrets: No significant reduction in numbers (<20%). ▪ Migratory waders, especially of estuarine-dependent species: No significant reduction in numbers (20%). ▪ Waterfowl (ducks and geese): No significant reduction in numbers (<20%). ▪ Whole waterbird community: No significant reduction in numbers (<20%). ▪ Tern and gull roost at mouth: No significant reduction in numbers (<20%).

4.4 W12-UMHLATHUZE ESTUARY

For the purposes of this study, the system is thus sub-divided into six distinct zones, primarily to reflect the changes imposed on the system (**Figure 4.4**).

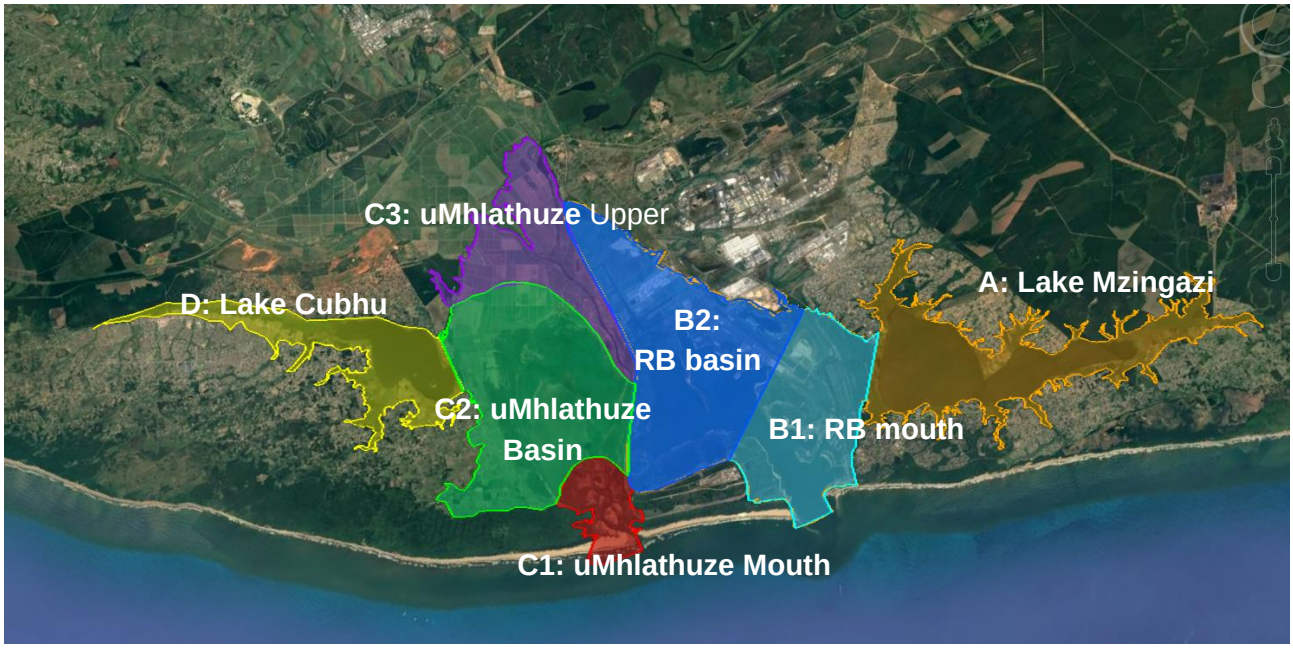

Figure 4.4 Zonation of the uMhlathuze Estuary

The RQOs for the uMhlathuze Estuary, to maintain the TEC, is presented in **Table 4.4**.

Table 4.4 RQOs for the uMhlathuze Estuary to maintain the TEC

PES:	D	REC:	D	TEC:	D

The following non-flow interventions will result in halting the negative trajectory and maintaining TEC:

Short term (<5 years): key interventions needed to restore/protect this important nursery area (e.g., sharks, rays and economically important fish species):

- Reduce very high fishing pressure (poaching and illegal gillnetting) by increasing compliance.
- Increase connectivity between lakes and downstream waters by reinstalling/installing functional fishways.
- Identify and protect areas in which the seagrass *Zostera capensis* reestablishment is occurring and reestablish/restore this important habitat near the yacht terminal.
- Improve access to uMhlathuze Estuary to allow for increased compliance, monitoring and research. Lack of access (through Port) leads to no oversight and results in no awareness of the high level of illegal activities.

Long term (5 - 10 years):

- Increase protection of mangrove areas by formal including in Sanctuary Protected Area (currently excluded from formal protection)
- Develop bird tourism (which will also improve access) that could provide livelihoods for local communities (e.g. Zululand Birding Route).
- Halt/restore declining water quality by instituting formal reticulation for urban development (supported through the Provincial Growth and Development Strategy) and implementing agricultural best practices (through the implementation of farm plans) to reduce nutrient enrichment to the estuary, lakes and port.

Component/ indicator	TEC	RQO
Hydrology	C	Maintain TEC (>63%). Protect the flow regime to create the required habitat for birds, fish, macrophytes, microalgae and water quality (DWS, 2023d): ▪ River inflow patterns should not: Differ by more than 5% from that of Present State 2022 (MAR = 289.59 x10^6 m^3) ▪ Monthly river inflow >0.5 m^3/s for more than 60% of the time. ▪ Monthly river inflow >20.0 m^3/s for more than 30% of the time. ▪ River inflow distribution patterns (flood components) differ by more than 10% (in terms of magnitude, timing and variability) from that of the Present State (2022) (DWS, 2023d).
Hydrodynamics	D/E	Maintain TEC (>38%). Maintain mouth conditions to protect estuarine ecosystems and the associated habitat for birds, fish, macrophytes, microalgae and water quality: The mouth should remain permanently open through an artificial mouth.
Physical habitat (sediments)	D	Maintain the TEC (>43%). Protect estuarine sediment distributions suitable habitat for estuarine biota: ▪ River inflow distribution patterns (flood components) should differ by <10% (in terms of magnitude, timing and variability) from that of the Present State (2022) (DWS, 2023d). ▪ Suspended sediment concentration from river inflow should deviate by less than 20% of the sediment load-discharge relationship to be determined as part of baseline studies (Present State 2022) (DWS, 2023d). ▪ Findings from the bathymetric surveys undertaken as part of a monitoring programme should not indicate changes in the sedimentation and erosion patterns in the estuary have occurred (± 0.5 m).
		Changes in sediment grain size distribution patterns not to cause exceedance tolerance of benthic invertebrates: ▪ The median bed sediment diameter should deviate by less than a factor of two from levels to be determined as part of baseline studies (Present State 2022) (DWS, 2023d). ▪ Sand/mud distribution in the middle and upper reaches should change by <20% from Present State (2022) (DWS, 2023d). ▪ Changes in tidal amplitude at the tidal gauge should be <20% from the Present State (2022) (DWS, 2023d).
Water quality (salinity)	C/D	Maintain TEC (>58%). Salinity regime to maintain TEC for dependent biotic components (DWS, 2023d). **Average flow condition:** ▪ Zone C1: <30 (Lower reaches). ▪ Zone C2: <25 (Middle reaches). ▪ Zone C3: <15 (Upper reaches). **Droughts:** ▪ Zone C1: 35 (Lower reaches). ▪ Zone C2: <30 (Middle reaches). ▪ Zone C3: <20 (Upper reaches).

Water quality (general)	**D**	Maintain the TEC (>43%). Water quality to be suitable for maintaining the TEC for dependent biotic components (DWS, 2023d). **Mhlathuze River inflow:** ▪ 7.5 < pH > 8.5. ▪ DO >6 mg/l. ▪ Turbidity <15 NTU (low flow). ▪ Turbidity high flows: Naturally turbid. ▪ DIN <200 µg/l. ▪ DIP <20 µg/l ▪ Toxic substances (water): See **Table A1** in **Appendix A**. ▪ Toxic substances (sediment): See **Table A2** in **Appendix A**.A **Mhlathuze Estuary:** ▪ Average turbidity <10 NTU (low flow). ▪ Turbidity high flow: naturally turbid. ▪ 7.5 < pH > 8.5. ▪ DO >6 mg/l. ▪ Zone C1: DIN <50 µg/ℓ; DIP <10 µg/l. ▪ Zone C2: DIN <100 µg/ℓ; DIP <15 µg/l. ▪ Zone C3: DIN < 200 µg/ℓ; DIP <20 µg/l. ▪ Toxic substances (water): See Table A.1 in Appendix A ▪ Toxic substances (sediment): See Table A.2 in Appendix A **For recreational use areas in estuary (see details in DEA, 2012):** ▪ Enterococci < 185 counts per 100 ml (90 percentile), and ▪ *E. coli* < 500 counts per 100 ml (90 percentile).
Microalgae	**D**	Maintain the TEC (>43%). Maintain the current microalgal assemblages, with a view to improvement where possible. Specifically, the loss of connectivity between the Zones has markedly reduced species richness (loss of salinity gradient) and abundance (habitat loss) (DWS, 2023d). **Phytoplankton:** ▪ Richards Bay (Zone B): 90th percentile value for phytoplankton biomass <5 µg Chl-a l^{-1}. ▪ uMhlathuze Estuary (Zone C): 90th percentile value for phytoplankton biomass <10 µg Chl-a l^{-1}. ▪ Lakes (Zone A and D): 90th percentile value for phytoplankton biomass <15 µg Chl-a l^{-1}. ▪ No presence of bloom conditions (represented by values >20 µg Chl-a l^{-1}); even isolated instances. ▪ No presence of potentially HAB-forming taxa. **Benthic Microalgae:** ▪ Richards Bay (Zone B): Basin (Zone B2): Average MPB biomass <50 mg Chl-a m^2; and Mouth (Zone B1): Average MPB biomass >10 mg Chl-a m^2 (i.e., to prevent further loss of available habitat). ▪ uMhlathuze Estuary (Zone C) and Lakes (Zone A and D): Average MPB biomass <50 mg Chl-a m^2. ▪ Entire system: Benthic diatom diversity (H') >3.
Macrophytes	**D**	Maintain the TEC (>43%) through: ▪ Maintaining the distribution of macrophyte habitats, for example, the small Zostera bed in Zone B2. Less than 10 % change in the area covered by different macrophyte habitats, particularly mangroves, Swamp Forest and *Zostera capensis* beds (see **Appendix B** and DWS, 2023d). ▪ Maintaining the integrity of the riparian zone. No invasive plants within the EFZ, from terrestrial to floating aquatic invasives, particularly in the Lakes. No unvegetated, cleared areas along the banks. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth.

Invertebrates	**E➔D**	Maintain the TEC (>23%) through: ▪ Macrobenthic and macrocrustacea abundance (including seasonal variation) and species richness in each estuary zones to not decrease by >20% and/or number of overall taxa not to decline to <100 in any sampling event. ▪ Macrobenthos to be represented by multiple taxa (from at least four phyla, including Annelida, Crustacea and Mollusca). ▪ Taxa indicative of stressed and/or organically enriched sediments should not dominate benthic abundance in all zones including A, C3 and D and whereby *Capitella capitata, Prionospio sexoculata* or *Oligochaeta* spp. represent <40% abundance at any site, during any season. ▪ Retain southern African and regionally endemic benthic species with no loss of any one of the core estuarine species for KZN estuaries (e.g., *Ceratonereis keiskama, Desdemona ornata, Dendronereides zululandica, Hymenosoma* sp.) during any survey. ▪ No loss of estuarine or marine macrocrustacea from Zones C2 and C1. *Penaeidae* prawns (at least 4 species) and crabs from *Portunidae* (at least 2 species) and *Grapsidae* (at least 2 species) to be present in all samples. ▪ Zone C3 should have consistent representation by catadromous prawns (*Macrobrachium, Varuna litterata*) and freshwater or freshwater tolerant carids (e.g., *Palaemon*). *Macrobrachium* and *Varuna* adults present in lower estuary in summer and *Varuna megalopae* are present in the estuarine channel during late autumn/early winter surveys. ▪ No shift in prawn community from balanced marine-freshwater assemblage towards freshwater or marine dominated assemblage. *Paratylodiplax blephariskios* to be present every year.
Fish	**D**	Maintain the TEC (>43%) through: ▪ Declines of <20% abundance (to be defined as an average with prediction limits) of marine estuarine-opportunist species and estuarine species as juveniles. ▪ Healthy transitional marine-estuary waters are maintained with good connectivity down the full length of the historic estuary and into the marine environment. Mullet do not occur throughout the system (all zones). All of the following mullet species occur in the system, *Pseudomyxus capensis, Mugil cephalus, Planiliza alata* (dominant in the upper reaches), *Osteomugil cunnesius, Planiliza macrolepis, Chelon dumerilii* (dominant in the lower reaches) at a full array of size classes. ▪ Functional connectivity is restored with Lakes Cubhu and Mzingazi. *Pseudomyxus capensis* occurs in Lakes Cubhu and Mzingazi. ▪ Marine estuarine-opportunist species should occur throughout Zone C1 and C2. The following species occur in these reaches: *Bothus pantherinus* (or *Pseudorhombus arsius*), *Caranx* spp., *Chelonodon laticeps, Amblyrhynchotes honckenii, Hilsa kelee, Platycephalus indicus, Pomadasys kaakan, Sillago sihama, Sphyraena jello, Stolephorus* spp, *Thryssa* spp. ▪ All zones of the estuary should function as high value nursery habitat to a diversity of marine estuarine-dependent species. All of the following species (in addition to the mullet above) occur in the estuary under normal (non-flood) flow conditions: *Leiognathus equula, Acanthopagrus vagus, Pommadasys commersonnii, Terapon jarbua, Rhabdosargus holubi, Caranx* spp., *Gerres filamentosus, Gerres methueni. Monodactylus argenteus, Pegusa nasuta.* ▪ Permanent populations of estuarine resident species should occur throughout the system. All three species of Ambassid occur (*Ambassis ambassis, Ambassis natalensis* and *Ambassis dussumieri*). At least three species of estuarine goby occur excluding mudskipper *Periophthalmus* spp. *Gilchristella aestuaria* occurs. ▪ Freshwater species are limited in their distribution to the upper reaches of the estuary. *Oreochromis mossambicus* distribution does not extend into Zone C2 or C1. ▪ A good trophic basis must exist for zooplanktivores (including several Clupeid species), benthivores, fishes that specialise in feeding on larger crustaceans and piscivores. Shifts in relative abundance of <20% (to be defined as an average with prediction limits) of *Gilchristella aestuaria* and other zooplanktivorous species (*Thryssa* spp. and *Stolephorus* spp.), benthivores (e.g. *Gerres* spp. and *Leiognathus equula*), fishes that specialise in feeding on larger crustaceans (e.g. *Pomadasys commersonnii*) and piscivores (*Agyrosomus japonicus*, *Caranx* spp.). ▪ The species assemblage should comprise indigenous species only. No non-indigenous fishes occur.
Birds	**C**	Maintain the TEC (>63%) by sustaining avifaunal community that includes representatives of all groups. ▪ Resident pair of African Fish Eagle present and breed successfully. ▪ Rare and highly specialized species, e.g. White-backed Night Heron, African Finfoot, Mangrove Kingfisher and Pels' Fishing-Owl: No significant reduction in numbers (<20%). ▪ Cormorants and/or herons/egrets: No significant reduction in numbers (<20%).

		▪ Migratory Palearctic waders, especially of estuarine-dependent species: No significant reduction in numbers (<20%). ▪ Waterfowl (ducks and geese): No significant reduction in numbers (<20%). ▪ Whole waterbird community: No significant reduction in numbers (<20%). ▪ Tern and gull roost at mouth: No significant reduction in numbers (<20%). ▪ No loss of piscivores, especially swimming species, due to entanglement in gill-netting.

4.5 W12-INHLABANE ESTUARY

For the purposes of this study, the system is thus sub-divided into three distinct zones, primarily to reflect the changes imposed on the system (**Figure 4.5**).

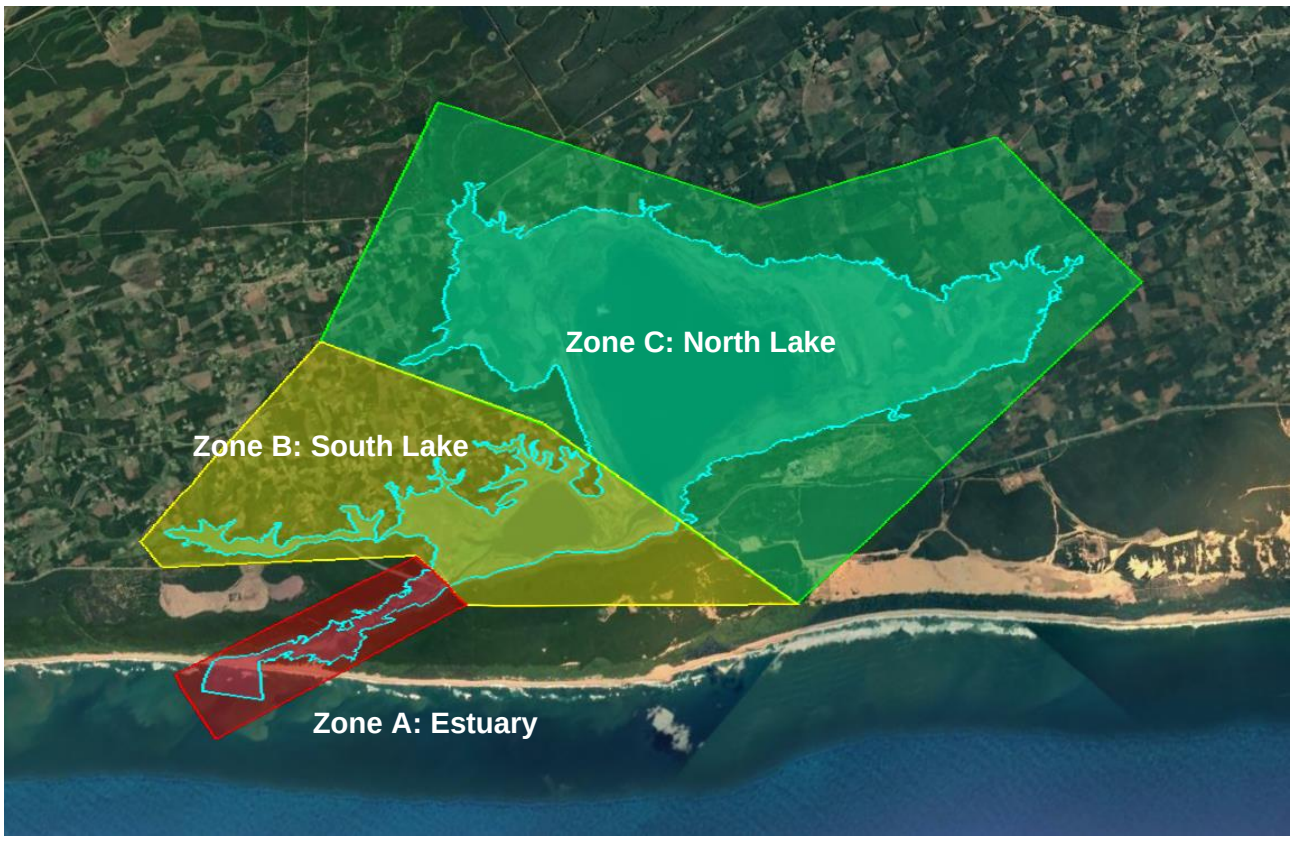

Figure 4.5 Zonation of the iNhlabane Estuary

The RQOs for the iNhlabane Estuary, to achieve the TEC, is presented in **Table 4.5**.

Table 4.5 RQOs for the iNhlabane Estuary to achieve the TEC

PES:	E↓	REC:	D	TEC:	D

The following non-flow interventions will result in halting the negative trajectory and maintaining TEC:

- Develop an Estuary Management Plan (requirement of the Integrated Coastal Management Act) for the iNhlabane Estuarine Lake System to identify key actions and coordinate restoration efforts.
- Develop an Estuary Mouth/Maintenance Management Plan to facilitate skimming of the berm at the mouth (>3.0 m mean sea level) and/or artificial breaching of the estuary. Note: Removal of 5 m^3 of sediment at the estuary triggers the need for EIA approval.
- Remove accumulated organic sludge with earth-moving equipment/dredging from the bottom strata to improve water quality (i.e., oxygen levels) in the system. This is a once-off intervention if water quality and marine connectivity improve, else may need to be repeated every 10 to 20 years.
- Ensure connectivity between the estuary and the various parts of the lakes. The current fishways are not functional. Increase connectivity between the estuary and various parts of the lakes by flow releases from the weir and possible reengineering of the fishway.
- Prevent disturbance of riparian vegetation, including trampling, cattle, fire, and removal of alien vegetation.
- Deteriorating water quality represents a significant threat, the risk is especially high during the closed state. Address diffuse runoff from housing not on formal reticulation systems. Look into innovative ways to manage wastewater in this area, e.g., artificial reed beds. No wastewater discharges (sewage or industrial) should be discharged into the lakes or estuary. Proactive regional strategic planning (e.g. in Provincial Growth and Development Strategy) is needed in the area to reduce the impact of future developments, for example, the disposal of waste is a key issue -waste cannot run into closed estuaries and lakes. Institute agricultural best practices (through the development of farm plans) to reduce nutrient-rich agriculture return flow.
- Increase freshwater runoff to estuaries and lakes through management/removal of unauthorised wood lots/plantations and removal of invasive alien vegetation species.

Component/ indicator	TEC	RQO
Hydrology	D	Maintain TEC (>43%). Protect the flow regime to create the required habitat for birds, fish, macrophytes, microalgae and water quality (DWS, 2023e): ▪ River inflow distribution patterns should not differ by <5% from that of restoration scenario (MAR = 26.35 x106 m^3). ▪ Historical EWR: Fishway continuous discharges 0.1 m^3/s. To improve marine connectivity the estuary requires 175 000 m^3 to fill up and breach, historical EWR specifies 33 m^3/s for 9 hours every 2 years. Such flow release will also result in variable lake levels which will also benefit water birds in the lakes. Drawdown of the lakes should not be at levels that could separate North and South Lakes.
Hydrodynamics	C/D	Maintain TEC (>58%). Maintain mouth conditions to protect estuarine ecosystems and the associated habitat for birds, fish, macrophytes, microalgae and water quality: ▪ Mouth closure occurs for 25% of the time.
Physical habitat (sediments)	E➔D	Maintain the TEC (>23%). Protect estuarine sediment distributions suitable habitat for estuarine biota (DWS, 2023e): ▪ River inflow distribution patterns (flood components) should differ by <20% (in terms of magnitude, timing and variability) from that of the Restoration scenario (2022). ▪ Suspended sediment concentration from river inflow should deviate by <20% of the sediment load-discharge relationship to be determined as part of baseline studies (Present State 2022). ▪ Findings from the bathymetric surveys undertaken as part of a monitoring programme should not indicate no changes in the sedimentation and erosion patterns in the estuary have occurred (± 0.5 m).
		Changes in sediment grain size distribution patterns not to cause exceedance tolerance of benthic invertebrates: ▪ Median bed sediment diameter deviates by less than a factor of two from levels of the present baseline (to be determined). ▪ Sand/mud distribution in the middle and upper reaches changed by <20% from the present baseline (to be determined). ▪ Changes in tidal amplitude at the tidal gauge change less than 20% from the present baseline (to be determined) as a result of sediment processes.
Water quality (salinity)	E➔D	Maintain TEC (>23%). Salinity regime to maintain TEC for dependent biotic components (DWS, 2023e). ▪ Bottom Salinity values >5 in the lower reaches (Zone A) of the estuary for 20% of the time.
Water quality (general)	D	Maintain the TEC (>43%). Water quality to be suitable for maintaining the TEC for dependent biotic components. **River inflow:**

		▪ 7.5 < pH > 8.5 consistently over 2 months. ▪ DO >6 mg/l. ▪ Turbidity <15NTU (low flow). ▪ Turbidity high flows naturally turbid. ▪ Inflow <5 m^3/s: NO_x-N <200 µg/l over 2 months; NH_3-N <30 µg/l over 2 months; PO_4-P <50 µg/l over 2 months. ▪ Inflow >5 m^3/s): Average DIN <300 µg/l; Average DIP <50 µg/l. ▪ Toxic substances (water): See Table A.1 in Appendix A ▪ Toxic substances (sediment): See Table A.2 in Appendix A **Estuary:** ▪ Average turbidity <10 NTU (low flow). ▪ Turbidity high flow, naturally turbid. ▪ 6.0 < pH > 8.5 in a sampling survey (to be verified by sampling). ▪ Average DO >6 mg/l in a sampling survey. ▪ Inflow <5 m^3/s: Average NO_x-N <200 µg/ℓ; Average NH_3-N <30 µg/l; Average PO_4-P <50 µg/l in a sampling survey. ▪ Inflows >5 m^3/s: Average NO_x-N <300 µg/ℓ; Average NH_3-N <20 µg/ℓ; Average PO_4-P <50 µg/ℓ in a sampling survey. ▪ Toxic substances (water): See **Table A1** in **Appendix A**. ▪ Toxic substances (sediment): See **Table A2** in **Appendix A**. **For recreational use areas in the estuary (see details in DEA, 2012):** ▪ Enterococci <185 counts per 100 ml (90 percentile), and ▪ *E. coli* <500 counts per 100 ml (90 percentile).
Microalgae	**D**	Maintain the TEC (>43%). Maintain the current microalgal assemblages, with a view to improvement. Specifically, the loss of marine connectivity in Zone A, as well as the loss of connectivity between the estuary and lakes, has markedly reduced species richness (mouth predominantly closed) and abundance (habitat loss) (DWS, 2023e). **Phytoplankton:** ▪ Estuary (Zone A): 90th percentile value for phytoplankton biomass <15 µg Chl-a l^{-1}. ▪ Lakes (Zone B and C): 90th percentile value for phytoplankton biomass <10 µg Chl-a l^{-1}. ▪ No presence of bloom conditions (represented by values >20 µg Chl-a l^{-1}); even in isolated instances. ▪ No presence of potentially HAB-forming taxa. **Benthic Microalgae:** ▪ Estuary: Average MPB biomass <50 mg Chl-a m^{-2} and benthic diatom diversity (H') > 2.5. ▪ Lakes: Average MPB biomass <10 mg Chl-a m^{-2} (i.e., to prevent further loss of available habitat) and benthic diatom diversity (H') >2. (*Based on average values recorded throughout estuary)
Macrophytes	**C/D**	Maintain the TEC (>58%) through: ▪ Maintain the distribution of macrophyte habitats with less than 10% change in the area covered by different macrophyte habitats – **Appendix B** and DWS (2023e). ▪ Maintain the integrity of the riparian zone by flooding and low nutrient levels: No unvegetated, cleared areas along the banks. No invasive plants (e.g. syringa berry, Brazilian pepper tree, lantana, *Chromolaena*, *Opuntia*) are largely absent from the riparian zone. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ No sugarcane in the EFZ (estuarine functional zone). ▪ No development or land cover change (e.g. mining, agriculture, plantations) in EFZ.
Invertebrates	**E➔D**	Maintain the TEC category (>23%) through: ▪ Invertebrate taxon components or community attributes should not decline further at any site, in any season. Thresholds are >5% change in plankton or benthic invertebrate community metrics (e.g., richness, diversity and evenness) and decline in macrobenthic densities by >5% (no.m^{-2}) in Zones A - C. ▪ Core of estuarine taxa to return to the system through over wash or open mouth conditions (Zone A), this is a potential recruitment pool for the remainder of the estuary and should be further present in at least the lower reaches of Zone A. ▪ A minimum of four core of estuarine taxa should always be present in Zone A with at least representatives from Mollusca. ▪ Distribution and relative abundance of invertebrate alien species (e.g., *Tarebia granifera*) to be < 25% of abundance at any site in Zones A - C. Invasive snails are limited to littoral margins of Zones B/C. ▪ Hypoxia tolerant *Chironomidae* and *Oligochaeta* should not dominate any site (DO <4 mg/l in >40% of the estuary). ▪ Freshwater prawns present in the estuary and lakes, and represented by multispecies communities, particularly in Zones B - C. ▪ Relict estuarine peracarids always found in Zones B-C with *Halmrapseudes*, *Grandidierella* and *Americorophium* >70% of site abundance.

		▪ Species with the propensity to harbour organisms that are harmful to humans should not be the dominant macrofauna community.
Fish	**E➔D**	Maintain the TEC category (>23%) through: ▪ Declines of <20% abundance (to be defined as an average with prediction limits) of marine estuarine-opportunist species and estuarine species as juveniles. ▪ Zone A should function as an estuary and provide viable nursery habitat to a diversity of marine estuarine-dependent species. *Rhabdosargus holubi* and several species of Mugillidae dominate the assemblage. *Ambassis ambassis, Ambassis natalensis, Glossogobius callidus, Planiliza alata, Planiliza macrolepis* and *Pseudomyxus capensis*, *Mugil cephalus, Osteomugil cunnesius, Rhabdosargus holubi, Terapon jarbua* all occur in Zone A, and each of these species is sampled at least every second year. ▪ Connectivity between the lake and estuary should be restored and retained by a functional fishway. Several marine estuarine-dependent species including *Planiliza alata, Planiliza macrolepis, Pseudomyxus capensis, Acanthopagrus vagus, Monodactylus argenteus* occur in the lake (Zones B and C). ▪ The full length of the system (Zones A, B and C) should support permanent populations of estuarine species comprising a mix of zooplankton feeders as well as benthivores. *Gilchristella aestuaria* and *Glossogobius callidus* occur in all zones of the system ▪ Freshwater estuarine-opportunist species should not dominate the fish assemblage (by abundance) in the estuary (Zone A). ▪ Freshwater stenohaline fishes should mostly be restricted to the upper reaches above the weir (Zones B and C), but could occur infrequently, in low abundances in the upper reaches of the estuary (Zone A). They should not occur near the estuary mouth. ▪ The species assemblage should comprise indigenous species only. No non-indigenous fishes occur.
Birds	**D**	Maintain the TEC (>43%) through: ▪ No significant reduction in bird numbers (<20%), including breeding numbers, of any of three main waterbird guilds: swimming piscivores (cormorant and darters), large wading carnivores (e.g. herons and egrets) and swimming herbivorous waterfowl (ducks and geese). ▪ Maintain colonial breeding sites of swimming piscivores.

4.6 W70-UMGOBEZELENI ESTUARY

The uMgobezeleni Estuarine Lake system (**Figure 4.6**) is in iSimangaliso Wetland Park and is more important than previously indicated. It is a fully functional estuarine lake system, e.g. new recruits of fish were recorded in uMgobezeleni Lake (<2 weeks old freshwater mullet that recruited from the sea). as well as new individuals of black mangroves in lower reaches. Given the poor status and negative trajectory of most estuaries in the region, it is important to manage this system to the highest possible condition.

Figure 4.6 Zonation of the uMgobezeleni Estuary.

The RQOs for the uMgobezeleni Estuary, to achieve the TEC, are presented in **Table 4.6**.

Table 4.6 RQOs for the uMgobezeleni Estuary to achieve the TEC

PES:	B↓	REC:	A	TEC:	A/B

The following non-flow interventions will result in halting the negative trajectory and maintaining TEC:

- Urgent action is needed to create awareness of the importance of mangroves and protect these threatened ecosystem types (e.g., road through mangroves).
- Ensure protection of swamp forest that acts as critical habitat and ensure estuary water quality (black water system).
- Eradicate illegal gillnets in the lakes to enhance nursery function and support coastal fisheries.
- Eradicate and monitor the occurrence of alien invasive species, e.g., spotted bass *Micropterus punctulatus*.
- Increasing the protection of the lakes (e.g. Other Effective Conservation Measures, Stewardship, adjusting park boundaries) as part of it is excluded from formal protection.
- Prevent land use clearing in the estuary functional zone.
- Create interventions (e.g. restoring natural bank vegetation, artificial wetlands, reduce the impact of grazing) within a 500 m buffer zone around the estuary functional zone, where no buildup infrastructure, to improve the nutrient status and reduce sediment inputs to the estuary and lakes.
- Deteriorating water quality represents a significant threat, the risk is especially high during the closed state. Address diffuse runoff from housing not on formal reticulation systems. Look into innovative ways to manage wastewater in this area, e.g., artificial reed beds. No wastewater discharges (sewage or industrial) should be discharged into the lakes or estuary. Proactive regional strategic planning (e.g. Provincial Growth and Development Strategy) is needed in the area to reduce the impact of future developments, for example, the disposal of waste is a key issue -waste cannot run into closed estuaries and lakes. Institute agricultural best practices (through the development of farm plans) to reduce nutrient-rich agriculture return flow.
- Maintain hydrological connectivity by ensuring that roads and bridges, e.g. crossing the estuary near the mouth, do not impact tidal and river flows.
- Prevent removal of bark from mangroves and other trees.
- Prevent undue disturbance of birds.

Component/ indicator	TEC	RQO
Hydrology	**B**	Maintain TEC (>93%). Protect the flow regime to create the required habitat for birds, fish, macrophytes, microalgae and water quality: ▪ Maintain groundwater resources within 15% of natural levels. ▪ Groundwater stress index: 0.15.
Hydrodynamics	**B**	Maintain TEC (>78%). Maintain open mouth conditions to protect estuarine ecosystems and the associated habitat for birds, fish, macrophytes, microalgae and water quality: ▪ Maintain a permanent connection to the sea (with the exception of drought conditions). ▪ Ensure connectivity between all parts of the Estuarine Lakes system (e.g. no construction of weirs, no blockages of bridges, ensure adequate culverts/trough flow under existing bridges).
Physical habitat (sediments)	**A/B**	Maintain the TEC (>88%). Protect estuarine sediment distributions suitable habitat for estuarine biota: ▪ River inflow distribution patterns (flood components) should differ by <20% (in terms of magnitude, timing and variability) from that of the Present State (2022). ▪ Suspended sediment concentration from river inflow should deviate by <20% of the sediment load-discharge relationship to be determined as part of baseline studies (Present State 2022). ▪ Findings from the bathymetric surveys undertaken as part of a monitoring programme should indicate no changes in the sedimentation and erosion patterns in the estuary have occurred (± 0.5 m).
		Changes in sediment grain size distribution patterns not to cause exceedance tolerance of benthic invertebrates: ▪ The median bed sediment diameter should deviate by less than a factor of two from levels to be determined as part of baseline studies (Present State 2022). ▪ Sand/mud distribution in the middle and upper reaches should change by <10% from Present State (2022).
Water quality (salinity)	**A/B**	Maintain TEC (>88%). Salinity regime to maintain TEC for dependent biotic components. ▪ Estuary 5 - 20. ▪ Lakes <1.
Water quality (general)	**B**	Maintain the TEC (>78%). Water quality to be suitable for maintaining the TEC for dependent biotic components. **River Inflow and Estuary:** ▪ Average turbidity <10 NTU (low flow). ▪ 6.0 < pH > 8.5 in a sampling survey (to be verified by sampling). ▪ Average DO >6 mg/l in a sampling survey. ▪ DIN <100 µg/l. ▪ DIP < 30 µg/l. ▪ Toxic substances (water): See **Table A1** in **Appendix A**. ▪ Toxic substances (sediment): See **Table A1** in **Appendix A**. **For recreational use areas in estuary (see details in DEA, 2012):** ▪ Enterococci <185 counts per 100 ml (90 percentile), and ▪ *E. coli* <500 counts per 100 ml (90 percentile).
Microalgae	**B**	Maintain the TEC (>78%) through: **Phytoplankton:** ▪ Estuary: 90th percentile value for phytoplankton biomass <10 µg Chl-a l^{-1}. ▪ Lakes: 90th percentile value for phytoplankton biomass <15 µg Chl-a l^{-1}. ▪ No presence of bloom conditions (represented by values >20 µg Chl-a l^{-1}); even isolated instances. ▪ No presence of potentially HAB-forming taxa. **Benthic Microalgae:** ▪ Average MPB biomass <50 mg Chl-a m^{-2} and benthic diatom diversity (H') > 2.5.
Macrophytes	**B**	Maintain the TEC (>78%) through: ▪ Maintain the distribution of macrophyte habitats with less than 10% change in the area covered by different macrophyte habitats (**Appendix B**). ▪ Maintain the integrity of the riparian zone by flooding and low nutrient levels: No unvegetated, cleared areas along the banks. No invasive plants (e.g. syringa berry, Brazilian pepper tree, lantana, *Chromolaena*, *Opuntia*) are largely absent from the riparian zone. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ No sugarcane in the EFZ (estuarine functional zone). ▪ No development or land cover change (e.g. mining, agriculture, plantations) in EFZ.
Invertebrates	**A/B**	Maintain the TEC (>88%) through:

		▪ Ensure the protection of full biodiversity, all functional groups in the estuarine and freshwater habitats. Endemic species are of special importance. ▪ No substantial reduction of populations of endemic species (falling below 50% of average abundance in estuary or lake). ▪ Declines of <10% in abundance of ingressing marine opportunistic species at the mouth (e.g., burrowing *Urothoe* spp.). ▪ uMgobezeleni Lake to support permanent populations of estuarine relict peracarid species (e.g., *Halmrapseudes digitalis*, *Grandidierella lignorum*). ▪ No additional alien invasive species (e.g., *Meretrix* or *Corbicula* spp.). ▪ No further ingression of invasive *Tarebia granifera* into estuarine reaches with the potential to outcompete native species. *T. granifera* to remain <20% of macrofauna abundance, especially at estuary head. ▪ Chironomidae spp. do not form the majority of macrofauna biomass and abundance. Equally, native Assimineidae should not form monospecific communities at any estuary site.
Fish	**B**	Maintain the TEC (>78%) through: ▪ Declines of <20% abundance (to be defined as an average with prediction limits) of marine estuarine-opportunist species and estuarine species as juveniles. ▪ The estuary provides viable nursery habitat to a diversity of marine estuarine-dependent species. Several species of Mugillidae dominate the assemblage. *Planiliza alata, Planiliza macrolepis*, *Pseudomyxus capensis*, *Mugil cephalus, Osteomugil cunnesius, Rhabdosargus holubi, Terapon jarbua* all occur in the estuary. ▪ The estuary supports permanent populations of estuarine species. *Ambassis ambassis, Ambassis natalensis, Glossogobius callidus* occur in the estuary. ▪ Connectivity between the lake and estuary is maintained. *Planiliza alata, Planiliza macrolepis, Pseudomyxus capensis, Acanthopagrus vagus, Monodactylus argenteus* occur in the uMgobezeleni Lake. ▪ uMgobezeleni Lake supports permanent populations of estuarine species. *Gilchristella aestuaria* and *Glossogobius callidus* occur in the lake. ▪ All trophic levels are represented in the fish assemblage. Detritivores (mullet) zooplanktivores (*Ambassis* spp., *Gilchristella aestuaria*), benthivores (*Gerres* spp., *Pomadasys commersonnii*) and piscovores (*Caranx* spp.) occur in the estuary. ▪ Freshwater stenohaline fishes are restricted to the upper reaches above the system. *Enteromius* and *Lacustricola* do not occur near the estuary mouth. ▪ The species assemblage should comprise indigenous species only. No non-indigenous fishes occur.
Birds	**A**	Maintain the TEC (>93%). Maintaining avifaunal community that includes representatives of all original groups as per present baseline: ▪ Resident pair of African Fish Eagle present and breed successfully. ▪ Rare and highly specialized species, e.g. White-backed Night Heron, Mangrove Kingfisher: No significant reduction in numbers (<20%). ▪ Cormorants and/or herons/egrets: No significant reduction in numbers (<20%). ▪ Waterfowl (ducks and geese): No significant reduction in numbers (<20%). ▪ Whole waterbird community: No significant reduction in numbers (<20%).

4.7 W70-KOSI

The system is in iSimangaliso Wetland Park and is of very high biodiversity and conservation importance. Largely groundwater dependant/fed and threatened by forestry (**Figure 4.7**).

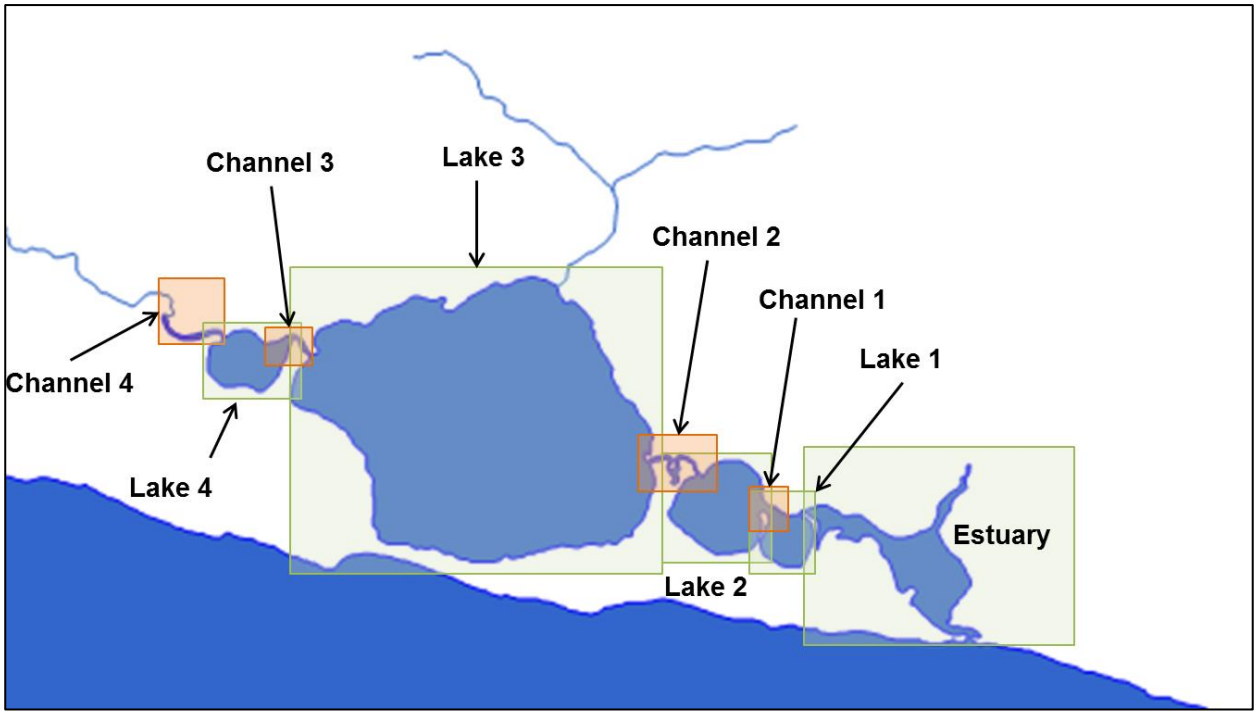

Figure 4.7 Zonation of the Kosi Estuarine Lake system

The RQOs for the Kosi Estuary, to achieve the TEC, are presented in **Table 4.7**.

Table 4.7 RQOs for the Kosi Estuary to achieve the TEC

PES:	A/B↓	REC:	A	TEC:	A

The following non-flow interventions will result in halting the negative trajectory and maintaining TEC (DWS 2016a):

- In line with existing fisheries management guidelines for the Kosi Lakes maintain the traditional subsistence fishery using traditional methods at sustainable levels (traditional methods refer to the back-facing traps and exclude gear such as diving masks and spear guns, augmented baskets (lined with nets / gill nets).
- Control and monitor crab harvesting (presently uncontrolled and sold in Durban).
- Control resource utilisation of reeds, sedges, and mangroves through the introduction of rest areas (refinement of existing plan).
- Control the burning of the floodplain vegetation, swamp forest and mangroves, e.g., through the development of an education programme.
- Prevent land-use change and control the clearing and draining of the peatlands and swamp forests for gardening.
- Control the usage of DDT, herbicides and pesticides in the catchment (a growing concern that the use of DDT and organic phosphates is having an impact because of their long resident time and vulnerability of the lake system); and
- Where not presently built-up (e.g. housing, roads), create a 2 km buffer around the estuary functional zone to protect groundwater from the impact of woodlots and commercial plantations.
- Capping the groundwater utilisation and reducing plantations – to be guided by a groundwater study that sets the level of restrictions on plantations and woodlots in the wider catchment to not impact the groundwater input into Kosi Estuarine Lake system.

Component/ indicator	TEC	RQO
Hydrology	A	Maintain TEC (>93%). Protect the flow regime to create the required habitat for birds, fish, macrophytes, microalgae and water quality: ▪ River and groundwater inflow distribution patterns should not differ by no more than 5% from that of from natural (DWS, 2016a). ▪ Groundwater stress index: 0.15.
Hydrodynamics	A	Maintain TEC (>93%) (DWS, 2016a). ▪ Maintain open mouth conditions to protect estuarine ecosystems and the associated habitat for birds, fish, macrophytes, microalgae and water quality. ▪ No mouth closure should occur. ▪ Tidal variation observed in Lake 1 and Lake 2 Changes in tidal amplitude at the tidal gauge of less than 10% from Present State (2015). ▪ Water level in the system is not above 1.3 m MSL for longer than a few days (not related to a flood).

Physical habitat (sediments)	**A**	Maintain the TEC (>93%): ▪ Protect estuarine sediment distributions suitable habitat for estuarine biota. Changes in sediment grain size distribution patterns should not cause exceedance tolerance of benthic invertebrates with median bed sediment diameter deviates by no more than a factor of two from levels to be determined as part of baseline studies (Present State 2015). ▪ No change to the grain size distribution and individual organic content relationships within each lake compartment. Lake 4 and the Estuary must typically support an average of 30% coarse sand, and Lakes 1 - 3 supporting fine to medium-grained sands with little to no mud (<3%). ▪ Findings from the bathymetric surveys undertaken as part of a monitoring programme should indicate no changes in the sedimentation and erosion patterns in the estuary have occurred (± 0.5 m). ▪ Suspended sediment concentration from river inflow should deviate by less than 20% of the sediment load-discharge relationship to be determined as part of baseline studies (Present State 2015) (DWS, 2016a)
Water quality (salinity)	**A**	Maintain TEC (>93%). Salinity regime to maintain TEC for dependent biotic components and should maintain a well-defined and typical gradient of (DWS, 2016a): ▪ Polyhaline/euhaline in the lower reaches of the mouth (typically marine and never less than 20). ▪ Mesohaline to euhaline in the mid/lower reaches to reflect the influence of the uKhalwe River. ▪ Lakes 1 and 2 should remain typically mesohaline, occasionally slightly polyhaline but for limited periods. ▪ Lake 3: Oligohaline state with salinity <5. ▪ Lake 4: Limnetic/oligohaline with salinity <1.
Water quality (general)	**A/B**	Maintain the TEC category (>88%) (DWS, 2016a). Water quality to be suitable for maintaining the TEC for dependent biotic components. **River inflow:** ▪ 7.0 < pH > 8 in any survey. ▪ DO >6 mg/l. ▪ Turbidity <10 NTU (low flow). ▪ Turbidity <15 NTU (higher flow – State 1). ▪ DIN <100 µg/l in 2 consecutive monthly sampling. ▪ DIP <10 µg/l in 2 consecutive monthly sampling. ▪ Toxic substances (water): See **Table A1** in **Appendix A**. ▪ Toxic substances (sediment): See **Table A2** in **Appendix A**. **Estuary and Lakes:** ▪ Average turbidity <5 NTU. ▪ 7.0 < pH > 8.5 at any station. ▪ DO >6 mg/l in surface samples (up to ~5 m water depth). ▪ Average DIN <100 µg/l in a sampling survey. ▪ Average PO_4-P <10 µg/l in a sampling survey. ▪ No nuisance matter (plastics) is present in estuary, channels and lakes. ▪ Toxic substances (water): See **Table A1** in **Appendix A**. ▪ Toxic substances (sediment): See **Table A2** in **Appendix A**. **For recreational use areas in estuary (see details in DEA, 2012):** ▪ Enterococci <185 counts per 100 ml (90 percentile), and ▪ *E. coli* <500 counts per 100 ml (90 percentile).
Microalgae	**A**	Maintain the TEC (>93%) through: **Phytoplankton:** ▪ Estuary and Lake 1 - 2: 90th percentile value for phytoplankton biomass <5 µg Chl-a l^{-1}. ▪ Lakes 3 - 4: 90th percentile value for phytoplankton biomass <10 µg Chl-a l^{-1}. ▪ No presence of bloom conditions (represented by values >20 µg Chl-a l^{-1}); even in isolated instances. ▪ No presence of potentially HAB-forming taxa; particularly in brackish regions. **Benthic Microalgae:** ▪ Estuary and Lake 1: Average MPB biomass <50 mg Chl-a m^{-2} and benthic diatom diversity (H') >3. ▪ Lake 2 - 4: Average MPB biomass <100 mg Chl-a m^{-2} and benthic diatom diversity (H') >2.5.
Macrophytes	**A/B**	Maintain the TEC (>88%) through (DWS, 2016a): ▪ Maintain the distribution and diversity of macrophyte habitats from the estuary to Lake 4. Lake 4 with a fringe of emergent reeds and sedges, large swamp forest areas on the west bank with Raphia australis (raphia palm) present.

		▪ No greater than 10% change in the area covered by different macrophyte habitats due to salinity changes of greater than 5 in Lake 3 and greater than 1 in Lake 4 (**Appendix B**). ▪ Extensive submerged macrophyte beds in Lake 3 with a diversity of species such as *Ceratophyllum demersum*, *Potamogeton sweinfurthii* and *Najas marina*. ▪ No loss of any of the dominant / characteristics species listed under ecological specifications. For example - loss of mangroves and raphia palms due to inundation (i.e. water depth greater than 60 cm for three months). ▪ Dominant species throughout the lakes include *Hibiscus tilieaceus* (lagoon hibiscus) and *Acrostichum aureum* (mangrove fern). ▪ Six mangrove species present with *Lumnitzera racemosa* and *Bruguiera gymnnorhiza* as far upstream from the mouth as Lake 2. ▪ No Loss of mangroves from Lake 2 due to prolonged freshwater conditions (>1 year in Lake 2). ▪ No Loss of freshwater reeds, sedges and swamp forest species due to groundwater inflow reduction. ▪ No invasive floating aquatic species present in the estuarine lake e.g. water hyacinth, Azolla, Hydrilla, Pistia.
Invertebrates	**B↑**	Maintain the TEC category (>78%) through (DWS, 2016a): ▪ Maintain current zooplankton, macrobenthic and macrocrustacea abundance (including seasonal variation) and species richness in each of the estuary and four lake regions. ▪ <50% contribution by abundance and biomass of any individual non-invasive taxon that suggests a shift in ecological balance. ▪ No disappearance of any group or indicator taxon for each sediment and salinity habitat combinations (as generally depicted by different lake and channel environments). ▪ A highly diverse complement of invertebrates from multiple Phyla, Classes and other groups, including congenerics in the Copepoda, Isopoda, Amphipoda. All invertebrate surveys (across the benthos and plankton) should include species from a minimum of 7 Phyla and particularly the Annelida, Arthropoda and Mollusca. ▪ Maintain present day (2016/2022) ratios of fewer polychaetes to more crustaceans (Amphipoda, Isopoda) in the sediments of Lakes 1and 2. Shifts to a dominance of Amphipoda/Crustacea elsewhere indicates an abundance of microalgae or where existing prey-eating polychaetes increase suggests a loss of microphytobenthos for amphipods. ▪ Fossorial species and suspension feeders, algal grazers, detritus feeders, carnivores and omnivores should dominate guild types in the estuary and lakes 1 - 3. A switch to surface/sub-surface deposit feeders indicates a change in habitat (grain size distribution and/or food source). ▪ *Kraussicallichirus kraussi* biomass should remain stable and dominate shallow subtidal habitat of Lakes 1 and 2, only. Ingression of sand prawn into Lake 3 suggests a prolonged ingression of saline water into Lake 3. ▪ The open mouth conditions during peak recruitment periods for crabs and larval stages of other macrocrustacea and macroinvertebrate species (generally spring) will support life cycle requirements for species dependent on an annual estuarine-marine link for larval and post larval recruitment. ▪ Salinity states within each lake compartment are important for invertebrate diversity and function to retain a full complement and range of freshwater to marine. Fauna should range from polyhaline species in the lower reaches, mesohaline species in Lakes 1 and 2, brackish tolerant fauna in Lake 3 and oligohaline freshwater species only in Lake 4. ▪ Catadromous crustaceans e.g., *Varuna litterata* should be always found and particularly in Lake 1 and the estuary, during reproductive periods. ▪ The invertebrate community should comprise indigenous species only. No spread of *Tarebia granifera* to areas inside the system beyond Lakes 3 and 4, or to surrounding pans, streams or wetlands.
Fish	**B↑**	Maintain the TEC category (>78%) through (DWS, 2016a): ▪ Declines of <20% abundance (to be defined as an average with prediction limits) of marine estuarine-opportunist species and estuarine species as juveniles. ▪ Lake 4, freshwater seep areas and inflowing streams support a diversity of primary freshwater fishes, along with secondary freshwater species. These should include *Hypseleotris dayi*, several *Enteromius* and *Lacustricola* species. At least one species of stenohaline freshwater fishes (*Enteromius* spp*., Lacustricola* spp.) is sampled in Lake 4. No lower lower than average abundance (to be defined as a mean with prediction limits) of freshwater fishes. ▪ The system retains functionality and health as habitat for a diversity of estuarine resident species which includes pelagic and demersal groups, as well as species with a high degree of dependence on specific vegetation habitats. Estuarine resident species should comprise both pelagic and demersal groups. The former dominated

		by *Gilchristella aestuaria, Ambassis* spp., and to a lesser degree *Hyporhamphus capensis*. These fishes should occur in abundance and 100% frequency in Lakes 4, 3 and Mtando Channel at least. Benthic groups should include goby species (*Croilia mossambica, Silhouettea sibayi, Glossogobius callidus* with 100% frequency, but also other species such as *Redigobius dewaali, Glossogobius giuris, Psammogobius biocellatus*), as well as *Eleotris* spp. *Hippichthys* spp. should occur in suitable habitat (submerged aquatic vegetation). The average abundance should not be lower (to be defined as a mean with prediction limits) of any of the main estuarine resident species (*Gilchristella aestuaria*, *Ambassis* spp., *Hyporhamphus capensis, Croilia mossambica, Silhouettea sibayi, Glossogobius callidus*). *Hippichthys* spp. should always be present. ▪ The system acts as a nursery and feeding habitat to a diversity of benthic feeding estuarine dependent marine fishes. Marine estuarine-dependent species (Whitfield category IIa, IIb, Vb) should dominate fishes sampled in estuarine habitats (i.e., excluding reef areas near the system mouth). Thus, the benthic feeding estuarine dependant marine species should occur throughout the linked lakes system as in all size classes (juveniles, sub-adults and adults). Abundances should be greatest in Lakes 1 and 2. Species should include mullet (to Lake 4), *Pomadasys commersonnii, Acanthopagrus vagus, Lutjanus argentimaculatus* and *Rhabdosargus sarba* (to Lake 2 at least). *Gerres* spp. should occur to Lake 3 at least as juveniles. All of these fishes should occur with 100% frequency. Size distributions should reflect those that would be expected under reference conditions. ▪ Piscivorous species, including *Sphyraena* spp., *Caranx* spp. and *Scomberoides* spp. should occur as juveniles and sub-adults to Lake 2 at least, and juveniles of the former two species should penetrate into Lake 3. ▪ Alien fish species should not occur.
Birds	**A/B**	Maintain the TEC (>88%) through (DWS, 2016a): ▪ Maintain the abundance of birds using the system, with overall bird abundance – excluding terns - not less than 1000 in three consecutive counts (the terns are excluded as their numbers show huge inter-annual variability.) ▪ Maintain the existing composition of feeding guilds (2016). The proportion of each of the guilds should be about 30% and none should deviate by more than 20% for more than three consecutive counts (i.e. the guilds should each be within 10 and 50 %). The guilds are: (i) the birds that feed on large (>10 cm) fish; (ii) the birds that feed on small (<10 cm) fish; and (iii) the combined abundance of the vegetation feeders and the invertebrate feeders. ▪ Ensure the continued presence of specified habitat-specialist species (i.e. use them as indicators of health of the system). No loss of any of the following sensitive species from the system: Pel's Fishing owl; African Pygmy Goose; African Finfoot; Palmnut Vulture.

4.8 ST LUCIA/IMFOLOZI

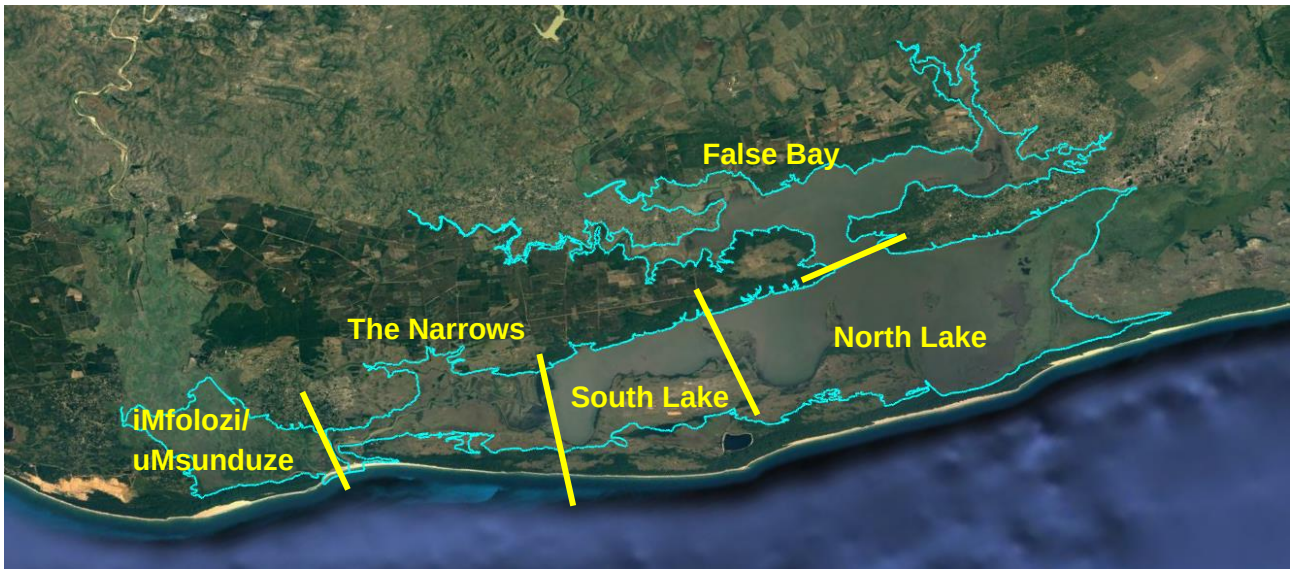

Figure 4.8 Zonation of the St Lucia/iMfolozi Estuarine Lake system

The RQOs for the St Lucia/iMfolozi Estuary, to achieve the TEC, are presented in **Table 4.8**.

Table 4.8 RQOs for the St Lucia/iMfolozi Estuary to maintain the TEC

PES:	D ↓↑	REC:	B	TEC:	C (Short term) B (long term)

The following non-flow interventions will result in halting the negative trajectory and improving the system to reach the TEC (DWS, 2016b; DFFE, 2022):

- St Lucia/iMfolozi should have a single mouth and with manipulation of the mouth (artificial breaching or closing) kept to a minimum as it increases drought/climate change vulnerability.
- Restore low-lying areas of the iMfolozi floodplain to natural vegetation to allow for natural processes (e.g., carbon sequestration, mouth closure). A detailed remote sensing study is needed to identify these low-lying areas that are inundated during the wetter cycle.
- Remove alien vegetation around the Lake, estuaries, and rivers.
- Limit further natural deforestation such as in the Dukuduku Forest.
- Eradicate illegal gillnetting from the system.
- Eradicate and monitor the occurrence of alien invasive species (plants, inverts and fish).
- Strategic planning is needed to prevent urbanization in the catchments feeding directly into the Lake and the Narrows.
- Reduce commercial forestation in the lake catchments to increase low flows as much as possible.
- In the uMfolozi River catchment, land care practices should focus on the most critical sub-catchment areas to limit future erosion and land degradation which could further reduce low flows.
- Unauthorised river abstractions especially the Mkuze and uMfolozi Rivers must be eliminated. DWS will need to undertake further investigations into limiting further forestry applications in St Lucia and uMfolozi catchments and review license conditions in relation to buffer zones. Validation and verification of water use is required and possibly leading to compulsory licensing.

Component/ indicator	TEC	RQO
Hydrology	C	Maintain TEC (>63%). Protect the flow regime to create the required habitat for birds, fish, macrophytes, microalgae and water quality (DWS, 2016b). **Maintain freshwater inflow from all influent rivers at a level that is as close to natural as possible but not less than under present-day conditions.** Runoff from the uMfolozi is particularly important for ensuring that the estuary mouth functions in a manner that resembles natural conditions, while runoff from the smaller rivers that discharge directly into the St Lucia lakes (Mkuse, Hluhluwe, Msinene, Nyalazi, Mpate River) and groundwater inputs are important for maintaining water level, preventing an increase in the occurrence of hypersaline conditions, and for mouth dynamics ▪ Minimum discharge at DWS gauging station W2H032 in the uMfolozi at 3 m^3/s to maintain an open mouth (outside of a defined drought period).
Hydrodynamics	C	Maintain TEC (>63%). Maintain open mouth conditions to protect estuarine ecosystems and the associated habitat for birds, fish, macrophytes, microalgae and water quality (DWS, 2016b): ▪ Phases not alternating at regular intervals, i.e. decadal shifts, as this could compromise the survival of sensitive stages. ▪ Maintain the water level in Lake at Charters Creek > 0.35 m mean sea level (to be confirmed with surveys). ▪ The estuary mouth should not be breached artificially except in an emergency or when exceptional circumstances prevail. This will allow more river flow to the lake during droughts and when breaching occurs it will open up a large mouth with a large tidal flow. ▪ Variations in water level in the Lakes should correspond as closely as possible to natural. Mean water level in the Lakes under natural conditions is estimated to be around 0.55 m mean sea level (MSL) and dropped below 0.1 m MSL less than 16% of the time. ▪ Mean water level in the lakes should not drop below 0.1 m MSL for more than 20% of the time outside of a defined drought period
Physical habitat (sediments)	C	Maintain the TEC (>63%). Protect estuarine sediment distributions suitable habitat for estuarine biota (DWS, 2016b): ▪ Channel morphology and bed level in the Lakes, Narrows and iMfolozi should resemble those under natural condition as far as possible, or where these have been substantially modified from natural, should not diverge further than Present Day. ▪ Change in bed level anywhere in the estuary by more than 10 cm away from natural or present-day conditions, as applicable, except following a major (>1:20 year flood).
		Changes in sediment grain size distribution patterns not to cause exceedance tolerance of benthic invertebrates (DWS, 2016b): ▪ No change should occur to the grain size distribution and individual organic content relationships within the Narrows and each lake compartment. ▪ Findings from bathymetric surveys undertaken as part of a long-term monitoring programme should not indicate changes in the sedimentation and erosion patterns in the estuary have occurred (± 0.5 m).

		▪ Suspended sediment concentration from river inflow should deviate by less than 20% of the sediment load-discharge relationship to be determined as part of baseline studies (Present State 2023).
Water quality (salinity)	D ↑	Maintain TEC (>43%). Salinity regime to maintain TEC for dependent biotic components (DWS, 2016b). ▪ Salinity structure in the Lakes, Narrows and iMfolozi should correspond as closely as possible with the natural condition. Average salinity in the Lakes under natural conditions ranged from 6.5 - 9.6, and exceeded 20 less than 10% of the time. ▪ Salinity levels in the Lakes outside of a defined drought period, and averaged over an extended period do not exceeds 20. ▪ Hypersaline conditions (salinity >35) are recorded outside of a defined drought period.
Water quality (general)	D ↑	Maintain the TEC (>43%). Water quality to be suitable for maintaining the TEC for dependent biotic components. Water quality in the influent rivers and in the estuary itself should approximate natural conditions as closely as possible. Important risk factors include elevated pH and nutrient levels in the influent waters and low oxygen levels in the estuary, especially at night (DWS 2016b). **River Inflow (DWS 2016a):** ▪ DIN <100 µg/l. ▪ DIP <30 µg/l. ▪ Toxic substances (water): See **Table A1** in **Appendix A**. ▪ Toxic substances (sediment): See **Table A2** in **Appendix A**. **Estuary (DWS 2016a):** ▪ DO >4 mg/l. ▪ Average TSS <50 mg/l levels (in the Narrows over a period of one year). ▪ Toxic substances (water): See **Table A1** in **Appendix A**. ▪ Toxic substances (sediment): See **Table A2** in **Appendix A**. **For recreational use areas in estuary (see details in DEA, 2012):** ▪ Enterococci < 185 counts per 100 ml (90 percentile), and ▪ *E. coli* < 500 counts per 100 ml (90 percentile).
Microalgae	D ↑	Maintain the TEC (>43%) through: ▪ Maintain low phytoplankton biomass throughout the estuarine lake. Phytoplankton biomass: <5 µg Chl-a l^{-1} in the estuary and <15 µg Chl-a l^{-1} in the lake. ▪ The system must be free of algal blooms or floating algal scum. ▪ Maintain the distribution of phytoplankton groups throughout the estuary. ▪ *Cyanophyceae* and *Chlorophyceae* dominant when the estuary is fresher and flagellated-taxa are dominant when the system is in a brackish/marine state. Blooms of *Cyanobacteria* can also form under hypersaline conditions.
Macrophytes	B	Maintain the TEC (>78%) through: ▪ Maintain the distribution and diversity of macrophyte habitats throughout the estuarine lake system with a less than 20% change in the area covered by different macrophyte habitats due to salinity changes (See **Appendix B**). ▪ Extensive submerged macrophyte beds can form in the south lake around Catalina Bay and Makakatana. No loss of dominant / characteristic submerged macrophyte species should occur. ▪ No loss of freshwater reeds, sedges and swamp forest species due to groundwater inflow reduction. ▪ No invasive floating aquatic species present in the estuarine lake e.g. water hyacinth, *Azolla*, *Hydrilla* and *Pistia*.
Invertebrates	D	Maintain the TEC category (>43%) through (DWS, 2016b and unpublished data): ▪ Ensure protection of full biodiversity, at least four salinity -derived functional groups in the estuarine, marine, freshwater and hypersaline habitats. Endemic species are of special importance, particularly when restricted to the Lake St Lucia System. ▪ Endemic or species with limited biogeographical distribution are maintained (<50% of average). No decrease in densities of *Paratylodiplax blephariskios* (<25% change in annual sample). To be targeted in the Narrows, which is the limited habitat of this species and requires an open mouth for larval exchange. ▪ Maintain zooplankton, zoobenthic and macrocrustacea abundance (including seasonal variation) and species richness in each of the Lakes, Narrows and iMfolozi System. No decrease in abundance of zooplankton (<20%) in terms of numbers per m^{-2} from at least 3 sample sites per zone, over 2 years, or for macrobenthos <15% change in numbers per m^{-2} from at least 5 sample sites, per zone, per year. ▪ No alien invasive species with potential to outcompete native species. Especially those with fresh/brackish water affiliations e.g., *Tarebia, Corbicula*. ▪ *Tarebia granifera* distribution is limited to iMfolozi system and higher salinity of the lower narrows should prevent penetration into St Lucia.

		▪ Species to include primarily estuarine affiliates (lakes and False Bay) but also freshwater representatives in the iMfolozi reaches and marine species at the mouth. ▪ Characteristic micro-crustaceans to be always found especially *Eriopisa chilkensis*, *Bolttsia minuta, Halmrapseudes cooperi* and *Afrochiltonia capensis* in the Narrows and lower South Lake. ▪ Abundance of all taxon groups are higher during spring before summer high flow periods and decline during the winter, low flow period. Considering seasonality, macrofauna diversity should not decline to <50 taxa in the system, with South Lake showing the greatest diversity (<25 taxa). ▪ Mouth to be open during peak recruitment periods for species with a life cycle dependent on an annual estuarine-marine link for larval and postlarval recruitment (mostly spring) for a diversity of Penaeidae prawns and multiple Decapoda. ▪ No shift in prawn community from marine dominated (Penaidea) towards freshwater dominated assemblage (Caridea). <20% decrease in relative abundance of estuarine dependent marine macrocrustaceans in estuary and lakes, and no loss of marine species. ▪ No dominance of Insecta in zooplankton or sediment macrofauna, especially with species tolerant of poor environmental conditions (e.g., Chironomidae).
Fish	**C**	Maintain the TEC category (>63%) through (DWS, 2016b): ▪ 75% or more of the estuarine lakes system acts as a nursery to a diversity of EDCII species but particularly EDCIIa species. An abundance (to be defined as an average with prediction limits) of EDCIIa species present as young juveniles in spring and early summer (*Acanthopagrus vagus, Agyrosomus japonicas, Elops machnata, Pommadasys comerssonnii, Rhabdosargus holubi, Terapon jarbua*) is not reached. ▪ A good trophic basis exists for predatory estuarine dependant marine species (e.g. *Agyrosomus japonicus, Elops machnata, Caranx* spp.). ▪ Estuarine resident species are represented by a core group (*Glossogobius spp., Oligolepis spp. Ambassis spp*. and *Gilchistella aestuaria*). The four dominant mullet species (*Mugil cephalus*, *Liza macrolepis*, *L. dumerelii* and *Valamugil cunnesius*) occur throughout the system represented by a full array of size classes and present in all samples. ▪ *Oreochromis mossambicus* limited to the upper reaches under estuarine conditions. ▪ Species assemblage comprises indigenous species only. ▪ Connectivity to a healthy transitional marine-estuary-freshwater system is maintained for 75% of the time. ▪ Connectivity between the iMfolozi and St Lucia is maintained even during dry cycles. ▪ No decline in nearshore linefish catches (e.g. *Rhabdosargus sarba*) occurs (not related to gear changes or bag limit restrictions).
Birds	**C**	Maintain the TEC (>63%) (DWS, 2016b). ▪ The estuarine lake system should contain a diverse avifaunal community that includes representatives of all the original groups, and that sustains the populations for which the system has acquired its conservation status. ▪ Numbers of waterbirds on the entire system, other than those that have or are increasing regionally such as Egyptian Goose, should not decline below 50 species or below 8000 birds for three consecutive counts. ▪ Dramatic reduction (<20%) in numbers of any of the colonially-breeding waterbirds, especially if not balanced by the establishment/growth of colonies elsewhere in the region ▪ Dramatic reduction in the diversity (evenness) of the avifaunal community, e.g. due to dominance by a few species.

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6 APPENDIX A: TOXIC SUBSTANCE RQOs

Table A1 Recommended RQOs for water metal concentrations (as derived from DWAF, 1995)

Metal	Recommended RQO
Arsenic (As)	12 µg/ℓ
Cadmium (Cd)	4 µg/ℓ
Chromium (Cr)	8 µg/ℓ
Copper (Cu)	5 µg/ℓ
Lead (Pb)	12 µg/ℓ
Mercury (Hg)	0.3 µg/ℓ
Nickel (Ni)	25 µg/ℓ
Silver (Ag)	5 µg/ℓ
Zinc (Zn)	25 µg/ℓ

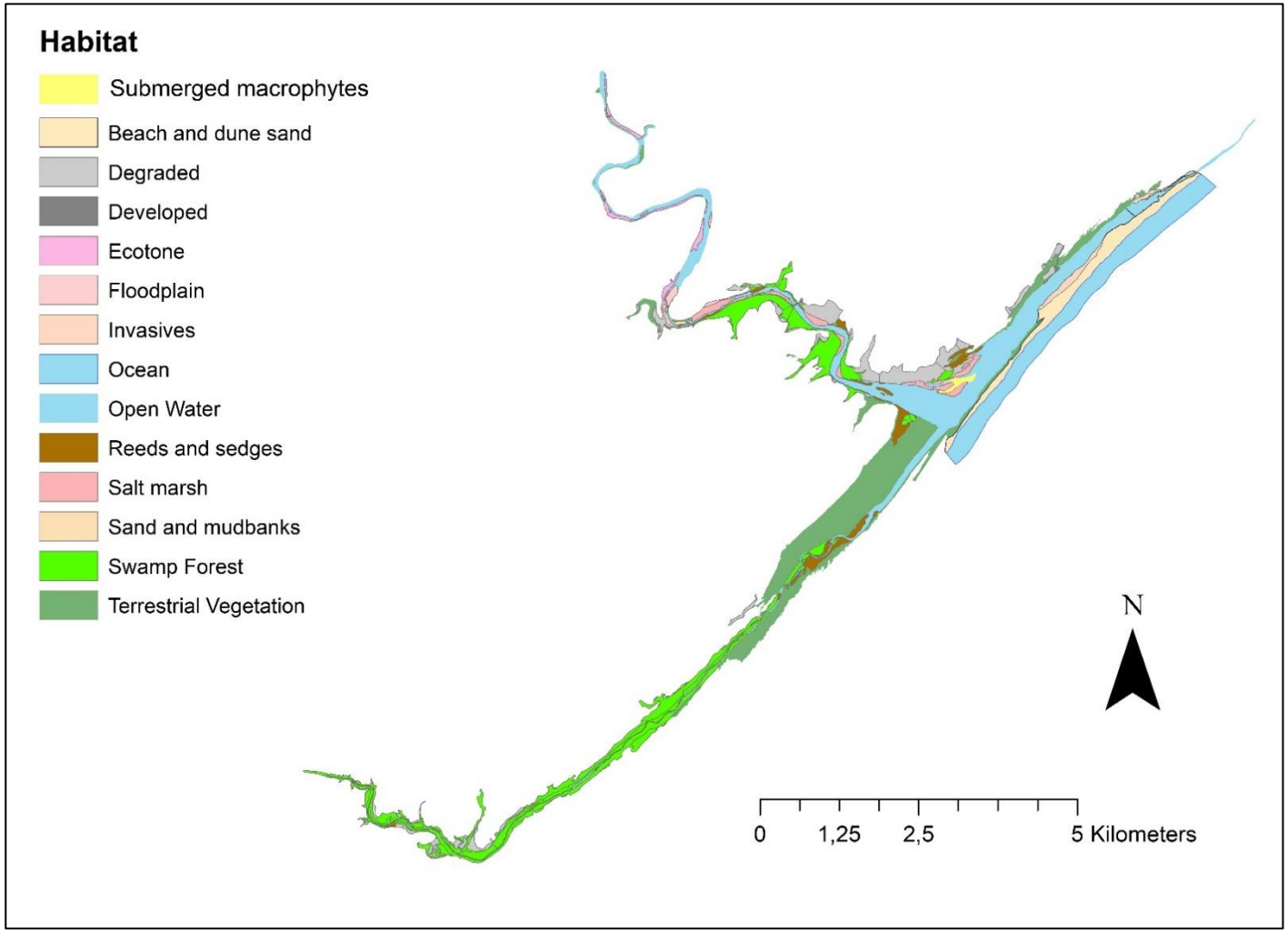
Table A2 Recommended RQOs for sediment metal and DDT concentrations (as derived from UNEP/Nairobi Convention Secretariat and CSIR, 2009)

Metal	Recommended RQO (mg/kg dry weight)
Arsenic	7.24
Cadmium	0.68
Chromium	52.3
Copper	18.7
Lead	30.2
Mercury	0.13
Nickel	15.9
Silver	0.73
Tin as Tributyltin-Sn	0.005
Zinc	124
Pesticide	**Recommended RQO** (µg/kg dry weight normalized to 1% organic carbon)
Total DDT	3.89

7 APPENDIX B: KEY ESTUARINE HABITATS

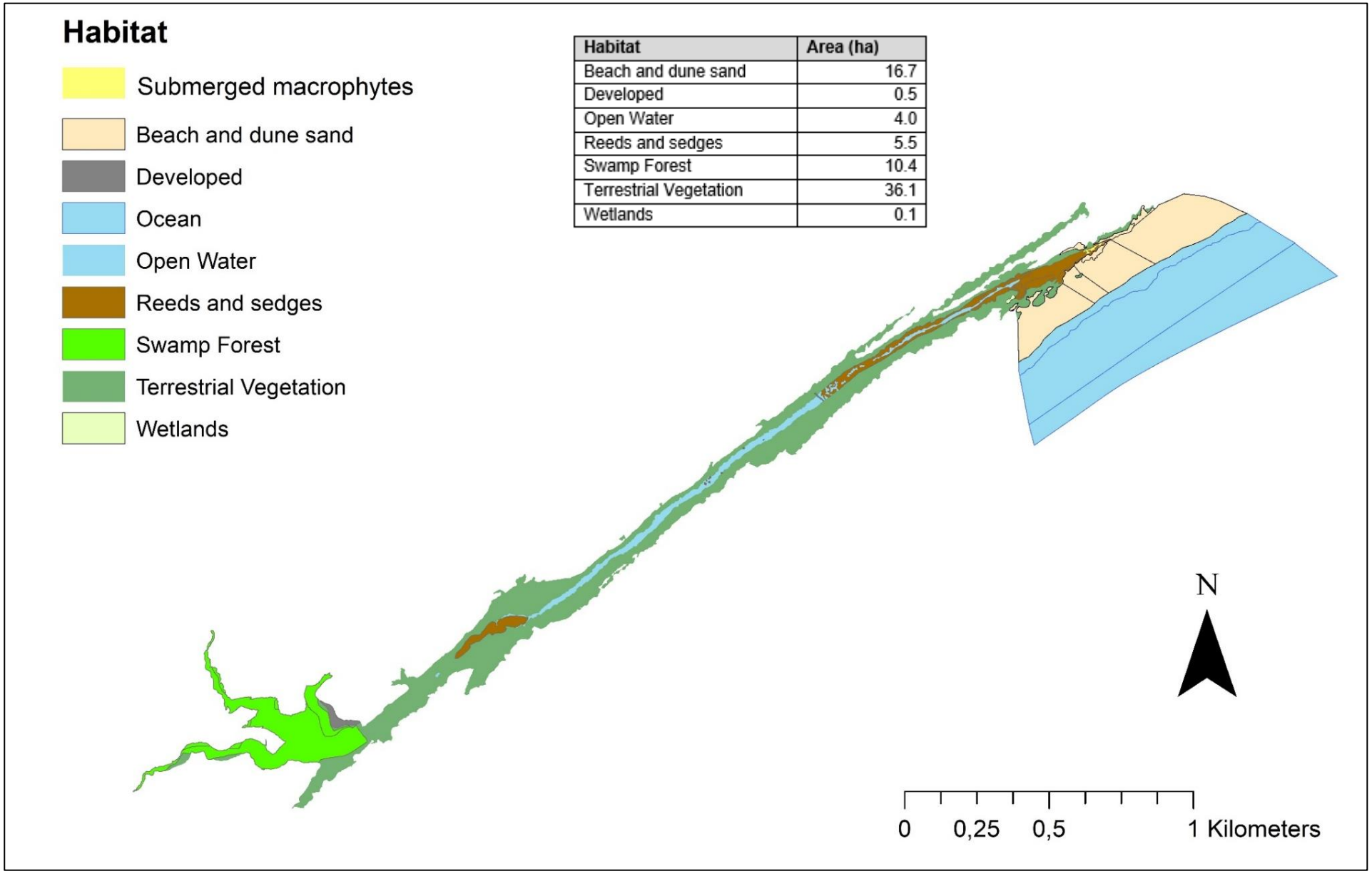
Maps of the key estuarine habitats are displayed in Section B1 – B8.

B1 AMATIGULU/INYONI ESTUARY



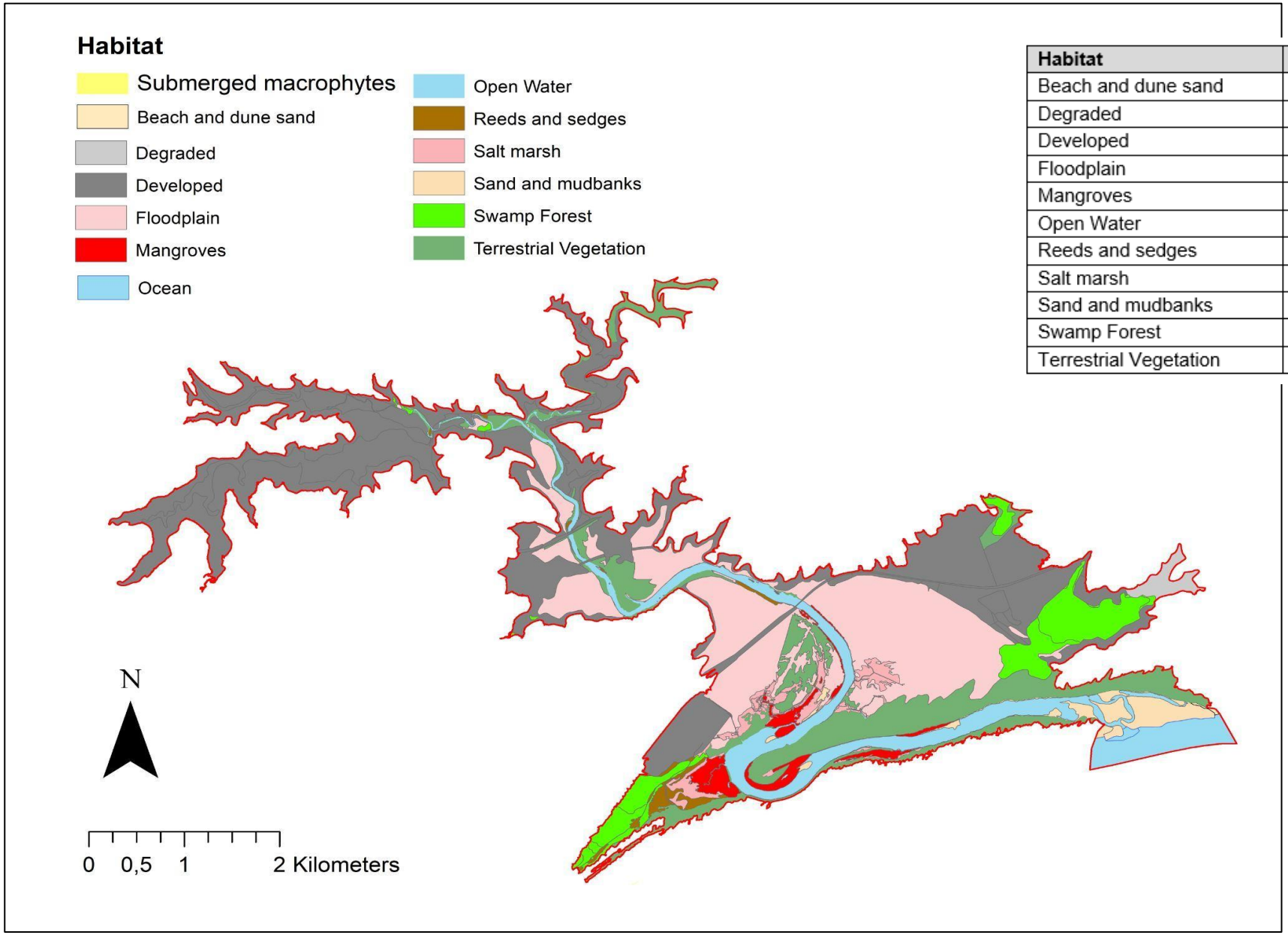
Habitat	Area (ha)
Beach and dune sand	98.0
Degraded	127.0
Developed	1.4
Ecotone	23.2
Floodplain	9.7
Invasives	16.4
Open Water	383.0
Reeds and sedges	48.6
Salt marsh	41.4
Sand and mudbanks	1.9
Swamp Forest	307.8
Terrestrial Vegetation	361.5

B2 ISIYAYA ESTUARY



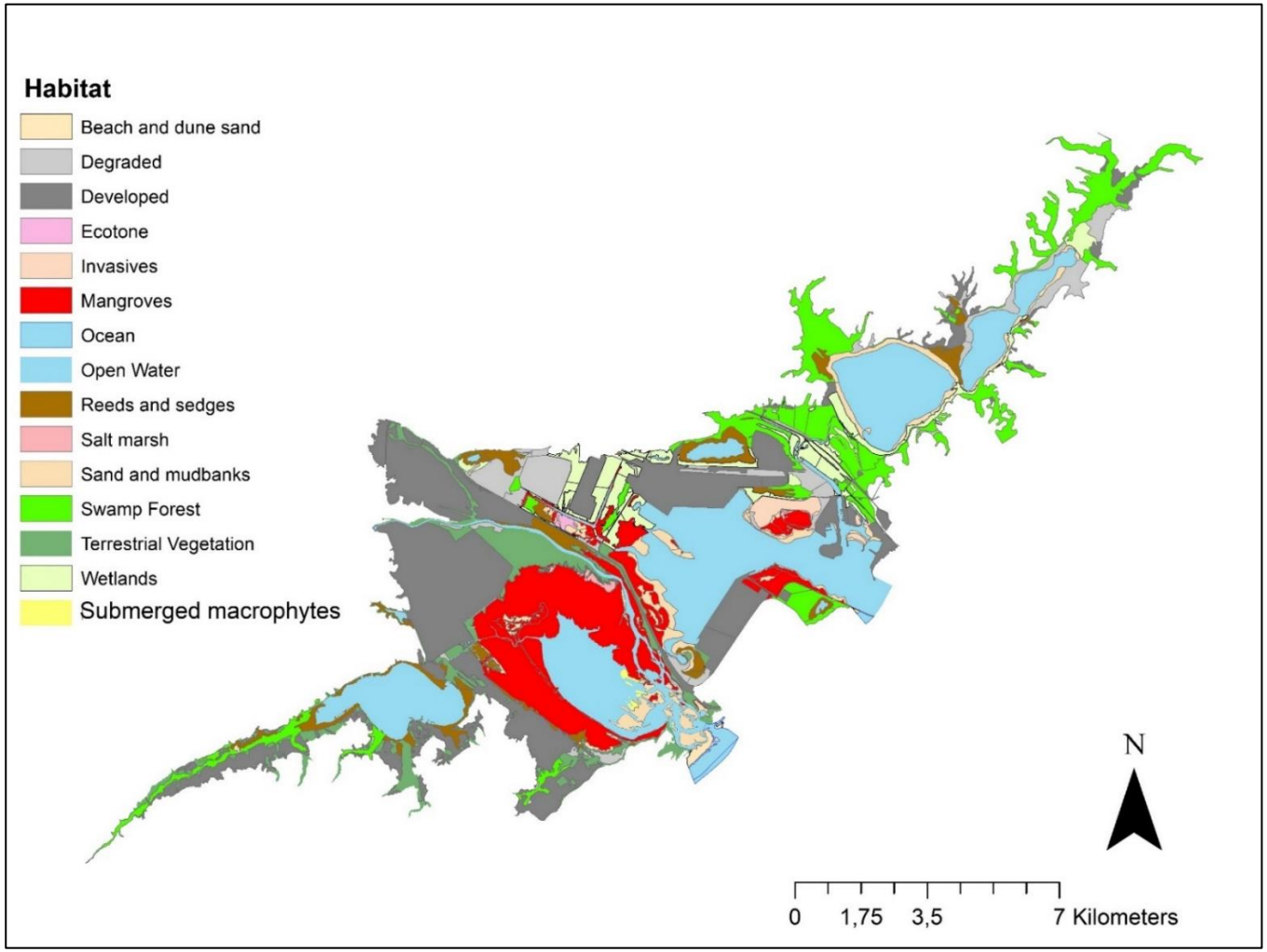
Habitat	Area (ha)
Beach and dune sand	16.7
Developed	0.5
Open Water	4.0
Reeds and sedges	5.5
Swamp Forest	10.4
Terrestrial Vegetation	36.1
Wetlands	0.1

B3 UMLALAZI ESTUARY



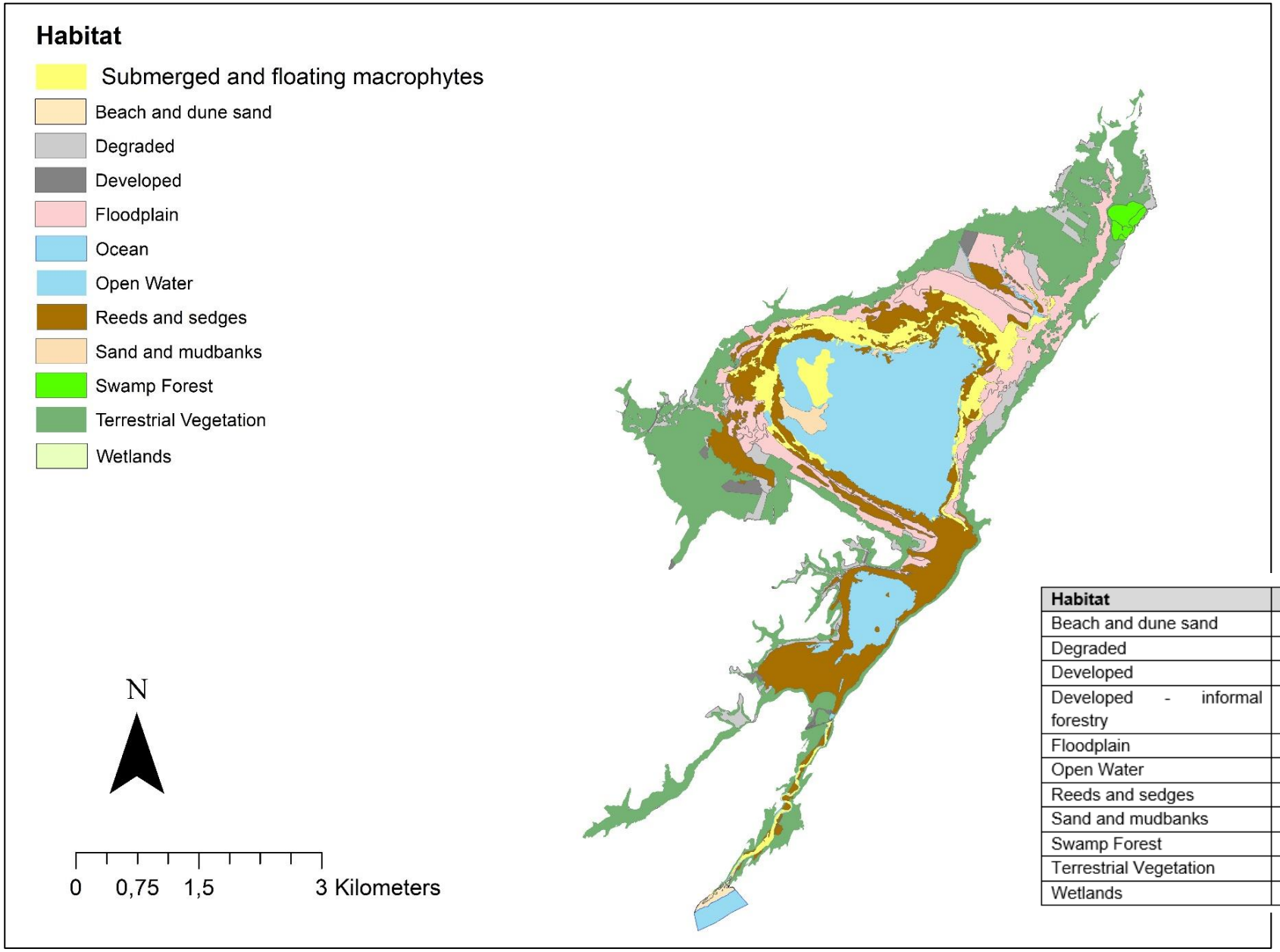
Habitat	Area (ha)
Beach and dune sand	1.0
Degraded	22.7
Developed	928.1
Floodplain	539.7
Mangroves	52.2
Open Water	183.0
Reeds and sedges	24.5
Salt marsh	57.6
Sand and mudbanks	61.2
Swamp Forest	149.2
Terrestrial Vegetation	348.8

B4 UMHLATHUZE ESTUARY



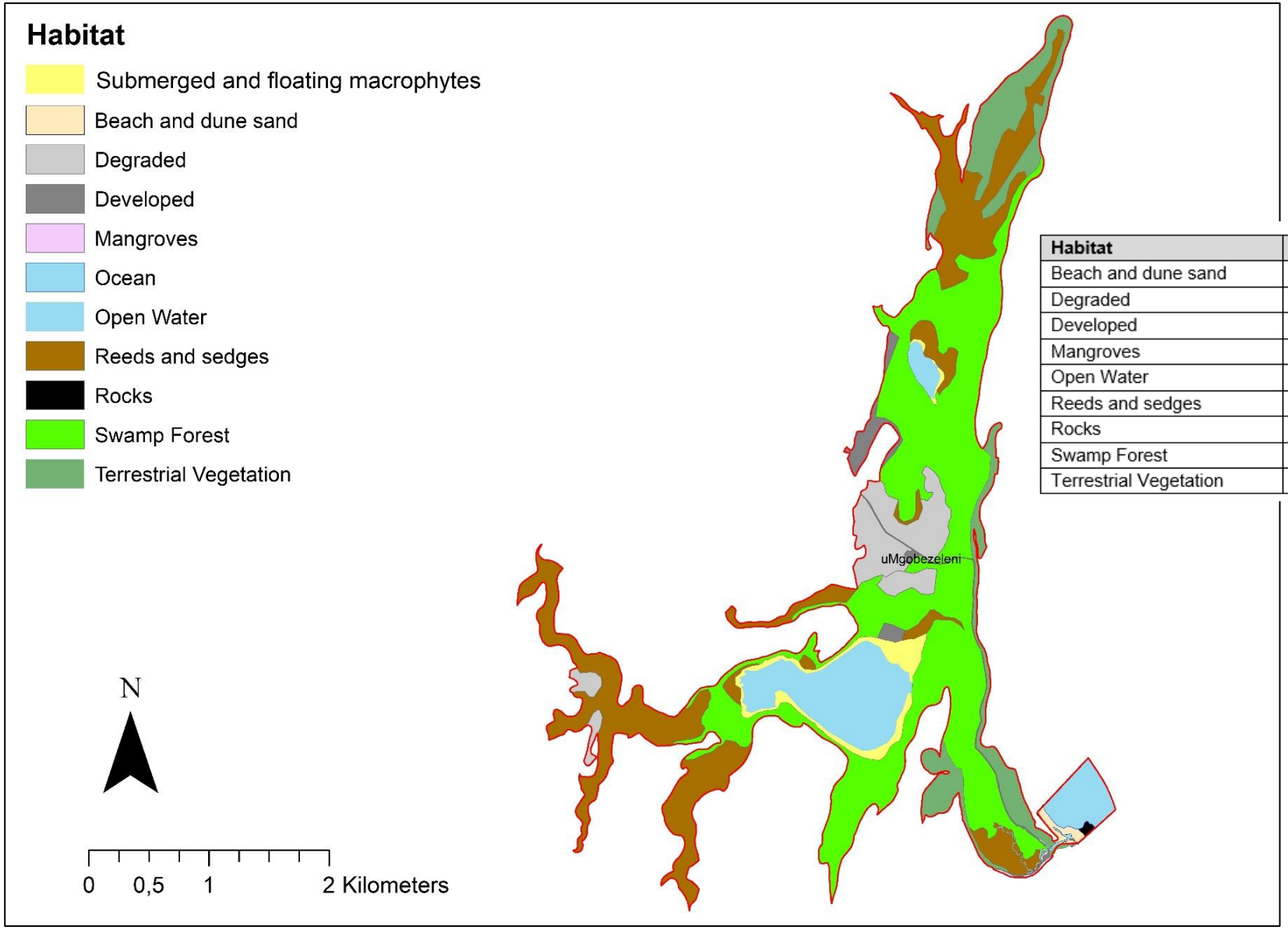
Richards Bay Habitat	Area (ha)
Beach and dune sand	1.4
Degraded	771.5
Developed	1348.1
Ecotone	19.9
Invasives	129.2
Mangroves	405.7
Open Water	2802.6
Reeds and sedges	343.8
Salt marsh	6.6
Sand and mudbanks	454.8
Swamp Forest	1539.9
Terrestrial Vegetation	40.0
Wetlands	770.8
uMhlathuze Habitat	**Area (ha)**
Beach and dune sand	32.2
Degraded	62.5
Developed	2556.8
Invasives	2.6
Mangroves	1465.3
Open Water	1417.8
Reeds and sedges	332.9
Salt marsh	30.7
Sand and mudbanks	245.5
Swamp Forest	221.4
Terrestrial Vegetation	929.7

B5 INHLABANE ESTUARY



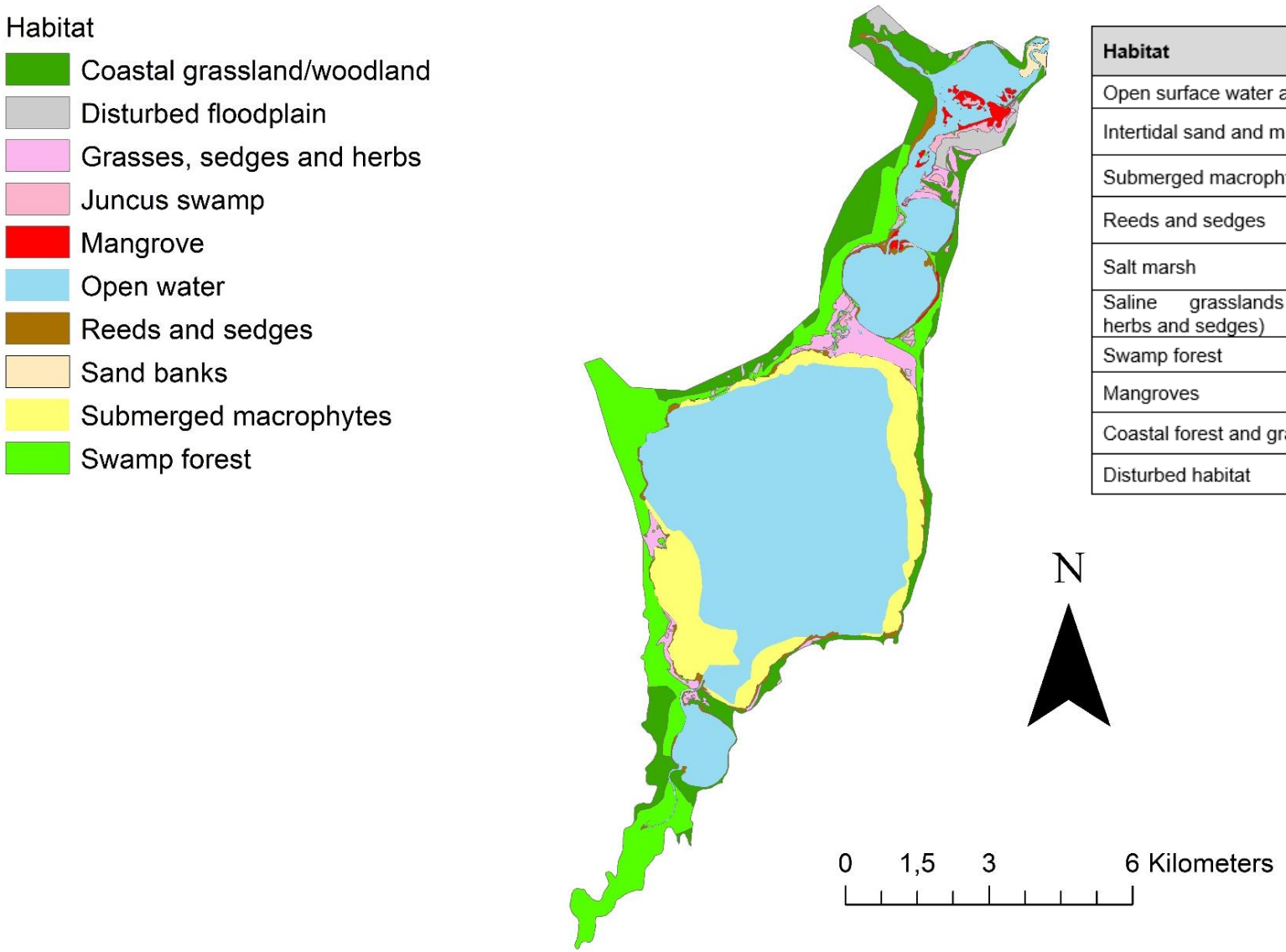
Habitat	Area (ha)
Beach and dune sand	5.8
Degraded	185.5
Developed	158.6
Developed - informal forestry	0.7
Floodplain	352.1
Open Water	531.2
Reeds and sedges	429.0
Sand and mudbanks	20.0
Swamp Forest	0.8
Terrestrial Vegetation	561.5
Wetlands	1.3

B6 UMGOBEZELENI ESTUARY



Habitat	Area (ha)
Beach and dune sand	5.0
Degraded	75.7
Developed	21.6
Mangroves	0.4
Open Water	129.3
Reeds and sedges	258.9
Rocks	1.1
Swamp Forest	421.8
Terrestrial Vegetation	116.5

B7 KOSI ESTUARY



Habitat	Area ha (2016)
Open surface water area	3367
Intertidal sand and mudflats	23
Submerged macrophytes	652
Reeds and sedges	127
Salt marsh	58
Saline grasslands (grasses, herbs and sedges)	229
Swamp forest	869
Mangroves	71
Coastal forest and grassland	721
Disturbed habitat	119

B8 ST LUCIA/IMFOLOZI ESTUARY

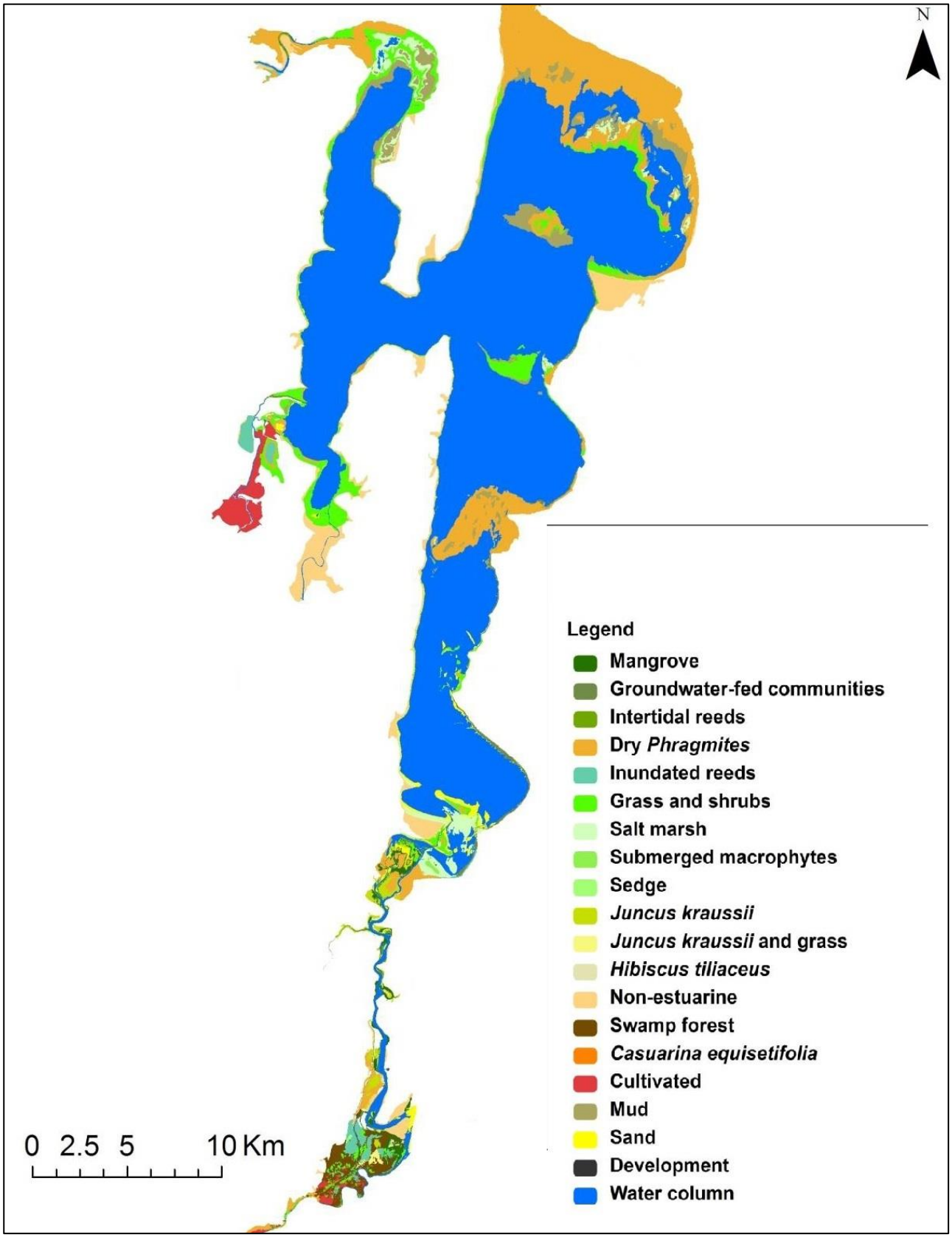


Table B1 Area covered by the different habitat units at the St Lucia Lakes

Location	Habitat unit	Area (ha)		
		1960	2001	2008
Eastern Shores	Dry *Phragmites*	3393.1	3752.4	4914.8
	Grass and shrubs	587.0	557.1	821.2
	Groundwater-fed communities	204.8	62.2	115.8
	Intertidal mudflats	15.3	4.6	1042.9
	Intertidal *Phragmites*	23.9	18.6	36.2
	Inundated *Phragmites*	1310.0	1019.5	16.0
	Juncus kraussii & grass	0	3.9	4.0
	Mangrove	0	0.7	0.8
	Salt marsh	0	21.2	617.1
	Sand	16.2	0.9	257.7
	Submerged macrophytes	62.2	0	19.3
	Water	2247.6	2419.1	14.5
Total		**7860.2**	**7860.2**	**7860.2**
Narrows	Back Channel	0	1.9	1.3
	Dredge spoil	43.7	123.8	131.2
	Dry *Phragmites*	457.1	374.4	372.6
	Grass and shrubs	31.4	71.3	63.3
	Hibiscus tiliaceus	6.5	8.0	8.6
	Intertidal *Phragmites*	6.6	27.6	117.5
	Inundated *Phragmites*	0	1.9	0.6
	Juncus kraussii	206.1	178.0	196.8
	Linking Channel	0	19.6	13.5
	Mangrove	246.5	289.8	304.1
	Mpate River	8.5	8.9	2.2
	Sand	29.4	24.5	114.9
	Sedges	0	0	0.2
	Water	291.1	197.2	0
Total		**1326.9**	**1326.9**	**1326.9**
Western Shores	Cultivated	*	*	518.3
	Dry *Phragmites*	*	*	629.4
	Grass and shrubs	*	*	1336.2
	Groundwater-fed communities	*	*	4.1
	Hluhluwe River	*	*	31.5
	Intertidal mudflats	*	*	580.8
	Intertidal *Phragmites*	*	*	41.1
	Inundated *Phragmites*	*	*	185.5
	Juncus kraussii & grass	*	*	0.03
	Mkuze River	*	*	8.04
	Mzinene River	*	*	77.05
	Nyalazi River	*	*	25.8
	Salt marsh	*	*	385.0
	Sand	*	*	159.1
Total		*	*	**3981.9**

Table B2 Area covered by the different habitat units at the uMfolozi Swamp

Location	Habitat unit	Area (ha)		
		1960	2001	2008
Mfolozi Swamps	Cultivated	*	*	162.1
	Casuarina equisetifolia	*	*	1.0
	Dredge spoil	*	*	82.9
	Dry *Phragmites*	*	*	57.1
	Grass and shrubs	*	*	120.7
	Intertidal *Phragmites*	*	*	26.2
	Inundated *Phragmites*	*	*	225.5
	Juncus kraussii	*	*	9.0
	Juncus kraussii & grass	*	*	46.6
	Sedges	*	*	6.1
	Swamp forest	*	*	486.3
Total		*	*	**1223.4**

8 APPENDIX C: COMMENTS AND RESPONSE REGISTER

No.	Section	Comment	From	Addressed?
GENERAL				
1.	General	The draft Reconciliation report for the Umfolozi catchment has been completed. The information in the text box below is an extract from the said Report. Please elaborate how the proposed EWRs impact on the proposed dam/s developments in the catchment and the subsequent water supply security for water users? ***Proposed Lake Nkata Off Channel Storage Dam*** *A number of proposed dams have previously been considered in the Umfolozi catchment. These are summarised in the Screening of Dam Options Report, prepared as part of this study. After completion of the water balances, the indication is that there are deficits in the lower Umfolozi catchment resulting from increasing domestic requirements, as well as the environmental requirement to maintain an open river mouth.* *Based on the requirements, and the proposed dam yields, the preferred option appears to be the Lake Nkata off channel storage dam. Previous assessments were undertaken on four dam sizes ranging from 30 million m^3 to 78 million m^3 and diversion capacities of 2 m^3/s and 2.5 m^3/s. Updated analyses were undertaken to determine whether the proposed dam would be able to supply the growing requirements of Matubatuba and Mpukunyoni WSSs as well as the minimum flows at the mouth."*	M Singh M Maharaj R Pillay	The recommended proposed dam has been assessed by incorporating the minimum flow requirements for the Umfolozi mouth. The EWR has been supplied in addition to supply towards the water supply scheme deficits.
2.	General	In all the Tables relating to the Water Quality RQOs: **Total metal concentrations in water not to exceed target values as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995 or official future updates thereof)** – Is this the full suite of metal concentrations? Please include the list of metals and associated TWQG as an appendix for ease of reference and completeness of the document. Often those who read this document will prefer to have all the relevant information within the body of one document to prevent errors and limit confusion.	M Singh M Maharaj R Pillay	See **Table A1** in **Appendix A** for detail.
3.	General	In all the Tables relating to the Water Quality RQOs: **Total metal concentration in sediment not to exceed target values as per West Indian Ocean (WIO) Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009 or official future updates thereof)** – Please include the list of metals and the target values as an appendix for ease of reference and completeness of the document. Often those who read this document will prefer to have all the relevant information within the body of one document to prevent errors and limit confusion.		See **Table A2** in **Appendix A** for detail.
4.	General	**Protect the flow regime to create the required habitat for birds, fish, macrophytes, microalgae and water quality** – in the RQO tables please also indicate the flow regime requirements.	M Singh M Maharaj R Pillay	Detail available in detail specialist reports. The Implementation report (Hydrology chapter) should provide a detailed breakdown of flows.
5.	General	**DDT in sediment exceeds target values as per sediment quality guidelines, e.g. WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009 or official future updates thereof).** - Please include the list of metals and the target values as an appendix for ease of reference and completeness of the document. Often those who read	M Singh M Maharaj R Pillay	See **Table A1** in **Appendix A** for detail.

No.	Section	Comment	From	Addressed?
		this document will prefer to have all the relevant information within the body of one document to prevent errors and limit confusion.		
6.	General	HAB – Harmful Algal Bloom – please include this in full the first time it is used or as part of the acronym table.	M Singh M Maharaj R Pillay	Harmful Algal Bloom (HAB) is used first time on page 4-3 and explained.
7.	General	While Appendix A is noted, are there any Google Earth KML files which contain the delineation of the estuary zones and vegetation coverage within these zones.	M Singh M Maharaj R Pillay	Shapefiles can be converted to KML and will be provided. Shapefiles will also be shared and uploaded to SANBI BGIS and given to KZN Provincial government for their viewer.
8.	General	The PSP should review and consider the outcomes and recommendations regarding water resources development in these catchments as per the Reconciliation Study as they would directly impact on proposed RQOs and the achievement thereof.	M Singh M Maharaj R Pillay	Noted.
9.	General	Climate change and variability in rainfall, may impact on the mouth closure dynamics and other aspects presented in the proposed RQO. How would DWS then address this? If the requirements cannot be met naturally, does this imply an intervention is required to achieve this recommendation.	M Singh M Maharaj R Pillay	Climate change will require regular review at decadal scales of present flow allocations to make sure that a balance is met between ecological and societal needs. Desalination is always an option in coastal environments to ensure that the Reserve is met for an estuary.
10.	Spelling Pg xxiii	Various spellings of Estuaries	R Cedras	No. As stated below the table the names adopted in the estuaries report are the official names assigned to the systems in the 'South African National Ecosystem Classification System' (and the *KwaZulu-Natal Department of Economic Development* and *Environmental Affairs) (*Dayaram *et al.,* 2021).
11.	Section 4.8 Pg 4-8	Spelling convention is inconsistent. Please check spelling elsewhere and in figure 6.8.	R Cedras	Corrected.
12.	Figure 1.1 Pg 1-2	Can we also have a map indicating the locations of the estuaries in the WMA?	N Jafta	The estuaries are too small and not visible on the regional map.
13.	Section 2.2 Pg 2-3	The overall target was to protect a minimum of 20% of the total **estuarine area**. National total estuarine area or 20% of each estuary?	N Jafta	20% of the total estuarine area. These targets are under review at present to meet Global Biodiversity Framework targets of 30%.
14.	Section 2.2 Pg 2-3	Paragraph in bold: Maybe not water sector as a whole, but the classification process and/or the water use authorisation or reconciliation strategies, as it may be a negotiated process with also users in mind. The Reserve may however have a stringent REC, to protect the water resource and with the consideration of the biodiversity and environmental targets. May you perhaps re-word this paragraph. **…not aligning/supporting long-term estuary management or estuary protection objectives –** please revise.	N Jafta	Changed 'Water Sector' to 'Water Resource Classification process'. Note however the outcome is the same in that the Water Sector objectives do not align with overall estuary management objectives.
15.	Section 3.1 Pg 3-1	There is no DWA 2013a under references.	N Jafta	Removed reference as it is not needed. All estuaries in the WMA are included in the list.

No.	Section	Comment	From	Addressed?
16.	Section 3.3 Pg 3-2	**Where limited data is available RQOs are usually determined rather than EcoSpecs as the requirements for RQOs are broader or less detailed**… I thought EcoSpecs are only based on ecology, and then RQOs would be a combination of EcoSpecs and user-specs, as they are about the TEC not the REC only.	N Jafta	Correct RQOs are set for both ecology and users, but the report also stresses that EcoSpecs are more detailed than RQOs in many cases. Sentence added to indicate that: RQOs also consider user requirements such as recreational water quality.
17.	Section 3.3 Pg 3-3	**RQOs are set for the short term (<5 years)** Short term only?	N Jafta	The RQOs were set for the 5-year period of the gazette. Both short-term and long-term remedial actions are listed as some may take years to address the downward trajectory.
18.	Section 3.4.3 Pg 3-4	**For estuaries where the Blue Flag status has been awarded, or for estuaries immediately adjacent to beaches awarded Blue Flag status, the ROQ for recreation in the "Excellent" category will be assigned**. - There may be some cases were beaches awarded with Blue Flag status loses it status in the ensuing years. How would DWS deal with this in terms of the RQOs? Will the prescribed RQOs still apply to a beach that has lost is Blue Flag status as the RQO will be gazetted?	M Singh M Maharaj R Pillay	Blue Flag is not legal requirement. Statement removed.
19.		For **other systems**, the output is usually? based on a hydrological time series generated for the **Present Ecological State (PES)** with an indication that the various components of the flow regime (baseflows and floods) meet the EWR requirement. ???? Which other systems? Are you indicating that usually for other systems the different components of the flow regime are separated? While in in this case that was not done? For the PES or the TEC?	N Jafta	Confusing sentences were deleted, and information added on groundwater-driven systems. Groundwater-driven systems were indicated as a percentage of natural inputs and Groundwater stress index value.
20.	Table 4.1 Pg 4-2	There are sections in the table were reference is made to, for example, not differing from >5% from the Present State, or reference is made to a background value (not provided in the text but instead another report is referred to) or the author refers to what has been presented in a previous report (e.g DWS 2015a) – In all of these cases, please include the actual values in the body of the document for ease of reference so that officials do not have to move back and forth between various documents. Baseline information should be incorporated within this document for ease of reference and completeness of the RQO report. Often those who read this document will prefer to have all the relevant information within the body of one document to prevent errors and limit confusion. This document should be such that it is able to be read as a stand-alone document. **THIS COMMENT APPLIES TO ALL TABLES.**	M Singh M Maharaj R Pillay	Added: (MAR = 113.77 x10^6 m^3) Note: Present Mean Annual Runoff (MAR) is a variable concept. Relative change in MAR and monthly runoff is more accurate than the absolute change. Details of assumptions are available in e-copies of supplementary material. See Comment 100 for details of these reports.
21.		Non-flow interventions: Is an Estuary Management Plan in place or is the recommendation to have one in place? Similar to below statement? Remember there were a lot of discussions during our meetings on terms like "curbing" without providing alternatives. Along the river or along the estuary? If also along the river, maybe up to how many kilometres upstream?	N Jafta	Status of Estuary Management Plans: ▪ aMatigulu/iNyoni Estuary - prioritised for 2024/5. ▪ iSiyaya Estuary - prioritised for 2024/5. ▪ uMlalazi Estuary - prioritised for 2024/5. ▪ uMhlathuze Estuary - DFFE plan. ▪ **iNhlabane Estuary – no plan**. ▪ uMgobezeleni Estuary – in progress.

No.	Section	Comment	From	Addressed?
		And, is it too contentious to add a buffer length? E.g. 20m, 32m, 10m? The streamflow reductions activities unit of the Department has an MoA with the sugar industry and they plan to use the recommendations from the Classification and RQOs studies to negotiate management of dryland sugarcane, including the implementation of buffers.		▪ Kosi Estuary - in progress. ▪ St Lucia/uMfolozi Estuary - in progress. Correct in that it will be a slow process to bring resource and land use to sustainable levels to balance ongoing ecological degradation with resource use in the area. Rivers will need to be buffered all the way as most systems are medium to heavily impacted resulting in nutrient and sediment pollution.
22.		…institute a buffer of natural vegetation along the river ….. The feasibility of this would need to be investigated and propose rewording to "investigate the feasibility of instituting a buffer of natural vegetation …." There may be some water users who may have either encroached the buffer area along the river or may have water use licences that need to be reviewed in terms of the planting or location of activities. In the absence of vegetation in the buffer zone, does this recommendation imply that vegetation will need to be planted.	M Singh M Maharaj R Pillay	The buffer is needed to improve the water quality (reduce nutrient and sediment input). It cannot be an "optional" improvement given that the required flow could not be provided (locked into existing use). The improved water quality was the only way to meet the conservation targets.
23.		Hydrodynamics: Mouth closure occurs more than 6 - 8 weeks in a year - **Is this saying mouth closure should occur more than 6-8 weeks?** Mouth closure occurs between September and March - **During the high flow/rainfall period?**	N Jafta	Corrected to indicate 'less than'.
24.		Hydrodynamics: With Climate change and variability in rainfall, might this not impact on the mouth closure dynamics presented in this RQO and how would DWS then address this? If the requirements cannot be met naturally, does this imply an intervention is required to achieve this recommendation.	M Singh M Maharaj R Pillay	At present anthropogenic impacts are larger than climate change impacts and can be managed by DWS. Under future climate conditions, DWS will have to restrict users more during drought conditions (and in some cases low flow periods) to ensure environmental sustainability. Desalination along the coast is a way to address this.
25.		Physical habitat (sediments): Is there no way of adding the TSS or water clarity values? And it is better to out the targets here than to refer the audience to go check a different report.	N Jafta	TSS should not be increased by more than 10% of ambient concentrations, as per 1995 guidelines (DWAF 1995). In 2008, the protection of coastal waters (including estuaries) became the responsibility of DFFE under the ICM Act. DFFE is in the process of revising the 1995 guidelines in which case these RQOs may have to be adjusted, where necessary.

No.	Section	Comment	From	Addressed?
26.		Physical habitat (sediments) No deviation in sedimentation and erosion patterns in the estuary to occur from the present baseline (refer to DWS, 2015). How can this status be maintained in the event of land use changes and/or extreme weather events.	M Singh M Maharaj R Pillay	See the recommendation for a natural vegetation buffer along estuary and river to control sediment input.
27.		Water quality (salinity): Salinity values **>5 in the upper reaches** - During which period/or state? ▪ Turbidity high flows naturally **turbid** - Is adding water clarity for these systems not possible?	N Jafta	Salinity should never increase above 5. Turbidity values can go very high – greater than 1000 NTU. Difficult to set realistic targets.
28.		Water quality (salinity): ▪ Please include units of measurement for the salinity values. **THIS COMMENT APPLIES TO ALL TABLES.** ▪ For river inflow: **pH: 7.5 < pH > 8.5 consistently over 2 months** - does this apply to any two months or consecutive months? ▪ Suggesting including/unpacking what is meant by NO_x for the reader.	M Singh M Maharaj R Pillay	Salinity is unit less as it is a ratio. Consecutive months. NO_x-N refers to Nitrate + Nitrite. NO_x - clarified where first used.
29.		Water quality (general): (Data could be reviewed depending on the results of the baseline study) Was the data from WMS not considered as a baseline?	S Majola	Statement removed.
30.		Microalgae: No bloom conditions (represented by values >20 µg Chl-a l^{-1}) Does this mean that under no circumstances should any recorded monitoring values be greater than 20 µg Chl-a l^{-1}? **THIS COMMENT APPLIES TO ALL TABLES.**	M Singh M Maharaj R Pillay	Correct. No bloom conditions should be occurring.
31.		Macrophytes: …and presence of **submerged macrophytes** (refer see Appendix A and DWS, 2023a) - There are no submerged macrophytes in Amatigulu according to the maps in Appendix A Invasive plants (e.g. syringa berry, Brazilian pepper tree, lantana, *Chromolaena*, *Opuntia*) **largely absent** from the riparian zone - Maybe these types of statements could read as: "Maintain invasive plants (e.g. ……) at less than 10% or 5% (example) cover ……..." Just to assist in their measurability ▪ **Unvegetated, cleared areas along the banks**. **Floating invasive aquatics ???? observed in the upper estuary reaches** - Should be observed? Or were observed? And allowed at less that 20%? And is it aquatic **plants** or macroalgae? I'm checking if the first statement is related to the second one on macroalgae. And what the RQO is **Sugarcane is present in the estuarine functional zone** – Is the recommendation/RQO to not have sugarcane in the EFZ? (NJ) Meaning what? How is the presence of sugarcane become an RQO? (SM)	N Jafta S Majola	Submerge macrophytes are highly variable in extent and occurrence and were not present during some of the field studies. Their extent was thus not mapped in all the systems. However, historical data show they do occur in some systems during some abiotic states. Changed to: ▪ Invasive plants (e.g. syringa berry, Brazilian pepper tree, lantana, *Chromolaena*, *Opuntia*) should be largely absent from the riparian zone. ▪ No unvegetated, cleared areas along the banks. ▪ Floating invasive aquatics should not be observed in the upper estuary reaches. ▪ Macroalgae cover should be <20% of estuarine water surface area. ▪ Sugarcane should not be present in the estuarine functional zone.

No.	Section	Comment	From	Addressed?
				▪ There should not be extensive land cover change of natural land in the iNyoni and aMatigulu EFZ – less than 5% change from 2023.
32.		Macrophytes: Maintain the distribution of macrophyte habitats to present baseline …" Please provide shapefiles mapping the extent of macrophyte habitats. Sugarcane is present in the estuarine functional zone. Extensive land cover change in the iNyoni and aMatigulu catchments and EFZ This sentence seems incomplete. Are we meant to prevent further expansion of sugarcane or limit impacts?	M Singh M Maharaj R Pillay	Shapefiles will be shared and uploaded to SANBI BGIS and given to KZN Provincial government for their viewer.
33.		Invertebrates: Maintain the TEC (>78%) through (**DWS 2015a, 2023a**) - I'm assuming the data from these references will be used as a reference for calculating number per m^2.	S Majola	Correct.
34.	Table 4.2 Pg 4-5	There are sections in the table were reference is made to, for example, not differing from >5% from the Present State (DWS, 2022), or reference is made to a background value (not provided in the text but instead another report is referred to) or the author refers to from what has been presented in a previous report (e.g DWS 2015a) – In all of these cases, please include the actual values in the body of the document for ease of reference so that officials do not have to move back and forth bet5%ween various documents. Baseline information should be incorporated within this document for ease of reference and completeness of the RQO report. Often those who read this document will prefer to have all the relevant information within the body of one document to prevent errors and limit confusion.	M Singh M Maharaj R Pillay	Added: MAR = 3.39 x10^6 m^3) Present Mean Annual Runoff (MAR) is a variable concept. Relative change in MAR and monthly runoff is more accurate than the absolute change. Details of assumptions are available in e-copies of supplementary material. See Comment 100 for details of these reports.
35.		**Mitigate the impacts of mining by ensuring a 1 km buffer zone of riparian vegetation -** Tricky. It basically means remove the mine and entire forestry.	N Jafta	No, it means remove part of mine near estuary.
36.		**Mitigate the impacts of mining by ensuring a 1 km buffer zone of riparian vegetation –** This will need to be investigated further to understand what activities are taking place in and around the proposed 1km buffer zone and to determine what water use activities are being engaged in, whether these are lawful or not and investigate the possibility of incorporating certain actions within existing water use authorisations.	M Singh M Maharaj R Pillay	Agree, but given that mining combined with denuded land because of forestry have major water quality impact in an estuary in a provincial park it needs to be done
37.		Reduce the direct impact of forestry on the estuary by instituting buffer zones around the estuary (e.g., 1 km zone), while over longer time scales baseflows should be restored by an overall reduction in forested areas in the catchment. The Regional office will have to investigate further to determine the legal status of the forestry in this catchment. Please note that it may be difficult to implement this as some forestry is existing lawful water use (pre- 1972). A policy position is required from Head Office: CME in this regard.	M Singh M Maharaj R Pillay	Also needs to be taken up with DFFE Working Group 7: Oceans and Coast – Mining Task Team to support this.
38.		Hydrodynamics: ▪ **Mouth closure occurs for <3% -** Is it practical?	N Jafta	Yes, as it should only close for brief periods. Has mangroves.
39.		Hydrodynamics: ▪ **Monthly river inflow <0.05 m^3/s for more than 10% of the time** - These flows are determined be based on releases from upstream or are these natural flows?.	S Majola	Present flows. No releases.

No.	Section	Comment	From	Addressed?
		▪ **Monthly river inflow <0.5 m^3/s for more than 87% of the time** - I'm guessing it will be >0.5 m3/s for 3% of the time?		
40.		Physical habitat (sediments): Findings from the bathymetric surveys undertaken as part of a monitoring programme indicate changes in the sedimentation and erosion patterns in the estuary have occurred (± 0.5 m). When was this study conducted and by whom?	S Majola	No baseline study.
41.		Water quality (salinity): **Bottom Salinity values not between 5 - 10 in the Lower reaches (Zone A) for more than 90% of the time -** Is the target that it should also be higher sometimes? (NJ). I think this sentence needs to be rephrased, it's a bit confusing. (SM)	N Jafta S Majola	▪ Changed to: ▪ Surface Salinity values >4 in the Lower reaches (Zone A) for more than 90% of the time (develop under persistent close mouth conditions). ▪ Bottom Salinity values between 5 - 10 should not occur in the Lower reaches (Zone A) for more than 90% of the time (develop under persistent close mouth conditions).
42.		Water quality, salinity: Please include units of measurement for the salinity values.	M Singh M Maharaj R Pillay	Salinity is unit less as it is a ratio.
43.		Water quality (general): ▪ Trace metals (freshwater quality guidelines for aquatic ecosystems, volume 7 (DWAF, 1996)?) ▪ Pesticides/herbicides (freshwater quality guidelines) **Estuary:** ▪ Total metal concentrations in estuary waters exceed target values as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995 or official future updates thereof). ▪ Total metal concentration in sediment exceeds target values as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009 or official future updates thereof). May these be tables that form part of the methods similar to the microbial table taken from the DEA guidelines. Or be an annexure. So that a person that picks up this document does not have to also go to 5 other documents to interpret what's here. Also, there are several water quality guideline documents and volumes and not everything in there speaks to this, so let's make this a user-friendly document.	N Jafta	See **Table A1** and **A2** in **Appendix A** for detail.
44.		Water quality, general: For river inflow – Please include the list of metals and pesticides/herbicides and associated target values as an appendix for ease of reference and completeness of the report.	M Singh M Maharaj R Pillay	See **Table A1** and **A2** in **Appendix A** for detail.
45.		**Average estuary salinity:** Is it ok to put it like this?: Salinity values =>23 in Zone A. Salinity values <=16>11 in Zone B.	S Majola	Estuary salinities are highly variable. While the average measure of salinity per zone per state was used in the EWR assessment and RQOs some leeway will be needed in

No.	Section	Comment	From	Addressed?
		Salinity values <=11>3 in Zone C. Salinity values <=3 in Zone D.		interpreting the data. Hence the = sign was not used.
46.		Water quality (general): **6.0** < pH > 8.5 - What causes the low pH both in the river inflow and estuary?	S Majola	Black water system from swamp forest.
47.		Microalgae: **Based on average values recorded throughout estuary** – How many sampling trips were used for the average values? Were low and high flows considered?	S Majola	Once-off detail sampling for microalgae. Some historical data is available. Where possible microalgae data was binned into hydrodynamic abiotic states to represent a range of flow conditions.
48.		Microalgae: **No bloom conditions (represented by values >20 µg Chl-a l^{-1}).** Does this mean that under no circumstances should any recorded values be greater than 20 µg Chl-a l^{-1}?	M Singh M Maharaj R Pillay	Correct.
49.		Macrophytes: **No development in estuarine functional zone. No plantations or agriculture (e.g. sugarcane) in the estuarine functional zone** Please refer to comment made under long term approach.	M Singh M Maharaj R Pillay	Estuary in Nature Reserve. It should not have development or agriculture in EFZ.
50.		There are sections in the table were reference is made to, for example, not differing from >5% from the Present State, or reference is made to a background value (not provided in the text but instead another report is referred to) or the author refers to what has been presented in a previous report (e.g DWS 2015a) – In all of these cases, please include the actual values in the body of the document for ease of reference so that officials do not have to move back and forth between various documents. Baseline information should be incorporated within this document for ease of reference and completeness of the RQO report. Often those who read this document will prefer to have all the relevant information within the body of one document to prevent errors and limit confusion. This document should be such that it is able to be read as a stand-alone document. **THIS COMMENT APPLIES TO ALL TABLES.**	M Singh M Maharaj R Pillay	Added: (MAR = 99.55 x10^6 m^3). Present Mean Annual Runoff (MAR) is a variable concept. Relative change in MAR and monthly runoff is more accurate than the absolute change. Details of assumptions are available in e-copies of supplementary material. See Comment 100 for details of these reports.
51.	Table 4.3 Pg 4-8	Interventions: **No wastewater** should be discharged into the system and agricultural best practices should be implemented through farm plans to reduce nutrient-rich agriculture return flow – No additional to current discharge (i.e. rejection of the WWTW expansion scenario)? Or even the current discharges need to be stopped? **Where possible, i.e. not build up, create interventions (e.g. replanting of natural vegetation, artificial wetlands, managing grazing) within a 500 m buffer zone around the EFZ to improve the nutrient status and reduce sediment inputs** – So is the idea that there is no removal of sugarcane and afforestation that is recommended, the only thing that needs to be done is to control their impacts and impacts of other activities and re-vegetate degraded areas?	N Jafta	Correct WW should not be discharged into this estuary. Treatment works should not be expanded. Restoration of EFZ is a separate bullet in this section.
52.		Interventions: **No wastewater should be discharged into the system ….**	M Singh M Maharaj R Pillay	Correct. Given that the system is in a Nature Reserve and DWS has allocated the river inflow to the point that close mouth/stagnant

No.	Section	Comment	From	Addressed?
		Does this mean no further wastewater should be discharged or does this also apply to existing authorised wastewater discharges? Again, this will have to be communicated to the municipality and this will have to be included in their IDPs and their water and sanitation master plans. The same would apply to other users. Can wastewater be discharged if it is treated to Special Limit Values?		conditions developed where before the system was well flushed. The only solution is to reduce nutrient pollution to prevent bloom and low oxygen events. The last survey during closed mouth conditions showed extremely low DO conditions.
53.		Interventions: **Undertake restoration of the uMlalazi EFZ and reduce agriculture impacts in the supratidal area of the system.** The Department can address illegal or unlawful activities. Head Office needs to provide guidance on how to deal with authorised agricultural activities in this area – what is the policy position on removal of existing authorised activities?	M Singh M Maharaj R Pillay	See the Implementation Plan. The lead authority should be the provincial departments that deal with agriculture and the environment. DWS is not the only responsible authority.
54.		Interventions: **Remove/prevent sand-mining in the upper reaches of the system.** The Department can address illegal or unlawful activities. Current authorised mining will have to be strictly regulated.	M Singh M Maharaj R Pillay	Also needs to be taken up with DFFE Working Group 7: Oceans and Coast – Mining Task Team to support this.
55.		Interventions: **Maintain hydrological connectivity by ensuring that roads and bridges do not impact tidal and river flows.** Culverts etc. will have to be maintained and depending on whether this is a national, provincial or local road/bridge, there are different institutions responsible to maintain culverts, etc. This should be specifically identified, and solutions/interventions proposed.	M Singh M Maharaj R Pillay	Correct and should be included in the Estuary Management Plan.
56.		Hydrology: **Monthly river inflow <0.25 m^3/s for more than 1% of the time** - Should not be? These statements throughout the document confuse me. They are missing direction. Is it a should or should not?	N Jafta	Corrected to indicate it 'should not be'.
57.		Hydrodynamics: Mouth closure occurs for less than **2 years out of ten** – And this mouth closure of less that 2-4 weeks per year should only occur in 2 years out of a 10 year period?	N Jafta	▪ Mouth closure occurs less than 2 - 4 weeks per annum at a water level > 1.5 m mean sea level. ▪ Mouth closure occurs for less than 2 years out of ten. ▪ Mouth closure occurs between September and March. ▪ No changes in tidal amplitude at the tidal gauge of more than 20% from Present State (2015). These are separate conditions and all need to be met.
58.		Hydrodynamics: **Mouth closures at specific times** - Climate change and variability in rainfall may impact on the timing and duration of mouth closure.	M Singh M Maharaj R Pillay	Correct, but at present anthropogenic allocations (especially low flows) exceed Climate Change impacts on mouth state.

No.	Section	Comment	From	Addressed?
59.		Physical habitat (sediments): **Suspended sediment concentration in river inflow deviates by <20% of the sediment load-discharge relationship of the present state (refer to DWS, 2015b)** - Please bring the information into this report. The comment is applicable to other similar recommendations/RQOs.	N Jafta	No measured data was available. Where available, information was incorporated as was the case for most water quality parameters.
60.		Water quality (salinity): Salinity values **<16 in Zone B** - Should it not be a range? E.g. 16-11 in Zone B 1-3 in Zone C? Or surface and bottom?	N Jafta	For the purpose of this study, the average salinity was calculated on measured data (one or more stations) for each zone for each state. This value was used in the RQO. Real-world measurements will be a range.
61.		Water quality (general): ▪ Total metal concentrations in water not to exceed target values as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995 or official future updates thereof). ▪ Total metal concentration in sediment is not to exceed target values as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009 or official future updates thereof). See above comment. Also applicable to the rest of the document.	N Jafta	See **Table A1** and **A2** in **Appendix A** for detail.
62.		Macrophytes … and the presence of **submerged macrophytes**. (refer to Appendix A and DWS, 2023c) - The habitat table does not show submerged macrophytes and it is not the first time they are referred to in the text but are not in Appendix A. What could they be falling under in the table? Also, may the shapefiles for the estuarine habitats please be shared.	N Jafta	Submerge macrophytes are highly variable in extent and occurrence and were not present during some of the field studies. Their extent was thus not mapped in all the systems. However, historical data show they do occur in some systems during some abiotic states. Shapefiles will be shared and uploaded to SANBI BGIS and given to KZN Provincial government for their viewer.
63.		Macrophytes: **Floating invasive aquatics observed in the upper estuary reaches. Macroalgae cover <20% of estuarine water surface area** - See previous comment.	N Jafta	Floating invasive aquatics are highly variable in extent and were not present during some of the field studies. Their extent was thus not mapped in all the systems. However, historical data show they do occur in some systems during some abiotic states.
64.		Macrophytes*:* **…Swamp Forest stands (> 159 ha) and the presence of submerged macrophytes. (refer to Appendix A and DWS, 2023c)** – Can the delineation of these areas be provided in a Google Earth kml file.	M Singh M Maharaj R Pillay	Shapefiles can be converted to KML and will be provided. Shapefiles will also be shared and uploaded to SANBI BGIS and given to KZN Provincial government for their viewer.
65.	Table 4.4 Pg 4-13	Water quality (river inflows): Please include the list of metals and pesticides/herbicides and associated target values as an appendix for ease of reference and completeness of the report.	M Singh M Maharaj R Pillay	See **Table A1** and **A2** in **Appendix A** for detail.
66.	Table 4.5 Pg 4-17	Non-flow interventions: **No wastewater discharges (sewage or industrial) should be discharged into the lakes or estuary.**	M Singh M Maharaj R Pillay	This system is not listed as having a formal WWTW on it. No new TW should be permitted as per SA policy for estuaries.

No.	Section	Comment	From	Addressed?
		Does this imply no additional wastewater can be discharged or does this also include existing authorised wastewater discharges? Again, this will have to be communicated to the municipality and this will have to be included in their IDPs and their water and sanitation master plans. This is not something that can happened overnight as all users discharging will have to be identified and engagements held to find suitable viable options. Can wastewater be discharged to the estuary if it is treated to Special Limit Values?		The iNhlabane Estuary is too small and closed for long periods to deal with any WW regardless of permit conditions.
67.		Physical habitat (sediments): There are certain sections where it is mentioned that the baseline has to be determined. Who is responsible for determining this baseline as it forms part of study completion – is this a task for DWS: Head Office? Why has this not been determined as part of this study?	M Singh M Maharaj R Pillay	As this estuary does not fall within a Nature Reserve or Park and DWS is responsible for the overallocation of water it will be DWS responsibility to monitor the impact on the system.
68.		Water quality (general): ▪ **Trace metals (to be determined).** ▪ **Pesticides/herbicides (to be determined).** When? By whom?	S Majola	Details on the sampling approach are in the Implementation report and specialist reports. Sampling should be conducted by the Management Authority and DWS.
69.		Water quality (general): **6.0 < pH > 8.5 in a sampling survey (to be verified by sampling).** Does this mean it was not verified during the project?	S Majola	Estuaries naturally range in pH as they comprise a mix of freshwater and seawater. Estimated pH range based on expert opinion as lack of historical data and once-off sampling prevent a high confidence RQO as indicated by brackets.
70.		Water quality (general): ▪ **(Data could be reviewed depending on the results of the baseline study).** Does this mean it was not verified during the project?	S Majola	Lack long long-term monitoring data. Once-off sampling needs further investigation.
71.		Water quality (general): **No sugarcane in the EFZ (estuarine functional zone).** DWS will need to undertake further investigations to determine if the sugarcane is authorised or unauthorised. If authorised, DWS Head Office need to advise on the way forward and provide a policy position on how to address this. Same applies to the authorised uses occurring within EFZ. Any proposed curtailment of existing water use in these sensitive areas has to be carefully considered in terms of financial and social implications.	M Singh M Maharaj R Pillay	See the Implementation Plan. The lead authority should be the provincial departments that deal with agriculture and the environment.
72.		▪ Suggest adding at the bottom of the table what is meant by NOx to assist the reader. ▪ River inflow pH: 7.5 < pH > 8.5 consistently over 2 months, does this apply to any two months or consecutive months? ▪ Who is responsible for determining the trace metals and pesticides/herbicides RQOs as it is mentioned that this will still need to be determined. Why has this not been completed as part of this study?	M Singh M Maharaj R Pillay	NO_x-N commonly refers to Nitrate + Nitrite. Added clarification the first time the term is used in the report. Consecutive months. Trace metals and pesticides/herbicides sampling are extremely costly and require regular trend monitoring. These were not prioritised for the flow requirement study.

No.	Section	Comment	From	Addressed?
				Baseline conditions should be determined by iSimangaliso Wetland Park Authority. This is indicated in the Implementation Plan.
73.	Table 4.6 Pg 4-19	Non-flow interventions: No sugarcane in the EFZ (estuarine functional zone). Will need to be incorporated into the EMP – DFFE?	M Singh M Maharaj R Pillay	Correct.
74.		Non-flow interventions: **No wastewater discharges (sewage or industrial) should be discharged into the lakes or estuary.** Does this imply no additional wastewater can be discharged or does this also include existing authorised wastewater discharges? Again, this will have to be communicated to the municipality and this will have to be included in their IDPs and their water and sanitation master plans. Can wastewater be discharged into the estuary if it is treated to Special Limit Values?	M Singh M Maharaj R Pillay	There is no WWTW discharging into the system. No new discharges should be allowed as it will cause eutrophication in a World Heritage site.
75.		Non-flow interventions: **Maintain hydrological connectivity by ensuring that roads and bridges…** Culverts etc. will have to be maintained and depending on whether this is a national, provincial or local road/bridge, there are different institutions responsible to maintain culverts, etc.	M Singh M Maharaj R Pillay	iSimangaliso Wetland Park Authority is responsible for structure as it is in the park. Indicated in the implementation plan.
76.		Non-flow interventions: **Eradicate and monitor the occurrence of alien invasive species…** How can this be executed and who will be responsible for undertaking this task.	M Singh M Maharaj R Pillay	iSimangaliso Wetland Park Authority is responsible as it is in the park. DFFE can assist with the monitoring. Indicated in the implementation plan.
77.		Hydrology: Please also indicate the flow regime requirements. *Maintain groundwater resources within 15% of natural levels.* **What is the baseline value? Please include for ease of reference.**	M Singh M Maharaj R Pillay	No detailed accurate information was available on the natural levels, hence relative RQO.
78.		Water quality (general) **6.0 < pH > 8.5 in a sampling survey (to be verified by sampling)** Why was this not conducted as part of this study? Please confirm that the lower limit value of pH is 6 and the reason for this range?	M Singh M Maharaj R Pillay	Estuaries naturally range in pH as they comprise a mix of freshwater and seawater. Estimated pH range based on expert opinion as lack of historical data and once-off sampling prevent a high confidence RQO as indicated by brackets.
79.	Table 4.8 Pg 4-26	Non-flow interventions: • Prevent land-use change and control the clearing and draining of the peatlands and swamp forests for gardening. This will need to be communicated to the local municipality to review their spatial planning - SPLUMA. **Where not built-up, create a 2 km buffer around the estuary functional zone to protect groundwater from the impact of woodlots and commercial plantations** -	M Singh M Maharaj R Pillay	Built-up refers to infrastructure. Changed to: Where not presently built-up (e.g. housing, and roads). Forestry needs to be reduced around the Kosi lakes areas to prevent drawdown.

No.	Section	Comment	From	Addressed?
		When it is said *"Where not built-up?* what will be the case where existing forestry is located around the estuary within the 2km buffer as that may be existing lawful use. DWS Head office to advise further in terms of a policy position and protocol to follow. **Capping the groundwater utilisation and reducing plantations – to be guided by a groundwater study that sets the level of restrictions on plantations and woodlots in the wider catchment to not impact the groundwater input into Kosi Estuarine Lake system** – Restrictions on community woodlots are a sensitive subject. According to Mr B Mdluli (DWS KZN Office), DWS Head Office did try to reduce plantations through enforcement, but this was not successful and was met with resistance. Groundwater is a significant source of water supply to communities in the area and capping groundwater use for domestic purposes needs to be reconsidered unless there are other available interventions. The issue of DDT was to be escalated between DWS and Department of Health. Please advise on progress in this regard.		Forestry is a commercial activity that can be controlled/removed/reduced. Domestic use is a necessity. Publication on DDT was distributed to DWS.
80.		Non-flow interventions: **Reduce commercial forestation in the lake catchments to increase low flows as much as possible.** The lake catchment have little or no activity of commercial forestry.	R Cedras	Some forestry in the catchment. The recommendation comes from DWS 2016b.
81.		Physical habitat (sediments): There are certain sections where it is mentioned that the baseline has to be determined. Who is responsible for determining this baseline as it forms part of study completion – is this a task for DWS: Head Office? Why has this not been determined as part of this study?	M Singh M Maharaj R Pillay	Sediment samples are costly to collect and analyse. Given the lack of historical information, time and financial constraints; sediment modeling and predictions were not prioritised in the Classification study. Some sediment samples were collected as part of the study and listed in detailed reports. See list provided in Comment 100.
82.		Water quality (salinity): **Polyhaline/euhaline/mesohaline/oligohaline** – Are there values (range of values) associated with these? Please include these values.	M Singh M Maharaj R Pillay	Explanation added to Glossary.
83.		Water quality (river inflows): Please include the list of metals and DDT associated target values as an appendix for ease of reference and completeness of the report.	M Singh M Maharaj R Pillay	See **Table A1** and **A2** in **Appendix A** for detail.
84.	Table 4.8 Pg 4-26	Non-flow interventions: **Reduce commercial forestation in the lake catchments to increase low flows as much as possible. In the uMfolozi River catchment, land care practices should focus on the most critical sub-catchment areas to limit future erosion and land degradation which could further reduce low flows." and "DWS will need to undertake further investigations into limiting further forestry applications in St Lucia and Mfolozi catchments and review license conditions in relation to buffer zones** – Can address illegal water use attached to forestry. Will be difficult to remove lawful commercial forestation – this will have to be investigated further – compulsory licencing could come into play or perhaps closing the catchment to further forestry. DWS Head Office should advise on policy position on how to address this matter, especially regarding existing lawful use, particularly pre-1972.		Correct.

No.	Section	Comment	From	Addressed?
85.		Hydrology: **Maintain freshwater inflow from all influent rivers at a level that is as close to natural as possible but not less than under present-day conditions.** Please check with the hydrology team (Caryn) regarding the impact of the proposed lower Mfolozi off-channel storage (Lake Nkata) on this requirement. It is being proposed through the Recon Strategy.	N Jafta	The EWR requirement of 3 m^3/s flows into St Lucia have been considered as a priority in all analyses regarding the off channel dam assessment in the Reconciliation strategy.
86.		Hydrology: Combined Mfolozi/Mkuze drought discharge of **5 m^3/s (including in 1.6 m^3/s in Mkuze** - If 1.6m^3/s is from Mkhuze, is it not implied that the Mfolozi portion is actually more that 3 m^3/s? And one of the actions from PSC 5 was to also dis-aggregate the combined 5 m^3/s, to reduce confusion and to assist with management of the system.	N Jafta	Drought discharge requirement was removed as it is not available.
87.		9.2 Hydrology: ▪ There two specific requirements mentioned (the same requirements as presented in the Water Resource Classes Report to which the Region raised its concern) : (i) a minimum discharge of 3 m^3/s at DWS gauging station W2H032 in the Mfolozi River to keep the mouth open (except during drought periods) and () a combined drought discharge of 5 m^3/s for both the Mfolozi and Mkuze rivers (including 1.6 m^3/s in the Mkuze River). ▪ The Estuaries Ecological Consequences Report (page vii, Volume 2) states that to fulfill these requirements, ***"the total present flow from both the Mfolozi and the St Lucia rivers are needed to achieved the Recommended Ecological Category (REC), i.e. any flow scenario that would involve a flow reduction from the Present will not meet the REC. Less than 1% change can be made to the Mfolozi river flows, but that the flow needs to be reallocated to the EWR of the St Lucia Rivers".*** Based on this requirement, it implies that no further development or water use allocations can be made. ▪ A presentation slide by Dr. Lara van Niekerk titled, "Estuaries: PEC, REC and Ecological Consequences" reiterates the requirement of both the Mfolozi and St Lucia rivers' present flow in achieving a C category **(Slide 24: *"Previous studies found that total present flow from both the Mfolozi and St Lucia rivers are needed to achieve a C"*).** [NB: Target Ecological Category (TEC) proposed is C (short term) and B (long term)]. ▪ The concern of the Region is that the RQOs have been set without consideration of the proposed off channel storage dams for the Umfolozi catchment. None of the scenarios as part of this study considered the proposed off channel storage dam. The Region has raised this on more than one occasion and is extremely concerned about the restrictions created by the St Lucia estuary flow requirements in terms of water security, community water supply and supporting Historically Disadvantaged Individuals (HDIs) through Water Allocation Reform. The socio-economic impacts of the flow requirements for the St Lucia Estuary, particularly around community water supply and overall water security, have not been addressed.	M Singh M Maharaj R Pillay	Drought discharge requirement was removed as it is not available.
88.		Hydrodynamics: ▪ The St Lucia estuary mouth closes when the river flow averaged over 30 days is less than 1.5 m^3/s at the uMfolozi River DWS gauging station W2H032 and the water level in Lake at Charters Creek is < 0.35 m mean sea level.	N Jafta	Modified to:

No.	Section	Comment	From	Addressed?
		This should probably not be here. I think the above target or RQO about 5 or 3 m^3/s is sufficient as a target. I think this should probably read as: "The water level at Charter's Creek should be maintained at 0.35 mmsl and above during drought". These statements should probably be more direct.		▪ Maintain the water level in Lake at Charters Creek > 0.35 m mean sea level (to be confirmed with surveys).
89.		Hydrodynamics: ▪ The estuary mouth should not be breached artificially except in an emergency or when **exceptional circumstances** prevail. **This will allow more river flow** to the lake during droughts and when breaching occurs it will open up a large mouth with a large tidal flow The St Lucia independent panel report raised that exceptional circumstances need to be defined. What will? It feels like something is missing here. Is it not the statements about it should be breached at a certain water level? And/or flows? Etc	N Jafta	iSimangaliso Wetland Park Authority is in the process of determining the mean sea level reference and baseline surveys that will inform at which height the system could potentially be breached. Cannot include it as an RQO. Exceptional circumstances are not an ecological concern but a social need and will thus be determined by management authority. The lower the mouth breaching level the more the ecology will be compromised (DWS 2016b). As this is an 'Estuarine lake' artificial breaching is independent of a specific river inflow as all flow matter to offset evaporation losses.
90.		Physical habitat (sediments): There are certain sections where it is mentioned that the baseline must be determined. Who is responsible for determining this baseline as it forms part of study completion – is this a task for DWS: Head Office?	M Singh M Maharaj R Pillay	Baseline conditions should be determined by iSimangaliso Wetland Park Authority. This is indicated in the Implementation Plan.
91.		Water quality (salinity): Hypersaline conditions (salinity >35) are recorded outside of a defined drought period. Is this a target? To have hypersaline conditions? (NJ) Please indicate which estuary or part of the lake you are referring to. (SM)	N Jafta S Majola	Hypersalinity occurs naturally in St Lucia during droughts. It is not a target but should not be seen as a negative when recorded during droughts. All measurements refer to where WQ monitoring stations are.
92.		Water quality (salinity): Please include units of measurement for the salinity values.	M Singh M Maharaj R Pillay	Salinity is a ratio and does not have physical units. Historically it was measured as Parts per Thousand (ppt) or practical salinity unit (PSU) but this is no longer the international standard.
93.		Water quality (general): Please include the list of metals and associated target values for water and sediment as an appendix for ease of reference and completeness of the report.	M Singh M Maharaj R Pillay	See **Table A1** and **A2** in **Appendix A** for detail.

No.	Section	Comment	From	Addressed?
94.		Macrophytes: ▪ **No loss of** freshwater reeds, sedges and swamp forest species due to groundwater inflow reduction - No hope for the mangroves?	NJ	Mangroves are highly variable and change with water level and mouth state. Too variable to set as RQOs.
95.	Appendix A	Other studies (Fish Tsitsikamma) must also have this appendix. It's really helpful in mapping out the area and seeing what the EFZ looks like.	S Majola	Noted.
96.	Exec summary	The way forward: This will also form part of information that will/can be input into an **implementation plan –** Please remember to tie the upcoming Monitoring plan with iSimangaliso IMP, EMP, MMP, and indeed Social/Economic Indicators, Jane Turpie touched on these, GEF:5). The later was found to be entirely missing by the DFFE Panel report, 2022. DWS Classification system which has these was developed by Prime Africa, funded by the WRC (WRC Project No K5/2465). Please visit it, if not already.	B Madikizela	Noted. The project team have communicated relevant information to iSimangaliso Wetland Authority.
97.	Figure 1.1 Pg 1-2	The uMsunduzi is of great importance is close to uMfolozi, not shown on the map-Why? Msundisi shown here could be Msinene river?	B Madikizela	uMsunduzi is part of the iMfolozi section. It does not have its own mouth. The official SANBI Estuary Functional Zone captured as part of the National Ecosystems Classification Map includes both systems in the delineation.
98.	Section 2.1 Pg 2-1	Consequently, it was necessary to develop a flexible, but legally defensible **NEMP** guiding estuarine managers at all levels to develop sound management plans to suit individual systems - Will it help to remind reader the NEMP here does not refer to National Eutrophication Monitoring Programme of DWS? Here we are talking about EMP, actually?	B Madikizela	NEMP Acronym captured in 'Terminology and Acronyms' and page 2-1 of the report. Readers will not likely confuse it with the National Eutrophication Monitoring Programme
99.	Section 3.4 Pg 3-2	This study (especially upcoming Monitoring Plan) must consider work by GEF:5 (Dr. Jane Turpie of Anchor Environmental, et al), Jean Harris (ongoing work, especially post Mouth breaching of Jan 2021).	B Madikizela	The GEF study formed the basis of the DWS 2016 study and therefore is fundamental to the recommendations.
100.	Section 3.4.2 Pg 3.3	Historical data sets used include CSIR Harrison observations and DWS data sets - Referencing, critical for new entries in the studies!	B Madikizela	Detail references in supporting estuary EWR reports: Department of Water and Sanitation (DWS). 2015a. Resource Directed Measures: Reserve determination study of selected surface water and groundwater resources in the Usutu/Mhlathuze Water Management Area. Amatikulu-Nyoni Estuary Rapid Environmental Water Requirements Determination. Report produced by CRUZ Environmental on behalf of Tlou Consulting (Pty) Ltd. Report no: RDM/WMA6/CON/COMP/1413. 1-160 pp. Department of Water and Sanitation (DWS). 2015b. Resource Directed Measures: Reserve determination study of selected surface water and groundwater resources in

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				the Usutu/Mhlathuze Water Management Area. uMlalazi Estuary Rapid Environmental Water Requirements Determination. Report produced by CRUZ Environmental. Report no: RDM/WMA6/CON/COMP/1313. Department of Water and Sanitation (DWS). 2016a. Resource Directed Measures: Reserve determination study of selected surface water and groundwater resources in the Usutu/Mhlathuze Water Management Area. Kosi Estuary Rapid Environmental Water Requirements Determination. Report produced by CSIR on behalf of Tlou Consulting (Pty) Ltd. Report no: RDM/WMA6/CON/COMP/2613. Department of Water and Sanitation (DWS). 2016b. Chief Directorate – Water Ecosystems: Reserve determination study of selected surface water and groundwater resources in the Usuthu/Mhlathuze Water Management Area. Lake St Lucia Intermediate EWR Assessment Report – Volume 1: Ecoclassification and EWR Assessment. Prepared by Tlou Consulting (Pty) Ltd and Anchor Environmental Consultants (Pty) Ltd. Report no: RDM/WMA6/CON/COMP/2213. Department of Water and Sanitation (DWS). 2023a. Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: aMatigulu/iNyoni Estuary Ecological Consequences Report. Prepared by: CSIR. DWS Report: WEM/WMA3/4/00/CON/CLA/0123 Vol 2 Supporting Information. Department of Water and Sanitation (DWS). 2023b. Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: iSiyaya

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				Estuary Ecological Consequences Report. Prepared by: CSIR. DWS Report: WEM/WMA3/4/00/CON/CLA/0123 Vol 2 Supporting Information. Department of Water and Sanitation (DWS). 2023c. Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: uMlalazi Estuary Ecological Consequences Report. Prepared by: CSIR. DWS Report: WEM/WMA3/4/00/CON/CLA/0123 Vol 2 Supporting Information. Department of Water and Sanitation (DWS). 2023d. Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: uMhlathuze Estuary Ecological Consequences Report. Prepared by: CSIR. DWS Report: WEM/WMA3/4/00/CON/CLA/0123 Vol 2 Supporting Information. Department of Water and Sanitation (DWS). 2023e. Classification of Significant Water Resources and Determination of Resource Quality Objectives for Water Resources in the Usutu to Mhlathuze Catchments: iNhlabane Estuary Ecological Consequences Report. Prepared by: CSIR. DWS Report: WEM/WMA3/4/00/CON/CLA/0123 Vol 2 Supporting Information.