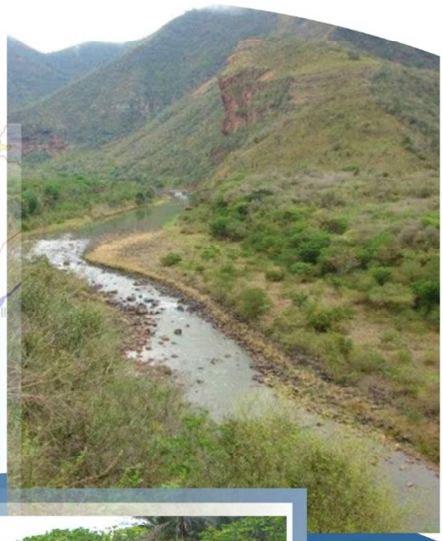
REPORT NUMBER: RDM/WMA11/00/CON/CLA/0615

CLASSIFICATION OF WATER RESOURCES AND DETERMINATION OF THE COMPREHENSIVE RESERVE AND RESOURCE QUALITY OBJECTIVES IN THE MVOTI TO UMZIMKULU WATER MANAGEMENT AREA

PROJECT NUMBER: WP 10679

VOLUME 4: ESTUARY RESOURCE QUALITY OBJECTIVES

SEPTEMBER 2015



water & sanitation
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Water and Sanitation
REPUBLIC OF SOUTH AFRICA

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Department of Water and Sanitation, South Africa, September 2015. Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: Volume 4: Estuary Resource Quality Objectives. Prepared by: Van Niekerk, Adams, Taljaard, Weerts. DWS Report: RDM/WMA11/00/CON/CLA/0615.

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6	Report Number: RDM/WMA11/00/CON/CLA/0212	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **BHNR**
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	Report Number: RDM/WMA11/00/CON/CLA/0115	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Volume 2d: Supporting Information on the Determination of Water Resource Classes –Ecological Consequences of Estuaries in T4, U2, U3, U5, U6, U7 and U8 of Operational Scenarios**
8.3	Report Number: RDM/WMA11/00/CON/CLA/0714	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Volume 3 Supporting Information on the Determination of Water Resource Classes – Estuary specialist appendices (electronic information only)**
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9.2	Report Number: RDM/WMA11/00/CON/CLA/0415	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Volume 2: Wetland RQOs**
9.3	Report Number: RDM/WMA11/00/CON/CLA/0515	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Volume 3: Groundwater RQOs**
9.4	**Report Number: RDM/WMA11/00/CON/CLA/0615**	**Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: Volume 4: Estuary RQOs**
10	Report Number: RDM/WMA11/00/CON/CLA/0715	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Implementation Report**
11	Report Number: RDM/WMA11/00/CON/CLA/0815	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Main Report**
12	Report Number: RDM/WMA11/00/CON/CLA/0116	Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Closing Report**

DEPARTMENT OF WATER AND SANITATION

CHIEF DIRECTORATE: WATER ECOSYSTEMS

CLASSIFICATION OF WATER RESOURCES AND DETERMINATION OF THE COMPREHENSIVE RESERVE AND RESOURCE QUALITY OBJECTIVES IN THE MVOTI TO UMZIMKULU WATER MANAGEMENT AREA

VOLUME 4: ESTUARY RESOURCE QUALITY OBJECTIVES

Approved for RFA by:

…… ***……***

Delana Louw
Project Manager

Date

DEPARTMENT OF WATER AND SANITATION (DWS)
Approved for DWS by:

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Chief Director: Water Ecosystems

Date

AUTHORS

Information in this report was authored by the multi-disciplinary group of specialists involved. Contributions were provided as follows:

- Lara van Niekerk: Estuary Component leader, Hydrodynamics and physical processes
- Dr Susan Taljaard: Water Quality
- Prof Janine Adams: Macrophytes
- Steven Weerts: Invertebrates and Fish

Additional input was also provided on the uMkhomazi, Mvoti and uMhlali Estuaries by:

- Prof Guy Bate: Microalgae
- Nicolette Forbes: Invertebrates
- Dr David Allen: Birds

Report Editor: Lara van Niekerk

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REPORT SCHEDULE

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First draft	September 2015
Final draft	November 2015

EXECUTIVE SUMMARY

BACKGROUND

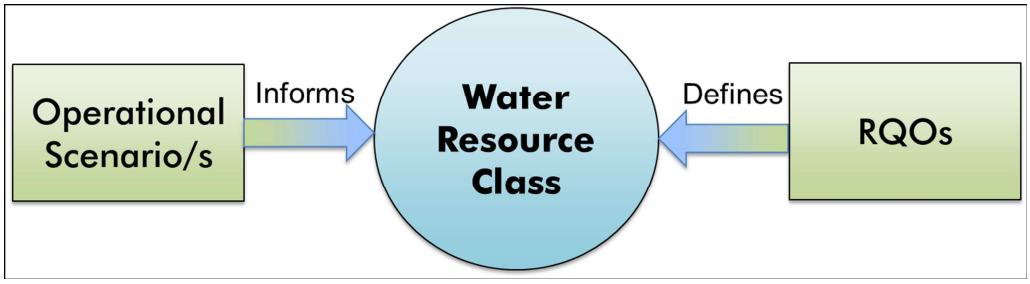
The Chief Directorate: Water Ecosystems (CD:WE) of the Department of Water and Sanitation (DWS) initiated a study during 2012 for the provision of professional services to undertake the Comprehensive Reserve, classify all significant water resources and determine the Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area (WMA). The Mvoti to Umzimkulu WMA encompasses a total catchment area of approximately 27,000 km^2 and occurs largely within Kwazulu-Natal.

This task forms *part* of Step 6, i.e. the development of RQOs and provision of numerical limits. This step is closely linked to the next step where the class configuration and RQOs are gazetted and implemented. The results of Step 6 are documented in this report.

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) therefore stipulates that "Resource Quality Objectives might describe, among other things, the quantity, pattern and timing of flow; water quality; the character and condition of habitat, and the characteristics and condition of the aquatic biota".

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 below).



Links between RQOs and the Water Resource Class and operational scenarios

PRIORITY ESTUARIES

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 Integrated Coastal Management (ICM) Act.

ECOSPECS, TPCs AND RQOs

For the purpose of RQO determination, the following differentiation is made between Ecological Specifications or EcoSpecs and RQOs. EcoSpecs are associated with the Ecological Reserve process and are usually provided per estuary. EcoSpecs are seen as detailed RQOs as they are quantifiable, measurable, verifiable and enforceable to ensure protection of all components of the resource, which make up ecological integrity (DWA, 2009a). Therefore, EcoSpecs are numerical and can be used for monitoring. Thresholds of Potential Concern (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 field work that has been undertaken, a monitoring baseline is therefore available and monitoring to determine whether the specifications are being achieved (or Ecological Category - EC) 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. Where a monitoring baseline is not available, EcoSpecs cannot be determined.

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.

RQOs are set for the 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).

PRIORITY ESTUARY RQOs

Detailed RQOs were developed for the Mvoti and uMkhomazi estuaries for the Target Ecological Category (TEC). For the remainder of the systems RQOs is described in terms of the Present Ecological State (PES). Where the PES does not meet the TEC a "↑" was used to indicate which individual components should improve to achieve the TEC. The configurations of EC, as well as quantification of RQOs are based on best available information at the time. The EC limits applicable to Estuaries are provided below:

EC Limits: Broad classes
A > 93
A/B > 87
B > 78
B/C > 72
C > 63
C/D > 57
D > 43
D/E > 37
E > 23
E/F > 17

Estuaries RQOs for hydrology, hydrodynamics, water quality, sediment dynamics, microalgae, macrophytes, invertebrates fish and birdsin High priority RUs

Component/ Indicator	TEC	RQO
uMKHOMAZI ESTUARY		
Hydrology	**C/D**	▪ Maintain the target EC (> 57%). Protection of estuarine ecosystem to achieve ECs and ROQs indicated for hydrodynamics, water quality, sediment dynamics and the various biotic components: River inflow distribution patterns differ by less than 5% from that of Scenario B (i.e. approved flow scenario for the uMkhomazi). ▪ Monthly river inflow > 1.0 m^3/s ▪ Monthly river inflow > 2.0 m^3/s persists for longer than three months in a row. ▪ Monthly river inflow > 5.0 m^3/s for more than 30% of the time.
Hydrodynamics	**A**	▪ Maintain the target EC (> 93%). Protection of estuarine ecosystem. ▪ Mouth closure occurs less than 2 - 3 weeks in a year. ▪ Mouth closure occurs for less than two years out of ten. ▪ Mouth closure does not occur between September and April.
Water quality	**C**	Maintain the target EC (> 63%). ROQs for water quality in **river inflow** to protect estuarine ecosystem, that is achieving the EC and ROQs indicated for the various biotic components: ▪ pH: 7.5 - 8.5. ▪ DO > 6 mg/L. ▪ Turbidity (low flow < $5m^3/s$): < 15 NTU. ▪ Turbidity (low flow > $5m^3/s$): Naturally turbid. ▪ Dissolved nutrients (low flow < $5m^3/s$): NO_x-N <150 µg/L; NH_3-N < 20 µg/L; PO_4-P < 10 µg/L. ▪ Dissolved nutrients (high flow > $5m^3/s$): NO_x-N < 200 µg/L; NH_3-N < 20 µg/L; PO_4-P < 20 µg/L. ▪ Trace metals (to be determined). ▪ Pesticides/herbicides (to be determined).
		Minimum requirement for recreational use (DEA, 2012): ▪ *Enterococci*: Ninety percentile (90%ile) over a 12 month running period ≤ 185 counts per 100 ml. ▪ *E. coli*: Ninety percentile (90%ile) over a 12 month running period ≤ 500 counts per 100 ml.
		ROQs for water quality in **estuary** to protect estuarine ecosystems, that is achieving the EC and ROQs indicated for the various biotic components: ▪ Salinity: 0 in the upper reaches; > 20 middle reaches during the low flow season; freshwater dominated for 70% of the time. ▪ Turbidity (low flow < $5m^3/s$): Average < 10 NTU in any sampling survey. ▪ Turbidity (high flow > 5): Naturally turbid. ▪ pH: Average 7.0 - 8.5 in any sampling survey. ▪ Dissolved oxygen: Average > 6 mg/L in any sampling survey. ▪ Dissolved nutrients (low flow < $5m^3/s$): Average NO_x-N < 150 µg/L, NH_3-N < 20 µg/L and PO_4-P < 10 µg/L in any sampling survey. ▪ Dissolved nutrients (high flow > $5m^3/s$): Average NO_x-N < 300 µg/L, NH_3-N < 20 µg/L and PO_4-P < 20 µg/L in any sampling survey. ▪ Total metal concentrations in water not to exceed target values as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Total metal concentration in sediment not to exceed target values as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).
Sediment dynamics	**B**	Maintain the target EC (> 78%). Ensure that turbidity or clarity levels stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).
		Flood regime to protect estuarine ecosystem's sediment distribution patterns and aquatic habitat (instream physical habitat: ▪ River inflow distribution patterns (flood components) differ by less than 20% (in terms of magnitude, timing and variability) from that of the Present State (2013). ▪ Suspended sediment concentration from river inflow deviates by less than 20% of the sediment load-discharge relationship to be determined as part of baseline studies (Present State 2013). ▪ Findings from the bathymetric surveys undertaken as part of a monitoring programme indicate that no changes in the sedimentation and erosion patterns in the estuary have occurred (± 0.5 m). ▪ Intertidal and subtidal habitat in upper reaches below the weir is available for estuarine species (increase by > 20% from present).

Component/ Indicator	TEC	RQO
		Changes in sediment grain size distribution patterns to maintain benthic invertebrates. ▪ The median bed sediment diameter deviates by less than a factor of two from levels to be determined as part of baseline studies (Present State 2013). ▪ Sand/mud distribution in middle and upper reaches change by less than 20% from Present State (2013). ▪ Changes in tidal amplitude at the tidal gauge of less than 20% from Present State (2013).
Microalgae	B	▪ Maintain the target EC (> 78%). Maintain current microalgae assemblages, specifically > 5 diatom species at a frequency > 3% of the total population in saline reaches (i.e. Zone A in low flow). ▪ Medium phytoplankton: > 5µg/L for more than 50% of the stations. ▪ Microphytobenthos (MPB): > 30 mg m^2 for more than 50% of the stations in the saline portion of the estuary. ▪ Observable bloom in the estuary.
Macrophytes	D	Maintain the target EC (> 43%). Maintain the 2015 distribution of macrophyte habitats: ▪ Maintain the integrity of the riparian zone particular where the sandmining no longer occurs. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ No sugarcane in the Estuarine Functional Zone (EFZ). ▪ No greater than 10% change in the area covered by different macrophyte habitats. ▪ No canalisation of lower reaches. ▪ No invasive plants (e.g. syringa berry, Spanish reed, black wattle, Brazilian pepper tree) largely absent from the riparian zone. ▪ No die-back of reeds and sedges in the lower reaches. ▪ No unvegetated, cleared areas along the banks. ▪ No floating invasive aquatics observed in the upper estuary reaches. ▪ No Sugarcane is present in the EFZ.
Invertebrates	B	Maintain the target EC (> 78%). Maintain current levels of zoobenthic abundance (including seasonal variation). Retain an invertebrate community assemblage in the estuary based on species diversity and abundance that includes a variety of indigenous species. This include the following: ▪ Species diversity (between 15 species in summer - 40 species in winter). ▪ Polychaetes, amphipods and tanaeids should numerically dominate during all seasons. However, abundance of all taxon groups should be higher during summer high flow periods and lower during winter low flow period. ▪ DOs should > 4 ppt in > 75% of the estuary ▪ Less than 20% change in the intertidal and subtidal habitats. ▪ No occurrence of invertebrate alien species (e.g. *Tarebia granifera*). ▪ No decrease in abundance of zooplankton (> 20%) in terms of numbers per m^{-2} over entire estuarine area (three sample sites) over three years. ▪ No decrease in abundance of benthic macroinvertebrates. ▪ No occurrence of *Paratylodiplax blephariskios* in annual sample.
Fish	D	▪ Maintain the target EC (> 43%). The upper reaches below weir in its entirety acts as a nursery to a diversity of EDC2 species (EDC2a especially). An abundance (to be defined as an average with prediction limits) of EDC2a species as young juveniles occur in spring and early summer (*Solea bleekeri, Acanthopagrus vagus, Ponmadasys comerssonnii, Rhabdosargus holubi*). ▪ A good trophic basis exists for predatory estuarine dependant marine species (e.g. *Agyrosomus japonicus, Carynx* spp.), i.e. mullet occur throughout the system represented by a full array of size classes. ▪ Estuarine residents species represented by core group (*Glossogobius* spp., *Oligolepis* spp. *Ambassis* spp. and *Gilchistella aestuaria*) in two consecutive years. ▪ *Oreochromis mossambicus* limited to the upper reaches of one C in the low flow period, i.e. do not extend into middle reaches for more than two consecutive years. ▪ Species assemblage comprises indigenous species only, no alien fish species are caught in the system. ▪ Connectivity to a healthy transitional marine-estuary waters is maintained. No decline in nearshore linefish catches (*A. japonicus*) (not related to gear changes or bag limit restrictions).
Birds	C	Maintain the target EC (> 63%). The estuary should contain a rich avifaunal waterbird community, occurring at high densities (relative to available shorelength) that includes representatives of all the major groups, i.e. aerial (e.g. kingfishers), swimming (e.g. cormorants) and large wading piscivores (e.g. herons), small invertebrate-feeding waders, including migratory Palaearctic sandpipers, herbivorous waterfowl (e.g. ducks and geese) and roosting terns and gulls. ▪ The presence of a resident pair of African Fish Eagle that breed successfully. ▪ Pied Kingfishers, White-breasted Cormorants or Reed Cormorants are recorded on more

Component/ Indicator	TEC	RQO
		than three consecutive counts spanning a period of 18 months or more. ▪ Numbers of waterbird species do drop below 10 for two consecutive counts
MVOTI ESTUARY		
Hydrology	**C/D**	Maintain the target EC (> 57%). Protect the flow regime to create the required habitat for birds, fish, macrophytes, microalgae and water quality: ▪ River inflow distribution patterns differ by more than 5% from that of Scenario A (i.e. the recommended flow scenario for the Mvoti Estuary). ▪ Monthly river inflow > 1.0 m^3/s. ▪ Monthly river inflow > 2.0 m^3/s persists for longer than three months in a row. ▪ Monthly river inflow > 2.0 m^3/s for more than 50% of the time.
Hydrodynamics	**A**	Maintain the target EC (> 93%). Maintain a mouth conditions to protect estuarine ecosystems and the associated habitat for birds, fish, macrophytes, microalgae and water quality: ▪ Mouth closure occurs less than two - three weeks in a year. ▪ Mouth closure occurs for less than two years out of ten. ▪ Mouth closure does not occurs between November and June.
Water quality	**C/D**	Maintain the target EC (> 57%). RQOs for river inflow to protect estuarine ecosystem, that is achieving the EC and ROQs indicated for the various biotic components: ▪ pH: 7.0 - 8.5. ▪ DO > 4 mg/L. ▪ Turbidity (low flow): < 15 NTU. ▪ Turbidity (low flow): Naturally turbid. ▪ Dissolved nutrients: NO_x-N < 400 µg/L; NH_3-N < 30 µg/L; PO_4-P < 25 µg/L. ▪ Trace metals (to be determined). ▪ Pesticides/herbicides (to be determined).
		ROQs for water quality in **estuary** to protect estuarine ecosystem, that is achieving the EC and ROQs indicated for the various biotic components: ▪ Salinity: Salinity > 20 PSU one km from the mouth; Salinity < 1 PSU for > 50% of the time?? ▪ Turbidity (low flow): Average < 10 NTU in any sampling survey. ▪ Turbidity (high flow): Naturally turbid. ▪ pH: Average 7.0 - 8.5 in any sampling survey. ▪ Dissolved oxygen: Average > 4 mg/L in any sampling survey. ▪ Dissolved nutrients: Average NO_x-N < 400 µg/L, NH_3-N < 30 µg/L and PO_4-P < 25 µg/L in any sampling survey. ▪ Total metal concentrations in water not to exceed target values as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Total metal concentration in sediment not to exceed target values as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).
Sediment dynamics	**B/C**	Maintain the target EC (> 72%). Flood regime to protect estuarine ecosystems sediment distribution patterns and aquatic habitat (instream physical habitat): ▪ River inflow distribution patterns (flood components) differ by no more than 20% (in terms of magnitude, timing and variability) from that of the Present State (2013). ▪ Suspended sediment concentration from river inflow deviates by no more than 20% of the sediment load-discharge relationship to be determined as part of baseline studies (Present State 2013). ▪ Findings from the bathymetric surveys undertaken as part of a monitoring programme indicate no changes in the sedimentation and erosion patterns in the estuary have occurred (± 0.5 m). ▪ Changes in tidal amplitude at the tidal gauge of no more than 20% from Present State (2013).
		Changes in sediment grain size distribution patterns not to cause exceedance tolerance of benthic invertebrates. ▪ The median bed sediment diameter deviates by less than a factor of two from levels to be determined as part of baseline studies (Present State 2013). ▪ Sand/mud distribution in middle and upper reaches change by no more than 20% from Present State (2013).
Microalgae	**B**	Maintain the target EC (> 78%). Maintain current microalgae assemblages, specifically > five diatom species at a frequency > 3% of the total population in lower saline reaches: ▪ Medium phytoplankton: > 3µg/L for more than 50% of the stations. ▪ MPB: > 20 mg m^2 for more than 50% of the stations in the saline portion of the estuary. ▪ Observable bloom in the estuary.
Macrophytes	**D**	▪ Maintain the target EC (> 43%). Maintain the distribution of macrophyte habitats, particularly the freshwater mangrove, *Barringtonia racemosa* stand at the mouth of the estuary so that there is no greater than 10% change in macrophyte habitat.

Component/ Indicator	TEC	RQO
		▪ Control the spread of hygrophilous grasses into open water area, i.e. no decrease in open water habitat to less than 16 ha. No increase in reeds and sedges and encroachment into main water channel due to nutrient enrichment, sedimentation and infilling of intertidal habitat. ▪ Prevent the spread of invasive plants, trees and shrubs as well as aquatic invasive plants. No invasive plants (e.g. syringa berry, Brazilian pepper tree) and aquatic invasives (e.g. water hyacinth) cover > 5% of total macrophyte area. ▪ No sugarcane in the EFZ.
Invertebrates	**E**	N/A
Fish	**D**	Maintain the target EC (> 43%). Protect the estuarine ecosystems functioning as: ▪ A nursery for a limited diversity and abundance of estuarine dependant marine fishes, which use the system through to their late juvenile and adult life stages. ▪ Habitat for a limited diversity and abundance of estuarine resident fishes which complete their life cycles in the estuary. ▪ Habitat for a limited diversity and abundance of freshwater fishes. ▪ A migration corridor for facultative catadromous eels. ▪ This will require that there be no loss of the following: ▪ Any one of the following species *Mugil cephalus*, *Myxus capensis* from Zones A, B and C ▪ Any two of the following species *G. aestuaria*, *Ambassis* spp., *Glossogobius* spp. from the estuary. ▪ Any one of the following species *Barbus* spp, *O. mossambicus* from Zones A, B and C. ▪ *Anguilla* spp. from upstream river habitats (this should be noted in ecological specifications in documentation pertaining to the EWR (river EcoSpecs and monitoring)).
Birds	**E**	Maintain the target EC (> 23%). The estuary should contain a rich avifaunal waterbird community, occurring at high densities (relative to available shorelength) that includes representatives of all the major groups, i.e. aerial (e.g. kingfishers), swimming (e.g. cormorants) and large wading piscivores (e.g. herons), small invertebrate-feeding waders, including migratory Palaearctic sandpipers, herbivorous waterfowl (e.g. ducks and geese) and roosting terns and gulls. This means that the following will be observed: ▪ Presence of successful breeding by Collared Pratincoles and the resident pair of African. ▪ Fish Eagles. ▪ Numbers of bird species do not drops below 30 for three consecutive counts. ▪ Number of roosting terns recorded in mid-summer no fewer than 2000.

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ACRONYMS AND ABBREVIATIONS

DIN	Dissolved Inorganic Nitrogen
DIP	Dissolved Inorganic Phosphate
DO	Dissolved Oxygen
DWA	Department of Water Affairs (Change after 2008)
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water Affairs and Sanitation (Change after May 2014)
EC	Ecological Category
EcoSpecs	Ecological Specifications
EFZ	Estuarine Functional Zone
EWR	Ecological Water Requirement
GI	gastrointestinal
ICM	Integrated Coastal Management
IUA	Integrated Unit of Analysis
KZN	KwaZulu-Natal
NEMP	National Estuarine Management Protocol
NWA	Nationl water Act
NWRC	National Water Resource Classification
NWRS	National Water Resource Strategy
PES	Present Ecological State
REC	Recommended Ecological Category
RQO	Resource Quality Objective
RU	Resource Unit
Sc	Scenario
SQ	Sub Quaternary
TEC	Target Ecological Category
TOCE	Temporary open closed estuary
TPC	Threshold of Potential Concern
WIO	Western Indian Ocean
WMA	Water Management Area
WWTW	Waste Water Treatment Works

1 INTRODUCTION

1.1 BACKGROUND

There is an urgency to ensure that water resources in the Mvoti to Umzimkulu Water Management Area (WMA) are able to sustain their level of uses and be maintained at their desired states. The determination of the Water Resource Classes of the significant water resources in Mvoti to Umzimkulu WMA will ensure that the desired condition of the water resources, and conversely, the degree to which they can be utilised is maintained and adequately managed within the economic, social and ecological goals of the water users (DWA, 2011). The Chief Directorate: Water Ecosystems of the Department of Water and Sanitation (DWS) initiated a study during 2012 for the provision of professional services to undertake the Comprehensive Reserve, classify all significant water resources and determine the Resource Quality Objectives (RQOs) in the Mvoti to Umzimkulu WMA.

The objective of this task was to describe and document the resource quality objectives for each estuary linked to the Target Ecological Category (TEC) associated with the Water Resource Class. The output of this task will serve as input to the implementation, monitoring and Legal Notice.

1.2 INTEGRATED STEPS APPLIED IN THIS STUDY

The integrated steps for the National Water Classification System, the Reserve and RQOs (DWA, 2012) are supplied in Table 1.1.

Table 1.1 Integrated study steps

Step	Description
1	Delineate the units of analysis and Resource Units, and describe the status quo of the water resource(s) (completed).
2	Initiation of stakeholder process and catchment visioning (on-going).
3	Quantify the Ecological Water Requirements and changes in non-water quality ecosystem.
4	Identification and evaluate scenarios within the Integrated Water Resource Management process.
5	Evaluate the scenarios with stakeholders and determine Water Resource Classes.
6	**Develop draft RQOs and numerical limits.**
7	Gazette and implement the class configuration and RQOs.

This task forms ***part*** of Step 6, i.e. the development of RQOs and provision of numerical limits. This step is closely linked to the next step where the class configuration and RQOs are gazetted and implemented. The results of Step 6 are documented in this report. The information generated during Step 1, 3, 4 and 5 forms the basis of the RQOs.

1.3 INTRODUCTION TO RQOs

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) therefore stipulates that “Resource Quality Objectives might describe, among other things, the quantity, pattern and timing of flow; water quality; the character and condition of habitat, and the characteristics and condition of the aquatic biota”.

The 7 steps to be applied during the determination of RQOs and guidelines to determine RQOs are provided in DWA (2011). Habitat and Biota RQOs (referred to as Ecological Specifications (EcoSpecs) and Thresholds of Potential Concern (TPC)) are according to DWA (2010).

1.4 TASK D6: RQO STEPS AND INTEGRATION

As there is significant overlap in the RQO steps with the Classification and Reserve steps, integrated steps have been designed which incorporate the RQO steps in an iterative manner. These seven intergated steps (Table 1.2) were used in the present Mvoti to Umzimkulu study.

Table 1.2 RQO steps as integrated in the Integrated Classification Steps

Integrated steps		RQO steps	Comment
1	Delineate the units of analysis and Resource Units (RUs), and describe the status quo of the water resource(s) (completed).	1. Delineate Integrated Units of Analysis (IUAs) and define RUs.	RUs are defined at a broad level on a sub-quaternary (SQ) basis.
		3. Prioritise and select RUs for RQO determination.	Process to determine priority areas called hotspots defines the priority levels for RQO determination.
2	Initiation of stakeholder process and catchment visioning (on-going).	2. Establish a vision for the catchment and key elements for the IUAs.	Undertaken during Step 1 above.
3	Quantify the Ecological Water Requirements (EWRs) and changes in non-water quality ecosystem.	3. Prioritise and select RUs for RQO determination.	More detailed RUs defined for high priority rivers.
		4 Prioritise sub-components for RQO determination, select indicators for monitoring and propose direction of change.	Undertaken during Step 1 and 3 as part of the EcoClassification process.
4	Identification and evaluation of scenarios within the Integrated Water Resource Management process.		
5	Evaluate the scenarios with stakeholders and determine Water Resource Classes.	6. Agree on RUs, RQOs and numerical limits with stakeholders.	Is undertaken during all preceding stakeholder meetings. RQOs (hydrological) are agreed on during the Water Resource Class decision making as the hydrological RQOs are the flows associated with the Water Resource Class.
6	**Develop draft RQOs and numerical limits.**	5. Develop draft RQOs and numerical limits.	The focus in this step is on finalising the habitat, biota and water quality RQOs.
7	Gazette and implement the class configuration and RQOs.	7. Finalise and gazette RQOs	

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 1.1).

Figure 1.1 Links between RQOs and the Water Resource Class and operational scenarios

Various scenarios were tested and the selected Water Resource Class indicated for each scenario (DWS, 2014), i.e. in some cases a selection of scenarios for the purpose of classification would result in the same Water Resource Class.

RQOs are determined for the hydrology and water quality and Ecological Categories (ECs) associated with the Water Resource Class for the present conditions.

In some cases Water Resource Class is set to maintain the status quo and Recommended Ecological Category (REC) in some areas by addressing some non-flow related issues.

1.6 LEGESLATIVE CONTEXT FOR RQOs IN ESTUARIES

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

- South Africa's NWA (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. Therefore, estuary management must allow for a dynamic process that facilitates integrated cross-sectorial planning and implementation including stakeholders involved in land-use planning, management of freshwater and marine resources, amongst others. Consequently, it was necessary to develop a flexible, but legally defensible NEMP providing guidance to estuarine managers at all levels to develop sound management plans to suit individual systems. South Africa's NEMP was published in May 2013. The 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 management of estuaries.
- Establish procedures or provide guidance regarding 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.
- 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 (in accordance with the ICM Act), there are numerous existing management initiative 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 (Biodiversity Act as articulated in the Nationl Biodiversity Assessment (NBA) 2011 and future updates).
- Integrated Development Plans and Spatial Development Frameworks (Municipal Systems Act).
- Classification of water resources, including estuaries (NWA).
- Living resources management plans (Marine Living Resources Act).
- Biodiversity targets and incorporation of DWS water resource classification process

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 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). A target of 20% was set for the total area of each type.

In the case of estuaries, protection is not only effected 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 on the basis of its Ecological Class (A, B, C or D) determined under the National Water Resources Classification System (Dollar, *et al*. 2010). The outcome of the Classification process therefore informs and supports other estuary planning initiates, and products developed as part of this process are aligned as much as possible with other management initiates.

1.7 NAMING OF RIVERS AND ESTUARIES

Names of the rivers and estuaries used are according to the Government Gazette No. 848 (1 October 2010). All other names are according to what is used in the existing databases. For reference, the Ezimvelo KZN Wildlife list of names or synonyms for KwaZulu-Natal (KZN) estuaries are included as Appendix B.

1.8 STUDY AREA

RQOs were evaluated at all estuaries in each of the three estuary Integrated Units of Analysis (IUAs) illustrated in in Appendix C.

- Southern Cluster 1 IUA.
- Southern Cluster 2 IUA.
- Central Cluster IUA.
- Northern Cluster.

1.9 PURPOSE AND OUTLINE OF THIS REPORT

The purpose of this document is to provide a summary of the narrative and numerical RQOs for the Estuaries in the study area.

The report outline is as follows:

Chapter 1: Introduction
This Chapter provides general background to the project Task.

Chapter 2: Indicator Components and Approach
This Chapter provides an overview of the various indicator components and over arching approach. It outlines the various multi-disciplinary methodologies adopted during this task.

Chapter 3: Target Ecological Categories for RQo determination
The TEC associated with the Water Resource Class are provided as a summary table.

Chapter 4 - 7: Resource Quality Objectives
These chapters provide the RQOs of the individual estuaries in the WMA.

Chapter 8: References

Chapter 9: Appendix A: Estuarine Habitats
Area cover data for habitats in Mvoti to Umzimkulu WMA based on old and new data is provided.

Chapter 10: Appendix B: Estuary Synonym List for KZN Estuaries
Estuary synonym list for KZN estuaries are listed.

Chapter 11: Appendix C: Estuary IUAs
Integrated Units of Analysis (IUAs) are illustrated.

Chapter 12: Appendix D: Report Comments
Comments from reviewers are listed.

2 INDICATOR COMPONENTS AND APPROACH

Once the IUAs have been defined, RUs and biophysical nodes must be identified for different levels of 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, 1999a, 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 sytem also plays a role to select 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 hotspot assessment (DWA, 2013a) (Step 1 of the integrated steps for the National Water Resource Classification (NWRC); DWAF (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 availabe 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 montoring results were identified as part of the estuary hotspot assessment and include (DWA, 2013a):

- Zolwane
- Ku-Boboyi
- Tongazi
- Kandandhlovu
- Mpenjati
- Kaba
- Mvutshini
- Vungu
- Zotsha
- Boboyi
- Mbango
- Mzimkulu
- Koshwana
- Intshambili
- Mhlabatshane
- Mfazazana
- Kwa-Makosi
- Mvuzi
- Sezela
- Mkumbane
- Mzinto
- Mahlongwa
- Mahlongwane
- uMkhomazi
- Ngane
- Umgababa
- Lovu
- Mbokodweni
- Sipingo
- Durban Bay
- Mgeni
- Mhlanga
- uMdloti
- uThongathi
- Mhlali
- Bob's Stream
- Seteni
- Mvoti
- Mdlotane
- Zinkwasi

2.1 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 numberical RQOs as they are quantifiable, measurable, verifiable and enforceable to ensure protection of all components of the resource, which make up ecological integrity (DWA, 2009). 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 field work 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 limted 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 were detailed fieldwork has not been undertaken. Where a monitoring baseline is not available, EcoSpecs cannot be determined.

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.

2.2 FORMAT OF RQO COMPONENTS

RQOs are set for the short-to medium term (5 to 10 year period) for the 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).

Hydrological RQOs are provided as a flow regime (described by means of a flow durarion table) associated with the TEC for Mvoti and uMkhomazi Estuary. For the other systems the output is based on a hydrological time series generated for the Present Ecological State (PES) with an indication if the various components of the flow regime (baseflows and floods) meet the EWR requirement.

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 2.3.3.

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

- Overall TEC.
- PES for each component.
- Ecological objectives for components.

Detailed RQOs were developed for the Mvoti, uMkhomazi and Mhlali estuaries for the TEC. For the remainder of the systems RQOs is described in terms of the PES. Where the PES does not meet the TEC a "↑" was used to indicate which individual components should improve to achieve the TEC.

2.3 APPROACH FOLLOWED IN DEVELOPING ESTUARY RQOs

2.3.1 Hydrodynamics

Ezemvelo KZN Wildlife weekly observational data on estuary mouth conditions along the KZN coastline was collated from 1999 to 2013 for this study. The average percentage 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 the hydrodynamics RQOs.

If an estuary is very sensitive to flow modification (e.g. very small or shallow) and/or in an A or B Category, a ±5% variation was allowed for 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% variance from the current data set was allowed for over a 5 year period. Were more information was available it was incorporated in the RQOs.

2.3.2 Salinity

Salinity RQOs were derived from measured data or extrapolated for similar systems. 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). Data sets used include CSIR Harrison observations, DWS data sets and Forbes and Demetriades (2009).

2.3.3 Water Quality

For estuaries, unlike for 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 the purposes of 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 KZN coast, as well as expert knowledge, target ranges were proposed for various water quality health categories as listed in Table 2.1.

Table 2.1 Proposed RQOs for water quality associated with ecosystem health for the estuaries in WMA 11

Variable	Health Category					
	A	B	C	D	E	F
Dissolved oxygen (DO)	Average in estuary ≥ 6 mg/l		Average in estuary ≥ 4 mg/l	Average in lower estuary ≥ 4 mg/l		
Turbidity	Estuary: Clear (< 10 NTU) accept during high flows			Estuary: Mostly clear (< 15 NTU) 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	▪ Substance concentrations in estuarine sediment not to exceed targets as per Western Indian Ocean (WIO) Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009). ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters Department of Water Affairs and Forestry (DWAF,1995).					

These target RQOs are not cast in stone, but are considered most appropriate for this desktop level assessment of the KZN estuaries. For this study the water quality RQOs were equated to the corresponding REC/TEC category allocated to an estuary. Where the PES category for water quality was below the REC/TEC category, water quality was identified as a potential risk and the

water quality RQOs equivalent to the REC/TEC category were proposed. Where the WQ PES category was higher than the REC/TEC, the ROQs 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 2.2 (DEA, 2012).

Table 2.2 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. 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 was awarded.

2.3.4 Macrophytes

The RQOs were set for each estuary based on available data and recent field surveys. Cowie (2015) sampled some estuaries in 2013/2014 (Appendix A, Estuarine Habitat) and those data can be considered to be of high confidence. All other macrophyte RQOs are based on historical data and descriptions and are considered to be of low confidence. Expert opinion and Google images were used to make the assessments. RQOs were generally set to maintain the distribution of current macrophyte habitats (< 20% change in the area), maintain the integrity of the riparian zone and floodplain habitat and to prevent the spread of invasive plants in both the water column and riparian zone. Further planned wastewater input to some of the estuaries will results in reed encroachment, algal blooms and floating aquatic invasives such as water hyacinth. Estuaries with important mangrove and swamp forest habitats were identified where present.

2.3.5 Invertebrates

The RQOs were set for each estuary based on expert opinion informed by first-hand knowledge of KwaZulu-Natal (KZN) estuaries. Estuaries were categorised according to mouth state (mouth open frequency) using Ezemvelo KZN Wildlife weekly observational data (see Section 2.3.1 above). RQOs were established for different categories of estuary; temporary open closed estuaries (TOCEs) that are predominantly closed (< 30% mouth open), open/closed (30 - 60% mouth open), predominantly open (60 - 90% open) and permanently open estuaries (> 90% open). These categories were based on the categorisation adopted for fish (see below, Section 2.3.6). These RQOs should be further developed and refined as part of the monitoring requirements of individual systems.

2.3.6 Fish

The RQOs were set for each estuary based on analysis of available data and expert opinion informed by first-hand knowledge of KZN estuaries. The most spatially extensive dataset presently available for such assessment comes from the work of Harrison and co-workers who sampled KZN systems in 1998 and 1999 as part of a national assessment of the status of South African estuaries (Harrison *et al*., 2000). Estuaries sampled by these researchers were categorised according to their mouth state (mouth open frequency) using Ezemvelo KZN Wildlife weekly observational data (see Section 2.3.1 above). Preliminary fish lists (% abundance and frequency of occurrence) based on Harrison *et al*. (2000) and expert opinion were drawn for different categories of estuary; TOCEs that are predominantly closed (< 30% mouth open), open/closed (30 - 60% mouth open), predominantly open (60 - 90% open) and permanently open estuaries (> 90% open). These categories were based on work currently underway investigating connectivity in KZN estuaries (Weerts, unpublished). These fish lists were used to establish RQOs. 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 TARGET ECOLOGICAL CATEGORIES FOR RQO DETERMINATION

The TEC associated with the Water Resource Class are set out in Table 3.1. The summary table provides the PES, the REC, the TEC and the interventions required to achieve this. These interventions are key to RQOs as it must ensure that the interventions are considered. More information on the Water Resource Class and the TEC which makes up the Catchment Configuration is supplied in DWS (2015).

Table 3.1 SC 1: Detailed catchment configuration, interventions and TEC motivations

Estuary	REC	PES	TEC motivation	TEC
Mtamvuma	A/B	B	Interventions required to achieve the REC of an A/B: ▪ Restoration of estuarine riparian habitat. ▪ Reduce/control fishing high pressure. ▪ Protect baseflows to estuary to maintain mouth state and salinity profile. A/B TEC is immediately applicable.	**A/B**
Zolwane	B	B	TEC set to maintain the PES and REC and is immediately applicable.	**B**
Sandhlunlu	C	C	TEC set to maintain the PES and REC and is immediately applicable.	**C**
Kuboyoyi	B	B	TEC set to maintain the PES and REC and is immediately applicable.	**B**
Tongazi	B/C	B/C	TEC set to maintain the PES and REC and is immediately applicable. Scenarios that comply with the TEC are acceptable.	**B/C**
Kandanhlovu	B	B	TEC set to maintain the PES and REC and is immediately applicable.	**B**
Mpenjati	B	B/C	Interventions required to achieve the REC: ▪ Remove/reduce impact of sand mining. ▪ Improve water quality. ▪ Restore estuarine riparian habitat. The B TEC is immediately applicable if the above non-flow related activities are addressed. Water quality should also be improved and standards for existing situation and future scenarios should be investigated to allow for improvement.	**B**
Umhlangankulu	C	C	TEC set to maintain the PES and REC and is immediately applicable.	**C**
Kaba	C	C	TEC set to maintain the PES and REC and is immediately applicable.	**C**
Mbizana	B	B	TEC set to maintain the PES and REC and is immediately applicable.	**B**
Mvuthsini	B/C	B/C	TEC set to maintain the PES and REC and is immediately applicable. Any scenario that achieves the TEC (eg Sc C) is acceptable.	**B/C**
Bilanhlolo	C	C	TEC set to maintain the PES and REC and is immediately applicable.	**C**
Umvazana	C	C	TEC set to maintain the PES and REC and is immediately applicable.	**C**
Kongweni	D	E	Interventions required to achieve the REC: ▪ Restoration of estuarine riparian habitat. ▪ Improve water quality. ▪ Reduce baseflows to estuary to maintain mouth state and salinity profile. The D can be achieved under current situation by removing half the waste and flow of current discharges. This has socio-economic implications and will be difficult to do. Therefore, the TEC is set to maintain the PES below a D. The system should not become a health hazard.	**E/F**
Vungu	B	B	TEC set to maintain the PES and REC and is immediately applicable. Implications for future use are that waste will have to be deposited elsewhere.	**B**
Mhlangeni	C	C	TEC set to maintain the PES and REC and is immediately applicable.	**C**
Zotsha	B	B/C	Interventions required to achieve the REC: ▪ Restoration of estuarine riparian habitat. ▪ Improve water quality. TEC set to achieve the REC and is immediately applicable. No future waste scenarios should be considered for this system.	**B**
Boboyi	B/C	B/C	TEC set to maintain the PES and REC and is immediately applicable.	**B/C**
Mbango	D	E	Interventions required to maintain the REC:	**EF**

Estuary	REC	PES	TEC motivation	TEC
			▪ Restore baseflows to estuary to maintain mouth state and salinity profile. ▪ Maintain water quality. ▪ Partial restoration of estuarine habitat. The D can be achieved under current situation by removing half the waste and flow of current discharges. This has socio-economic implications and will be difficult to do. Therefore, the TEC is set to maintain the PES below a D. The system should not become a health hazard.	
Umzimkulu	B	B	Interventions required to counteract the downward trajectory and to meet the REC/TEC: ▪ Eradicate invasive alien vegetation. ▪ Remove derelict, redundant and old quays, jetties, wharfs and revetments and rehabilitate banks. ▪ Prohibit dredge spoil dumping in inappropriate areas. ▪ Manage agricultural and industrial practices in the catchment.	**B**

Table 3.2 SC 2: Detailed catchment configuration, interventions and TEC motivations

Estuary	REC	PES	TEC motivation	TEC
Mtentwini	C	C	TEC set to maintain the PES and REC and is immediately applicable.	**C**
Mhlangamkulu	C	C	TEC set to maintain the PES and REC and is immediately applicable.	**C**
Domba	C	D	Interventions required to achieve the REC: ▪ Restore baseflows to estuary to maintain mouth state and salinity profile. ▪ Maintain water quality. ▪ Partial restoration of estuarine habitat. The PES is to be maintained as the TEC in the short term as restoration of baseflows have potential socio-economic implications. Further investigations can be undertaken as part of the estuarine management plans to determine whether improvement is possible even to a C/D by addressing non-flow measurements and/or to what degree baseflows can be elevated. No further scenarios should be considered as this could compromise potential improvement and as water quality must be maintained in its present state.	**D**
Koshwana	B	C/D	Interventions required to achieve the REC: ▪ Restore baseflows to estuary to increase mouth state and salinity profile. ▪ Improve water quality. ▪ Partial restoration of estuarine habitat. There is uncertainty regarding the capacity and discharge of the WWM works. To improve the estuary would either require removal of waste water and/or improvement of the treatment work to the required standard. Due to these uncertainties and the uncertainty around the implications of improvement, the TEC has been set to a C only. Once more information is available, the TEC can be reviewed.	**C**
Intshambili	B	C	Interventions required to achieve the REC: ▪ Restore baseflows to estuary to maintain mouth state and salinity profile. ▪ Improve water quality. ▪ Partial restoration of estuarine habitat. The PES is to be maintained as the TEC in the short term as information is not available on the increased baseflows required. Restoration of base flows are the key parameter which require improvement. Further investigations can be undertaken as part of the estuarine management plans to determine whether improvement is possible even to a B/C by addressing non-flow measurements and/or to what degree baseflows can be elevated. No scenarios should be considered.	**C**
Mzumbe	C	C/D		**C**
Mhlabatshane	A/B	B/C	Interventions required to achieve the REC: ▪ Catchment water quality. ▪ Restoration of estuarine habitat (riparian). As it is assumed that addressing catchment water quality may be difficult and not possible on the short term, it was evaluated whether only addressing the estuarine habitat will achieve an improvement. Improvement will be to a B which is set as the TEC and immediately applicable. The TEC therefore represents an improvement, but not to the REC.	**B**
Mhlungwa	C	C	TEC set to maintain the PES and REC and is immediately applicable.	**C**
Mfazazana	B	C	Interventions required to achieve the REC:	**C**

Estuary	REC	PES	TEC motivation	TEC
			▪ Improve baseflows to estuary to maintain mouth state and salinity profile. ▪ Improve water quality. ▪ Partial restoration of estuarine riparian habitat. The PES is to be maintained as the TEC in the short term as restoration of baseflows have potential socio-economic implications. Further investigations can be undertaken as part of the estuarine management plans to determine whether improvement is possible even to a B/C by addressing non-flow measurements and/or to what degree baseflows can be elevated.	
Kwa-Makozi	B	B/C	Interventions required to achieve the REC/TEC: ▪ Protect baseflows to estuary to maintain mouth state and salinity profile. ▪ Improve water quality. Partial restoration of estuarine habitat. The TEC is set to improve to a B.	**B**
Mnamfu	C	C	TEC set to maintain the PES and REC and is immediately applicable.	**C**
Mtwalume	C	C	TEC set to maintain the PES and REC and is immediately applicable.	**C**
Mvuzi	C	C	TEC set to maintain the PES and REC and is immediately applicable.	**C**
Fafa	C	C/D	Interventions required to achieve the REC: ▪ Restore estuarine riparian habitat. The C TEC is immediately applicable if the above non-flow related activities are addressed.	**C**
Mdesingane	D	D	TEC set to maintain the PES and REC and is immediately applicable.	**D**
Sezela	C	C	TEC set to maintain the PES and REC and is immediately applicable. Scenarios that comply with the TEC are acceptable.	**C**
Mkumbane	C	C	TEC set to maintain the PES and REC and is immediately applicable.	**C**
Mzinto	C/D	C/D	TEC set to maintain the PES and REC and is immediately applicable.	**C/D**
Nkomba	B/C	B/C	TEC set to maintain the PES and REC and is immediately applicable.	**B/C**
Mzimayi	C/D	C/D	TEC set to maintain the PES and REC and is immediately applicable.	**C/D**
Mpambanyoni	C	C	TEC set to maintain the PES and REC and is immediately applicable.	**C**

Table 3.3 CC: Detailed catchment configuration, interventions and TEC motivations

Estuary	REC	PES	TEC motivation	TEC
Mahlongwa	B	C	Interventions required to achieve the REC: ▪ Protect baseflows to estuary to maintain mouth state and salinity profile. ▪ Improve water quality. ▪ Partial restoration estuarine riparian habitat. ▪ Control and reduce fishing pressure. B TEC is immediately applicable.	**B**
Mahlangwana	B	C	Interventions required to achieve the REC: ▪ Protect baseflows to estuary to maintain mouth state and salinity profile. ▪ Improve water quality. ▪ Partial restoration estuarine riparian habitat. B TEC is immediately applicable.	**B**
uMkhomazi	B	C	▪ Interventions required to achieve the REC: Remove sandmining from the upper reaches below the Sappi Weir. ▪ Restoration of vegetation in the upper reaches and along the northern bank in the middle and lower reaches. ▪ Curb recreational activities in lower reaches. ▪ Reduce/remove cast netting in the mouth area. ▪ Relocate upstream, or remove, the Sappi Weir. ▪ Restore baseflows to estuary to maintain mouth state and salinity profile. The TEC of a B/C is immediately applicable and excludes the relocation of the SAPPI weir (as it may have economic consequences) and restoration of baseflows (difficult without a dam). The same anthropogenic measures under medium to long-term option Sc 21 (includes the dam) as well as Sc Ci and Di, will also achieve the B/C. However, putting any additional waste whatsoever in the uMkhomazi should be avoided due to the risk of mouth closure (especially pre-dam) and other options should be sought.	**B/C**
Ngane	C	C	TEC set to maintain the PES and REC and is immediately applicable.	**C**

Estuary	REC	PES	TEC motivation	TEC
Umgababa	B	C	Interventions required to achieve the REC: ▪ Restore baseflows to estuary to maintain mouth state and salinity profile. ▪ Improve water quality. ▪ Partial restoration of estuarine habitat. Without information on the baseflow requirements (and a way to supply it), the REC cannot be achieved in the short term. The TEC therefore represents an improvement, but not to the REC. Water quality and estuarine habitat must be improved to achieve the TEC which is immediately applicable. Once higher confidence information is available on this estuary, the TEC can be improved to a B. No waste water must be put into this system as it will then not make it possible to improve to the REC in the long term.	**B/C**
Msimbazi	A	B	Interventions required to achieve the REC: ▪ Protect baseflows to estuary to maintain mouth state and salinity profile. ▪ Improve water quality. ▪ Partial restoration of estuarine habitat. The TEC is set to maintain the PES. Improvement to the A will be difficult as one would have to remove some development in the catchment.	**B**
Lovu	B	C/D	Interventions required to achieve the REC: ▪ Restore baseflows to estuary to improve mouth state and salinity profile (Sc L4). ▪ Improve water quality. ▪ Partial restoration of estuarine habitat. Sc L4 (significant decrease in forestry and irrigation) may meet REC. Socio economic implications of this scenarios are significant and the immediately applicable TEC is set at a B/C by applying non-flow related measures. Further improvement may require measurements that have significant socio-economic consequences.	**B/C**
Little Manzimtoti	D	E	Interventions required to achieve the REC: ▪ Restore baseflows to estuary to improve mouth state and salinity profile. ▪ Significant improvement in water quality. ▪ Partial restoration of estuarine habitat. Immediate applicable maintain PES, as it is very difficult (costly) to achieve the D as this would require removing all waste. Further waste water scenarios can therefore be considered as long as the estuary does not become a health hazard and there is compliance to other relevant legal requirements.	**EF**
aManzimtoti	D	D/E	Interventions required to achieve the REC: ▪ Catchment water quality. ▪ Riparian habitat. REC of a D is immediately applicable.	**D**
Mbokodweni	D	E	Interventions required to achieve the REC: ▪ Restore baseflows to estuary to improve mouth state and salinity profile. ▪ Significant improvement in water quality. ▪ Partial restoration of estuarine habitat. Immediate applicable maintain PES, as it is very difficult (costly) to achieve the D as this would require removing all waste. Further waste water scenarios can therefore be considered as long as the estuary does not become a health hazard and there is compliance to other relevant legal requirements.	**EF**
Sipingo	D	F	Interventions required to achieve the REC: ▪ Restore as much as possible baseflows to estuary to improve mouth state and salinity profile. ▪ A significant improvement in water quality (storm water) needed. ▪ Partial restoration of estuarine habitat. It is not possible to improve the estuary to a D as there is limited restoration potential. It must be noted that the mangrove habitat should not be compromised within the estuary. Stormwater the overriding problem.	**EF**
Durban Bay	D	E	It is not possible to improve the estuary to a D as there is limited restoration potential. It must be noted that the white mangrove habitat should not be compromised within the estuary.	**EF**
Durban Bay Shallow water and intertidal zone	D	E	Interventions required to restore functionality to Durban Bay applicable to the specific important areas within the bay: ▪ Protect baseflows to estuary to maintain mouth state and salinity profile. ▪ Improve water quality (storm water management). ▪ Reduce fishing effort. ▪ Partial restoration of estuarine habitat in upper reaches. The restoration of this area requires a TEC of a D and is immediately	**D**

Estuary	REC	PES	TEC motivation	TEC
			applicable.	
uMngeni	D	D/E	Interventions required to achieve the REC/TEC: ▪ Restoration of macrophytes: removal of alien plant species, replanting/ reintroduction with indigenous species (some of which is already occurring). ▪ Wetland engineering (creation of new wetland habitats in close proximity to the uMngeni River banks. ▪ Implement flow allocation in an estuary friendly manner. ▪ Review the current breaching policy that only requires breaching after 2 to 3 weeks, this poses a risk to plant communities and birds. ▪ Develop an Estuary Management Plan. The above interventions can achieve the TEC which is immediately applicable. Any scenarios that result in a D TEC are acceptable.	**D**
Mhlanga	B	D	Interventions required to achieve the REC: ▪ Restore baseflows to estuary to improve mouth state and salinity profile. ▪ A significant improvement in water quality needed. ▪ Partial restoration of estuarine habitat. If the existing pumping scheme comes into operation, it should achieve REC. The TEC is therefore set as the REC and is immediately applicable.	**B**
uMdloti	C	D	Interventions required to achieve the REC: ▪ Restore baseflows to estuary to improve mouth state and salinity profile. ▪ A significant improvement in water quality needed. ▪ Partial restoration of estuarine habitat. Further investigation need to be conducted to see to what extend the catchment quality can be improved to meet the REC. The importance rating should also be reviewed as it is likely that improvement to a C may not be required. The TEC that is therefore immediately applicable is set to maintain the PES. A scenario that includes more waste water to a specific limit must be investigated as this could achieve the TEC.	**D**
uThongathi	C	D	There is concern regarding the importance rating. Improvement is therefore based on low confidence importance (1 point). Based on the longterm TEC is set as a D and all scenarios apart from Aiii will maintain the present state. In the short term, the EC may degrade to a lower category until indirect re-use or other mitigation measures are implemented.	**D**

Table 3.4 Detailed NC catchment configuration, interventions and TEC motivations

Estuary	REC	PES	TEC motivation	TEC
Mhlali	B/C	C/D	Interventions required to achieve the REC: ▪ Reduce the nutrient input from the WWTW and catchment to control growth of reeds and aquatic invasive plants. ▪ Remove the sugarcane from the Estuary Functional Zone (below 5 m contour). ▪ Removal of vegetation from main river channel in upper reaches, including invasive alien plants. ▪ Ensure that the estuary is not artificial breached. ▪ Remove the old saltwater weir from middle reaches of system. Intervention without removal of WW will achieve a C, but not REC. However, infrastructure has already been constructed and licenses awarded for an increases in waste (from .8 to 6 Ml/D) (Sc D). Any increase of waste from current is likely to result in a decreased (from PES) state as nutrients are the key factor in this estuary.	**D**
Bob Stream	B/C	B/C	TEC set to maintain the PES and REC and is immediately applicable.	**B/C**
Seteni	B/C	B/C	TEC set to maintain the PES and REC and is immediately applicable.	**B/C**
Mvoti	C	D	Interventions required to achieve the REC: ▪ Improvement of oxygen levels in the estuary, through for example, removal of the high organic content from the Sappi Stanger effluent. ▪ Reduce the nutrient input from the catchment by 20%. ▪ Remove the sugarcane from the Estuary Functional Zone (below 5 m contour). If the Sappi effluent is retained, but other interventions applied TEC = C/D. Sc 21, 22, 41, 42 and 43 (which includes a proposed dam) will also achieve the TEC with the above measures. Limited increase in WW to this system is not likely to degrade it below a D as long as the system remains open. The TEC is set as a C/D which can be maintained with a new dam, possibly	**C/D**

Estuary	REC	PES	TEC motivation	TEC
			limited increases in waste water, and by addressing the interventions above without the removal or organic content from the SAPPI effluent.	
Mdlotane	A/B	B	Interventions required to achieve the REC: ▪ Improve water quality. ▪ Partial restoration of estuarine habitat. The TEC is set as an A/B.	**A/B**
Nonoti	C	C	TEC set to maintain the PES and REC and is immediately applicable.	**C**
Zinkwazi	A/B	B/C	Interventions required to achieve the REC/TEC: ▪ Protect baseflows to estuary to ensure mouth state and salinity regime. ▪ Improve water quality. ▪ Partial restoration of estuarine habitat. Measures should be put in place to improve to a B and the TEC of a B is immediately applicable. It is felt that achieving an A/B will required a scale of interventions that is difficult and with negative socio-economic implications.	**B**

4 SOUTHERN CLUSTER 1 IUA: ESTUARY RQOs

4.1 MTAMVUNA RQOs

PES:	B	REC:	A/B	TEC:	A/B

Components that require interventions to achieve the TEC:
- Restoration of estuarine riparian habitat.
- Reduce/control fishing high pressure.
- Protect baseflows to estuary to maintain mouth state and salinity profile.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
B	275.19	239.49
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:

B	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (levels to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

A	Mouth open conditions should be maintained within the current range: 78% (± 10%).

Water quality: Salinity

B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid waters in the lower reaches should be between 10 and 15.

Water quality: Other

B	**Ecosystem health**	**Recreational use**	Yes
	Dissolved Inorganic Nitrogen (DIN): Freshwater inflow, 50%ile < 0.2 mg/l. Dissolved Inorganic Phosphate (DIP): Freshwater inflow, 50%ile < 0.015 mg/l. Dissolved Oxygen (DO): Entire estuary, average ≥ 6 mg/l. Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Microbiology: Sufficient levels (DEA, 2012)	

Macrophytes (plants)

B↑	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats (accounts for natural changes due to the dynamic nature of estuaries). ▪ Improve/maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance (litter problematic) and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Lantana, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Maintain present salinity regime to maintain reed and sedge habitats (< 50% loss of reed and sedge habitats in non-flood year).

Invertebrates

B	As sampled by plankton net, grab and dip nets/traps (as appropriate): • Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 25%. ▪ Zooplankton should be dominated by estuarine copepods *Acartia natalensis* and *Pseudodiaptomus hessei*, but include other groups such as mysids. Meroplankton are abundant.

	▪ Macrobenthos should be abundant and dominated by polychaetes but should include amphipods, isopods, tanaids and the crab *Hymenosoma projectum.* Insect taxa should occur in the far upper reaches only. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *Callichirus kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *Scylla serrata*, *Varuna litterata, Macrophthalmus* sp.*,* Sesarmidae and *Uca* sp*.* ▪ Molluscan assemblage should include bivalves (including tellinids, *Solen cylindraceus and Eumarcia paupercula*) and gastropods (including *Nassarius kraussianus*, *Natica* spp. and *Polinices* sp.). ▪ Invasive alien species should not occur.
Fish	
C↑	As sampled by seine and gill net in open waters: ▪ 35 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of seven species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *Glossogobius callidus, Myxus capensis* and *Rhabdosargus holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *Pomadasys commersonni* and *Argyrsoomus japonicas* should be sampled with 100% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp and *Sphyraena* spp.). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.

4.2 ZOLWANE RQOs

PES:	**B**	**REC:**	**B**	**TEC:**	**B**

Key components that require protection to maintain the TEC:
- Baseflows to estuary to maintain mouth state and salinity profile.
- Maintain water quality.
- Maintain of estuarine riparian habitat.

Flow:

PES	**nMAR (MCM)**	**pMAR (MCM)**
	2.19	**2.31**
A	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:	
B	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (levels to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.
Mouth state:	
A	Mouth open conditions should be maintained within the current range: 81% (± 5%).
Water quality: Salinity	
A	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should be between 5 and 10 (to be confirmed).
Water quality: Other	

B	Ecosystem health:	Recreation use:	Yes
	▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l. ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l. ▪ DO: Entire estuary, average ≥ 6 mg/l. ▪ Turbidity: Estuary, clear (<10 NTU) accept during high inflow events.	Microbiology: Sufficient levels (DEA, 2012).	

PES:	B	REC:	B	TEC:	B
	Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).				
Macrophytes (plants)					
B	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Prevent reed encroachment that may become problematic due to nutrient enrichment from proposed future Waste Water Treatment Works (WWTW) input.				
Invertebrates					
B	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 30%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by polychaetes but should include amphipods, isopods, tanaids and the crab *H. projectum.* Insect taxa should occur in the far upper reaches only. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata*, *V. litterata, Macrophthalmus* sp., Sesarmidae and *Uca* sp. ▪ Molluscan assemblage should include bivalves (including *S. cylindraceus, E. paupercula*) and gastropods (including *N. kraussianus*, *Natica* spp., *Polinices* sp.). ▪ Invasive alien species should not occur in abundance.				
Fish					
C	As sampled by seine and gill net in open waters: ▪ 30 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of six species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* and *A. japonicas* should be sampled with 80% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp and *Sphyraena* spp.). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

4.3 SANDLUNDLU RQOs

PES:	C	REC:	C	TEC:	C
Key components that require protection to maintain the TEC: ▪ Protect baseflows to estuary to maintain mouth state and salinity profile. ▪ Maintain water quality. ▪ Maintain of estuarine riparian habitat.					
Flow:					

PES	nMAR (MCM)	pMAR (MCM)
	5.07	**5.00**
A	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	
Sediment processes:		

PES:	C	REC:	C	TEC:	C

C	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.
Mouth state:	
A	Mouth open conditions should be maintained within the current range: 60% (± 10%).
Water quality: Salinity	
B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 15 (to be confirmed).
Water quality: Other	

B	**Ecosystem health:**	**Recreation use:**	N/A
	▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l. ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l. ▪ DO: Entire estuary, average ≥ 6 mg/l. ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Not identified as recreational area in stakeholder meeting.	

Macrophytes (plants)	
C	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). Submerged macrophytes have been recorded in the estuary historically. ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.
Inverts	
D	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.
Fish	
E	As sampled by seine and gill net in open waters: ▪ 18 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of four species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* and *A. japonicas* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.

4.4 KU-BOBOYI RQOs

PES:	B	REC:	B	TEC:	B

Key components that require protection to maintain the TEC:
- Protect baseflows to estuary to maintain mouth state and salinity profile.
- Maintain water quality.
- Maintain of estuarine riparian habitat.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
	1.00	**0.99**
A	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:

B	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

B	Mouth open conditions should be maintained within the current range: 53% (± 5%).

Water quality: Salinity

A	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 10 (to be confirmed).

Water quality: Other

	Ecosystem health:	**Recreation use:**	N/A
B	▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l. ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l. ▪ DO: Entire estuary, average ≥ 6 mg/l. ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Not identified as recreational area in stakeholder meeting.	

Macrophytes (plants)

B	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Lantana, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.

Inverts

B	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur.

PES:	B	REC:	B	TEC:	B
	▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.				
Fish					
C	As sampled by seine and gill net in open waters: ▪ 13 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of four species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

4.5 TONGAZI RQOs

PES:	B/C	REC:	B/C	TEC:	B/C
Key components that require protection to maintain the TEC: ▪ Protect baseflows to estuary to maintain mouth state and salinity profile. ▪ Maintain water quality. ▪ Maintain of estuarine riparian habitat.					
Flow:					

PES	nMAR (MCM)	pMAR (MCM)
	7.00	**7.32**
A	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:			
B	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.		
Mouth state:			
B	Mouth open conditions should be maintained within the current range: 91% (± 5%).		
Water quality: Salinity			
A	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 10 (to be confirmed).		
Water quality: Other			
C	Ecosystem health:	**Recreational use:**	Yes
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (<10 NTU) accept during high inflow events Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Microbiology: Sufficient levels (DEA, 2012).	

PES:	B/C	REC:	B/C	TEC:	B/C

Macrophytes (plants)

C	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Prevent macroalgal blooms and reed encroachment which are likely to become problematic due to nutrient enrichment from proposed future WWTW input.

Inverts

C	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 30%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by polychaetes but should include amphipods, isopods, tanaids and the crab *H. projectum.* Insect taxa should occur in the far upper reaches only. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata*, *V. litterata, Macrophthalmus* sp.*,* Sesarmidae and *Uca* sp. ▪ Molluscan assemblage should include bivalves (including *S. cylindraceus, E. paupercula*) and gastropods (including *N. kraussianus*, *Natica* spp., *Polinices* sp.). ▪ Invasive alien species should not occur in abundance.

Fish

D	As sampled by seine and gill net in open waters: ▪ 30 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of six species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* and *A. japonicas* should be sampled with 80% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp and *Sphyraena* spp.). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.

4.6 KANDANDHLOVU RQOs

PES:	B	REC:	B	TEC:	B

Key components that require protection to maintain the TEC:
- Protect baseflows to estuary to maintain mouth state and salinity profile.
- Maintain water quality.
- Maintain of estuarine riparian habitat.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
A	**1.53**	**1.60**
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:

C	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in

PES:	B	REC:	B	TEC:	B

	middle and upper reaches do not change by more than 20% from Present State over a five year average.
Mouth state:	
A	Mouth open conditions should be maintained within the current range: 54% (± 5%).
Water quality: Salinity	
B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 5 (to be confirmed).
Water quality: Other	

C	**Ecosystem health:**	**Recreational use:**	N/A
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ **DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk).** ▪ **DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk).** ▪ **DO: Entire estuary, average ≥ 6 mg/l (high risk).** ▪ Turbidity: Estuary, clear (<10 NTU) accept during high inflow events Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Not identified as recreational area in stakeholder meeting.	

Macrophytes (plants)	
B	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). In particular the swamp forest habitat is of importance. ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Improve the salinity regime to encourage the re-establishment of mangrove habitat and prevent reed encroachment.
Inverts	
B	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 30%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species should not occur in abundance.
Fish	
C	As sampled by seine and gill net in open waters: ▪ 18 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of five species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 80% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp.). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.

4.7 MPENJATI RQOs

PES:	B/C	REC:	B	TEC:	B

Components that require interventions to achieve the TEC:
- Remove/reduce impact of sand mining.
- Improve water quality.
- Restore estuarine riparian habitat.
- Protect baseflows to estuary to maintain mouth state and salinity profile.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
	23.61	**23.77**
A	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:

D↑	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

B	Mouth open conditions should be maintained within the current range: 70% (± 5%).

Water quality: Salinity

A	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid waters in the lower reaches should between 20 to 30, the middle reaches should be between 15 to 25, and the upper reaches between 10 to 15. Refer to DWS WQ data for baseline.

Water quality: Other

	Ecosystem health:	**Recreational use:**	N/A
C↑	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Not identified as recreational area in stakeholder meeting.	

Macrophytes (plants)

D↑	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). In particular the swamp forest habitat is of importance. ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Prevent macroalgal blooms and reed encroachment which are likely to become problematic due to nutrient enrichment from proposed future WWTW input.

Inverts

D↑	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 30%.

PES:	B/C	REC:	B	TEC:	B
	▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by polychaetes but should include amphipods, isopods, tanaids and the crab *H. projectum.* Insect taxa should occur in the far upper reaches only. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Molluscan assemblage should include bivalves (including *E. paupercula*) and gastropods (including *N. kraussianus, Natica* spp.). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata*, *V. litterata, Macrophthalmus* sp., Sesarmidae and *Uca* sp. ▪ Invasive alien species should not occur in abundance.				
Fish					
D↑	As sampled by seine and gill net in open waters: ▪ 25 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of five species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* and *A. japonicas* should be sampled with 80% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

4.8 UMHLANGANKULU RQOs

PES:	C	REC:	C	TEC:	C
Key components that require protection to maintain the TEC: ▪ Protect baseflows to estuary to maintain mouth state and salinity profile. ▪ Maintain water quality. ▪ Maintain of estuarine riparian habitat.					
Flow:					
PES	**nMAR (MCM)**		**pMAR (MCM)**		
	2.87		2.87		
A	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).				
Sediment processes:					
D	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.				
Mouth state:					
A	Mouth open conditions should be maintained within the current range: 33% (± 10%).				
Water quality: Salinity					
B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 10 (to be confirmed).				
Water quality: Other					
E	**Ecosystem health:**		**Recreational use:**	N/A	
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.025 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 4 mg/l (high risk).		Not identified as recreational area in stakeholder meeting.		

PES:	C	REC:	C	TEC:	C
	▪ Turbidity: Estuary, clear (< 15 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).				
Macrophytes (plants)					
C	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Improve the salinity regime to encourage the growth of mangroves.				
Inverts					
E	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.				
Fish					
D	As sampled by seine and gill net in open waters: ▪ 13 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of four species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

4.9 KABA RQOs

PES:	C	REC:	C	TEC:	C
Key components that require protection to maintain the TEC: ▪ Protect baseflows to estuary to maintain mouth state and salinity profile. ▪ Maintain water quality. ▪ Maintain of estuarine riparian habitat.					
Flow:					
PES	**nMAR (MCM)**		**pMAR (MCM)**		
A	**3.15**		**3.07**		
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).				
Sediment processes:					
C	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat).				

PES:	C	REC:	C	TEC:	C
	The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.				
Mouth state:					
A	Mouth open conditions should be maintained within the current range: 27% (± 10%).				
Water quality: Salinity					
B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 5 (to be confirmed).				
Water quality: Other					
E	Ecosystem health: Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l (high risk) ▪ DIP: Freshwater inflow, 50%ile < 0.025 mg/l (high risk) ▪ DO: Entire estuary, average ≥ 4 mg/l (high risk) ▪ Turbidity: Estuary, clear (< 15 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).		**Recreational use:** Not identified as recreational area in stakeholder meeting.		N/A
Macrophytes (plants)					
D	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Maintain present salinity regime to prevent encroachment of reeds into the open water.				
Inverts					
D	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei.* ▪ Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab *H. projectum* and insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) are dominated by *V. litterata*. ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.				
Fish					
D	As sampled by seine and gill net in open waters: ▪ 10 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of three species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

4.10 MBIZANA RQOs

PES:	B	REC:	B	TEC:	B

Key components that require protection to maintain the TEC:
- Protect baseflows to estuary to maintain mouth state and salinity profile.
- Maintain water quality.
- Maintain of estuarine riparian habitat.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
	36.30	**35.52**
A	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:

C	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

A	Mouth open conditions should be maintained within the current range: 54% (± 5%).

Water quality: Salinity

A	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid waters in the lower reaches should be between 20 to 35, the middle reaches should be between 10 to 20, and the upper reaches between 5 to10 (to be confirmed).

Water quality: Other

	Ecosystem health:	**Recreational use:**	N/A
C	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Not identified as recreational area in stakeholder meeting.	

Macrophytes (plants)

C	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Maintain present salinity regime to prevent encroachment of reeds into the open water.

Inverts

C	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 30%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa.

PES:	B	REC:	B	TEC:	B
	▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species should not occur in abundance.				
Fish					
C	As sampled by seine and gill net in open waters: ▪ 18 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of five species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 80% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp.). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

4.11 MVUTSHINI RQOs

PES:	B/C	REC:	B/C	TEC:	B/C
Key components that require protection to maintain the TEC: ▪ Protect baseflows to estuary to maintain mouth state and salinity profile. ▪ Maintain water quality. ▪ Maintain of estuarine riparian habitat.					
Flow:					
PES	**nMAR (MCM)**		**pMAR (MCM)**		
A	**1.66**		**1.63**		
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).				
Sediment processes:					
B	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.				
Mouth state:					
B	Mouth open conditions should be maintained within the current range: 42% (± 5%).				
Water quality: Salinity					
B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 5 (to be confirmed).				
Water quality: Other					
D	**Ecosystem health:**		**Recreational use:**	Yes	
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile <0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile <0.015 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995).		Ramsgate (Blue Flag) Microbiology: Excellent levels (DEA, 2012).		

PES:	B/C	REC:	B/C	TEC:	B/C
	▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).				
Macrophytes (plants)					
C	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Maintain present salinity regime to prevent encroachment of reeds into the open water. ▪ Prevent macroalgal blooms and reed encroachment which are likely to become problematic due to nutrient enrichment from proposed future WWTW input.				
Inverts					
C	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 30%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species should not occur in abundance.				
Fish					
C	As sampled by seine and gill net in open waters: ▪ 18 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of five species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 80% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp.). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

4.12 BILANHLOLO RQOs

PES:	C	REC:	C	TEC:	C
Key components that require protection to maintain the TEC: ▪ Protect baseflows to estuary to maintain mouth state and salinity profile. ▪ Maintain water quality. ▪ Maintain of estuarine riparian habitat.					
Flow:					
PES	**nMAR (MCM)**		**pMAR (MCM)**		
A	**5.02**		**4.98**		
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).				
Sediment processes:					
D	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined).				

PES:	C	REC:	C	TEC:	C

	▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.
Mouth state:	
A	Mouth open conditions should be maintained within the current range: 47% (± 10%).
Water quality: Salinity	
B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 10 (to be confirmed).
Water quality: Other	

D	**Ecosystem health:**	**Recreational use:**	Yes
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Ramsgate (Blue Flag) Microbiology: Excellent levels (DEA, 2012).	

Macrophytes (plants)	
E	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.
Inverts	
D	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.
Fish	
D	As sampled by seine and gill net in open waters: ▪ 13 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of four species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.

4.13 UVUZANA RQOs

PES:	C	REC:	C	TEC:	C

Key components that require protection to maintain the TEC:
- Protect baseflows to estuary to maintain mouth state and salinity profile.
- Maintain water quality.
- Maintain of estuarine riparian habitat

Flow:

PES	nMAR (MCM)	pMAR (MCM)
A	1.05	1.05

Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).

Sediment processes:

C

- The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined).
- Changes in tidal amplitude of less than 20% from present (to be determined).
- Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

A Mouth open conditions should be maintained within the current range: 32% (± 10%).

Water quality: Salinity

A The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 5 (to be confirmed).

Water quality: Other

F

Ecosystem health:	**Recreational use:** N/A
Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.025 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 4 mg/l (high risk). ▪ Turbidity: Estuary, clear (<15 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Not identified as recreational area in stakeholder meeting.

Macrophytes (plants)

C

- Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries).
- Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat.
- No invasive floating aquatic species present in the estuary e.g. water hyacinth.
- Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.
- Prevent further spread of reeds into water channel.

Inverts

D

As sampled by plankton net, grab and dip nets/traps (as appropriate):
- Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%.
- Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei.*
- Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab *H. projectum* and insect taxa.
- Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos.
- Penaeid and carid (Caridina and Macrobrachium) prawns should occur.

PES:	C	REC:	C	TEC:	C
	▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) are dominated by *V. litterata*. ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.				
Fish					
D	As sampled by seine and gill net in open waters: ▪ 10 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of three species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

4.14 KONGWENI RQOs

PES:	E	REC:	D	TEC:	EF
Water quality: Salinity					
D	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should be between 5 and 10 (to be confirmed).				
Water quality: Other					
F	**Recreational use:**				Yes
	Major holiday destination Microbiology: Sufficient levels (DEA, 2012).				

4.15 VUNGU RQOs

PES:	B	REC:	B	TEC:	B
Key components that require protection to maintain the TEC: • Protect baseflows to estuary to maintain mouth state and salinity profile. • Maintain water quality. • Maintain of estuarine riparian habitat					
Flow:					
PES	**nMAR (MCM)**		**pMAR (MCM)**		
B	**27.79**		**28.88**		
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).				
Sediment processes:					
B	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.				
Mouth state:					
B	Mouth open conditions should be maintained within the current range: 95% (± 5%).				
Water quality: Salinity					
B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Bottom waters should exceed 20 (to be confirmed).				

Water quality: Other			
D	**Ecosystem health:**	**Recreational use:**	Yes
	▪ Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (<10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Uvongo beach Microbiology: Sufficient levels (DEA, 2012).	
Macrophytes (plants)			
B	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the small reed area which accounts for natural changes due to the dynamic nature of estuaries). ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Prevent macroalgal blooms which are likely to become problematic due to nutrient enrichment from proposed future WWTW input.		
Iverts			
C	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 30%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by polychaetes but should include amphipods, isopods, tanaids, and polychaetes. Insect taxa should occur in the upper littoral reaches littoral only. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species should not occur in abundance.		
Fish			
C	As sampled by seine and gill net in open waters: ▪ 30 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of six species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* and *A. japonicas* should be sampled with 80% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.		

4.16 MHLANGENI RQOs

PES:	C	REC:	C	TEC:	C

Key components that require protection to maintain the TEC:
- Protect baseflows to estuary to maintain mouth state and salinity profile.
- Maintain water quality.
- Maintain of estuarine riparian habitat.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
	9.29	**9.82**
B	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

PES:	C	REC:	C	TEC:	C

Sediment processes:

D	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

B	Mouth open conditions should be maintained within the current range: 55% (± 10%).

Water quality: Salinity

B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should be between 10 and 15 (to be confirmed).

Water quality: Other

	Ecosystem health:	**Recreational use:**	N/A
C	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.025 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 4 mg/l (high risk). ▪ Turbidity: Estuary, clear (<10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Not identified as recreational area in stakeholder meeting.	

Macrophytes (plants)

D	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Prevent macroalgal blooms and reed encroachment which are likely to become problematic due to nutrient enrichment from proposed future WWTW input.

Iverts

D	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.

Fish

D	As sampled by seine and gill net in open waters: ▪ 13 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of four species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence.

PES:	C	REC:	C	TEC:	C
	▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

4.17 ZOTSHA RQOs

PES:	B/C	REC:	B	TEC:	B

Components that require interventions to achieve the TEC:
- Restoration of estuarine riparian habitat.
- Improve water quality.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
B	15.74	16.25
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:

B	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

C	Mouth open conditions should be maintained within the current range: 76% (± 5%).

Water quality: Salinity

D	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should be between 5 and 10 (to be confirmed).

Water quality: Other

D↑	**Ecosystem health:**	**Recreational use:**	N/A
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Not identified as recreational area in stakeholder meeting.	

Macrophytes (plants)

C↑	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.

Inverts

C↑	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by

PES:	B/C	REC:	B	TEC:	B
	more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by polychaetes but should include amphipods, isopods, tanaids and the crab *H. projectum.* Insect taxa should occur in the far upper reaches only. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Molluscan assemblage should include bivalves (including *E. paupercula*) and gastropods (including *Natica* spp.). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata*, *V. litterata, Macrophthalmus sp.,* Sesarmidae and *Uca* sp. ▪ Invasive alien species do not dominate macrobenthos.				
Fish					
B	As sampled by seine and gill net in open waters: ▪ 18 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of four species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* and *A. japonicas* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

4.18 BOBOYI RQOs

PES:	B/C	REC:	B/C	TEC:	B/C
Key components that require protection to maintain the TEC: ▪ Protect baseflows to estuary to maintain mouth state and salinity profile. ▪ Maintain water quality. ▪ Maintain of estuarine riparian habitat.					
Flow:					
PES	**nMAR (MCM)**		**pMAR (MCM)**		
B	**8.25**		**8.07**		
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).				
Sediment processes:					
C	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.				
Mouth state:					
A	Mouth open conditions should be maintained within the current range: 95% (± 5%).				
Water quality: Salinity					
A	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 5 (to be confirmed).				
Water quality: Other					
C	**Ecosystem health:**		**Recreational use:**	N/A	
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk).		Not identified as recreational area in stakeholder meeting.		

PES:	B/C	REC:	B/C	TEC:	B/C
	▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).				
Macrophytes (plants)					
C	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. Restrict sugarcane cultivation within the Estuary Functional Zone. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Prevent macroalgal blooms and reed encroachment which are likely to become problematic due to nutrient enrichment from future WWTW input.				
Inverts					
B	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by polychaetes but should include amphipods, isopods, tanaids and the crab *H. projectum.* Insect taxa should occur in the far upper reaches only. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata*, *V. litterata, Macrophthalmus sp.,* Sesarmidae and *Uca sp,* ▪ Molluscan assemblage should include bivalves (including *E. paupercula*) and gastropods (including *N. kraussianus*, *Natica* spp.). ▪ Invasive alien species do not dominate macrobenthos.				
Fish					
C	As sampled by seine and gill net in open waters: ▪ 25 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of five species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* and *A. japonicas* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp and *Sphyraena* spp.). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

4.19 MBANGO RQOs

PES:	E	REC:	D	TEC:	EF
Water quality: Salinity					
D	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should be between 5 and 10 (to be confirmed).				
Water quality: Other					
E	**Recreational use:**				N/A
	Not identified as recreational area in stakeholder meeting.				

4.20 UMZIMKULU RQOs

PES:	B	REC:	B	TEC:	B

Components that require interventions to counteract the downwards trajectory and meet the TEC:
- Eradicate invasive alien vegetation.
- Remove derelict, redundant and old quays, jetties, wharfs and revetments rehabilitate banks.
- Prohibit dredge spoil dumping in inappropriate areas.
- Manage agricultural and industrial practices in the catchment.
- Control/reduce and control fishing pressure.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
B	**1452.49**	**1175.14**
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:

C	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

B	Mouth open conditions should be maintained within the current range: 97% (± 3%).

Water quality: Salinity

B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches between 20 to 30, the middle reaches should be between 15 to 25, and the upper reaches between 0 and 5.

Water quality: Other

	Ecosystem health:	**Recreational use:**	Yes
B	▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l. ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l. ▪ DO: Entire estuary, average ≥ 6 mg/l. ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Paddling Microbiology: Sufficient levels (DEA, 2012).	

Macrophytes (plants)

B	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). In particular the swamp forest habitat is of importance. ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Maintain present salinity regime to maintain reed and sedge habitats (< 50% loss of reed and sedge habitats in non-flood year).

Inverts

C	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 30%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other

PES:	B	REC:	B	TEC:	B

	groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by polychaetes but should include amphipods, isopods, tanaids, polychaetes and the crab *H. projectum.* Insect taxa should occur in the far upper reaches only. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata*, *V. litterata, Macrophthalmus* sp., Sesarmidae and *Uca* sp. ▪ Molluscan assemblage should include bivalves (including *S. cylindraceus, E. paupercula*) and gastropods (including *N. kraussianus*, *Natica* spp., *Polinices* sp.). ▪ Invasive alien species should not occur in abundance.
Fish	
B	As sampled by seine and gill net in open waters: ▪ 30 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of six species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* and *A. japonicas* should be sampled with 80% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp and *Sphyraena* spp.). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.

5 SOUTHERN CLUSTER 2 IUA: ESTUARY RQOs

5.1 UMTHENTE (MTENTWENI) RQOs

PES:	C	REC:	C	TEC:	C

Key components that require protection to maintain the TEC:
- Protect baseflows to estuary to maintain mouth state and salinity profile.
- Maintain water quality.
- Maintain of estuarine riparian habitat.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
C	12.07	11.14
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:

D	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

B	Mouth open conditions should be maintained within the current range: 40% (± 10%).

Water quality: Salinity

B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 5 (to be confirmed).

Water quality: Other

D	**Ecosystem health:**	**Recreational use:**	Yes
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.025 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 4 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Microbiology: Sufficient levels (DEA, 2012).	

Macrophytes (plants)

D	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Prevent further reed encroachment into the main water channel.

Inverts

C	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other

PES:	C	REC:	C	TEC:	C
	groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.				
Fish					
C	As sampled by seine and gill net in open waters: ▪ 13 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of four species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

5.2 MHLANGAMKULU RQOs

PES:	C	REC:	C	TEC:	C
Key components that require protection to maintain the TEC: ▪ Protect baseflows to estuary to maintain mouth state and salinity profile. ▪ Maintain water quality. ▪ Maintain of estuarine riparian habitat.					
Flow:					

PES	nMAR (MCM)	pMAR (MCM)
	2.06	**1.73**
D	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:	
C	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.
Mouth state:	
C	Mouth open conditions should be maintained within the current range: 19% (± 10%).
Water quality: Salinity	
C	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 5 (to be confirmed).
Water quality: Other	

	Ecosystem health:	**Recreational use:**	Yes
D	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.025 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 4 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets	San Lameer Microbiology: Sufficient levels (DEA, 2012).	

PES:	C	REC:	C	TEC:	C
	as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009)				
Macrophytes (plants)					
C	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). Mangroves have been recorded in the estuary. ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Maintain present salinity regime to maintain reed and sedge habitats (< 50% loss of reed and sedge habitats in non-flood year).				
Inverts					
C	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei.* ▪ Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab *H. projectum* and insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) are dominated by *V. litterata*. ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.				
Fish					
C	As sampled by seine and gill net in open waters: ▪ 10 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of three species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

5.3 DAMBA RQOs

PES:	D	REC:	C	TEC:	D
Key components that require protection to maintain the TEC: ▪ Protect baseflows to estuary to maintain mouth state and salinity profile. ▪ Maintain water quality. ▪ Maintain of estuarine riparian habitat. However, it may be possible to elevate the TEC by improving water quality and restoring baseflows and riparian habitat. The degree to which this is achievable needs to be evaluated as part of an Estuary Management Plan.					
Flow:					

PES	nMAR (MCM)	pMAR (MCM)
	4.56	**3.85**
D	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	
Sediment processes:		

PES:	D	REC:	C	TEC:	D

D	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

D	Mouth open conditions should be maintained within the current range: 28% (± 10%).

Water quality: Salinity

C	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 5 (to be confirmed).

Water quality: Other

D	**Ecosystem health:**	**Recreational use:**	Yes
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.025 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 4 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Microbiology: Sufficient levels (DEA, 2012).	

Macrophytes (plants)

D	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Of particular concern would be > 20% change in the area covered by swamp forest and *Barringtonia racemosa*. ▪ Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. Ageratum conyzoides, Balloon vine (*Cardiospermum grandiflorum*), castor oil bush (*Ricinis communis*), Spanish Gold (*Sesbania punicea*) and Triffid weed (*Chromolaena odorata*) cover < 5% of total macrophyte area. ▪ Prevent further reed encroachment into the main water channel.

Inverts

C	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei.* ▪ Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab *H. projectum* and insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) are dominated by *V. litterata*. ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.

Fish

D	As sampled by seine and gill net in open waters: ▪ 10 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of three species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur.

PES:	D	REC:	C	TEC:	D
	▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

5.4 KOSHWANA RQOs

PES:	C/D	REC:	B	TEC:	C

Components that require interventions to achieve the TEC:
- Maintain water quality.
- Partial restoration of estuarine habitat.
- Prevent low oxygen events that results in fish kills.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
B	2.06	2.05
	Present flows pose a risk to the REC. Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:

D	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

B	Mouth open conditions should be maintained within the current range: 26% (± 5%).

Water quality: Salinity

B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 10 (to be confirmed).

Water quality: Other

E	**Ecosystem health:**	**Recreational use:**	Yes
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Microbiology: Sufficient levels (DEA, 2012).	

Macrophytes (plants)

D↑	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ Area covered by invasive waterweeds (e.g. water hyacinth, *Azolla filiculoides*) and nuisance filamentous algae (e.g. Enteromorpha, Ulva, Cladophora) should cover < 50% of water surface area. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Prevent algal blooms and reed encroachment which are likely to become problematic due to nutrient enrichment from further WWTW input.

Inverts

PES:	C/D	REC:	B	TEC:	C

D	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei.* ▪ Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab *H. projectum* and insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) are dominated by *V. litterata*. ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.
Fish	
D	As sampled by seine and gill net in open waters: ▪ 10 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of three species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.

5.5 INTSHAMBILI RQOs

PES:	C	REC:	B	TEC:	C

Components that require interventions to achieve the TEC:
- Improve water quality.
- Partial restoration of estuarine habitat.
- Prevent low oxygen events that results in fish kills.

However, it may be possible to elevate the TEC by improving water quality and restoring baseflows and riparian habitat. The degree to which this is achievable needs to be evaluated as part of an Estuary Management Plan.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
	6.48	**4.86**
E	Present flows pose a risk to the REC. Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld, and if possible improved, to the estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:

C	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

D	Mouth open conditions should be maintained within the current range: 42% (± 5%).

Water quality: Salinity

B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 15 (to be confirmed).

Water quality: Other

C↑	**Ecosystem health:**	**Recreational use:**	Yes
	Water quality poses risk to REC/TEC, sufficiently reduced if:	Microbiology: Sufficient levels (DEA,	

PES:	C	REC:	B	TEC:	C
	▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).			2012).	
Macrophytes (plants)					
C	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Of particular concern would be > 20% change in the area covered by swamp forest and Barringtonia racemosa. ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.				
Inverts					
B	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.				
Fish					
C	As sampled by seine and gill net in open waters: ▪ 13 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of four species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

5.6 MZUMBE RQOs

PES:	C/D	REC:	C	TEC:	C
Components that require interventions to achieve the TEC: ▪ Restore estuarine riparian habitat.					
Flow:					
PES	**nMAR (MCM)**		**pMAR (MCM)**		
B	**58.53**		**52.78**		
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).				
Sediment processes:					

PES:	C/D	REC:	C	TEC:	C

D	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

C	Mouth open conditions should be maintained within the current range: 74% (± 10%).

Water quality: Salinity

B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 10 (to be confirmed).

Water quality: Other

	Ecosystem health:	**Recreational use:**	Yes
C	▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l. ▪ DIP: Freshwater inflow, 50%ile < 0.025 mg/l. ▪ DO: Entire estuary, average ≥ 4 mg/l. ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Microbiology: Sufficient levels (DEA, 2012).	

Macrophytes (plants)

E↑	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. Sugarcane covers a large area of the Estuarine Functional Zone (EFZ) and important swamp forest habitat has been removed. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Prevent further reed encroachment into the main water channel.

Inverts

D	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by polychaetes but should include amphipods, isopods, tanaids, polychaetes and the crab *H. projectum.* Insect taxa should occur in the far upper reaches only. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Molluscan assemblage should include bivalves (including *E. paupercula*) and gastropods (including *Natica* spp.). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata*, *V. litterata, Macrophthalmus* sp., Sesarmidae and *Uca* sp. ▪ Invasive alien species do not dominate macrobenthos.

Fish

D	As sampled by seine and gill net in open waters: ▪ 18 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of four species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* and *A. japonicas* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp).

PES:	C/D	REC:	C	TEC:	C
	▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

5.7 MHLABATSHANE RQOs

PES:	B/C	REC:	A/B	TEC:	B

Components that require interventions to achieve the TEC:
- Improve water quality.
- Partial restoration of estuarine riparian habitat.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
B	6.46	6.48

Present base flows pose a risk to the REC. Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld, where possible improved, to the estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).

Sediment processes:

C↑
- The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined).
- Changes in tidal amplitude of less than 20% from present (to be determined).
- Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

B: Mouth open conditions should be maintained within the current range: 50% (± 5%).

Water quality: Salinity

B: The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 20 and that of the middle reaches exceed 10 (to be confirmed).

Water quality: Other

D↑

Ecosystem health:	Recreational use: Yes
Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Blue Flag Beach Microbiology: Excellent levels (DEA, 2012).

Macrophytes (plants)

C↑
- Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). In particular the freshwater mangrove, Barringtonia racemosa, swamp forest would be of importance.
- Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat.
- No invasive floating aquatic species present in the estuary e.g. water hyacinth.
- Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.
- Maintain present salinity regime to maintain reed and sedge habitats (< 50% loss of reed and sedge habitats in non-flood year).

Inverts

PES:	B/C	REC:	A/B	TEC:	B
C↑	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 30%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species should not occur in abundance.				
Fish					
C↑	As sampled by seine and gill net in open waters: ▪ 18 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of five species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 80% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp.). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

5.8 MHLUNGWA RQOs

PES:	C	REC:	C	TEC:	C
Key components that require protection to maintain the TEC: ▪ Protect baseflows to estuary to maintain mouth state and salinity profile. ▪ Maintain water quality. ▪ Maintain of estuarine riparian habitat.					
Flow:					
PES	**nMAR (MCM)**		**pMAR (MCM)**		
B	**5.78**		**5.67**		
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).				
Sediment processes:					
E	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.				
Mouth state:					
B	Mouth open conditions should be maintained within the current range: 29% (± 10%).				
Water quality: Salinity					
B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 10 (to be confirmed).				
Water quality: Other					
C	**Ecosystem health:**		**Recreational use:**	Yes	
	▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l. ▪ DIP: Freshwater inflow, 50%ile < 0.025 mg/l. ▪ DO: Entire estuary, average ≥ 4 mg/l.		Microbiology: Sufficient levels (DEA, 2012).		

PES:	C	REC:	C	TEC:	C
	▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).				
Macrophytes (plants)					
D	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). In particular the freshwater mangrove, Barringtonia racemosa, swamp forest. ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat particularly by sugarcane cultivation. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.				
Inverts					
D	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei.* ▪ Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab *H. projectum* and insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) are dominated by *V. litterata*. ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.				
Fish					
D	As sampled by seine and gill net in open waters: ▪ 10 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of three species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

5.9 MFAZAZANA RQOs

PES:	C	REC:	B	TEC:	C
Key components that require protection to maintain the TEC: ▪ Protect baseflows to estuary to maintain mouth state and salinity profile. ▪ Maintain water quality. ▪ Maintain of estuarine riparian habitat. However, it may be possible to elevate the TEC by improving water quality and restoring baseflows and riparian habitat. The degree to which this is achievable needs to be evaluated as part of an Estuary Management Plan.					
Flow:					

PES	nMAR (MCM)	pMAR (MCM)
	2.77	**2.57**
B	**Present base flows pose a risk to the REC.** Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	
Sediment processes:		

PES:	C	REC:	B	TEC:	C

D	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

C	Mouth open conditions should be maintained within the current range: 24% (± 5%).

Water quality: Salinity

B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should be between 5 and 10 (to be confirmed).

Water quality: Other

	Ecosystem health:	**Recreational use:** Yes
D	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Microbiology: Sufficient levels (DEA, 2012).

Macrophytes (plants)

D	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). In particular the freshwater mangrove, Barringtonia racemosa, swamp forest. ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat particularly by sugarcane. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.

Inverts

D	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei.* ▪ Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab *H. projectum* and insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) are dominated by *V. litterata*. ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.

Fish

D	As sampled by seine and gill net in open waters: ▪ 10 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of three species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality.

PES:	C	REC:	B	TEC:	C
	▪ No fish kills should occur.				

5.10 KWA-MAKOSI RQOs

PES:	B/C	REC:	B	TEC:	B

Components that require interventions to achieve the TEC:
- Protect baseflows to estuary to maintain mouth state and salinity profile.
- Improve water quality.
- Partial restoration of estuarine habitat.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
B	3.23	3.03
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:

C↑	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

B	Mouth open conditions should be maintained within the current range: 37% (± 5%).

Water quality: Salinity

B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should be between 5 and 10 (to be confirmed).

Water quality: Other

	Ecosystem health:	**Recreational use:**	N/A
C↑	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Not identified as recreational area in stakeholder meeting.	

Macrophytes (plants)

C↑	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). In particular the freshwater mangrove, Barringtonia racemosa, swamp forest. ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.

Inverts

C↑	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 30%.

PES:	B/C	REC:	B	TEC:	B
	▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species should not occur in abundance.				
Fish					
C↑	As sampled by seine and gill net in open waters: ▪ 18 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of five species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 80% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp.). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

5.11 MNAMFU RQOs

PES:	C	REC:	C	TEC:	C
Key components that require protection to maintain the TEC: ▪ Baseflows to estuary to maintain mouth state and salinity profile. ▪ Maintain water quality. ▪ Maintain of estuarine riparian habitat.					
Flow:					
PES	**nMAR (MCM)**		**pMAR (MCM)**		
B	**3.08**		**2.88**		
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).				
Sediment processes:					
C	▪ The flood regime maintain the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow do not deviates by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.				
Mouth state:					
B	Mouth open conditions should be maintained within the current range: 42% (± 10%).				
Water quality: Salinity					
B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should be between 5 and 10 (to be confirmed).				
Water quality: Other					
D	**Ecosystem health:**		**Recreational use:**	N/A	
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.025 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 4 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events.		Not identified as recreational area in stakeholder meeting.		

PES:	C	REC:	C	TEC:	C
	Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).				
Macrophytes (plants)					
C	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). In particular the freshwater mangrove, Barringtonia racemosa, swamp forest is important. ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.				
Inverts					
D	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.				
Fish					
D	As sampled by seine and gill net in open waters: ▪ 13 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of four species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

5.12 MTWALUME RQOs

PES:	C	REC:	C	TEC:	C
Key components that require protection to maintain the TEC: ▪ Baseflows to estuary to maintain mouth state and salinity profile. ▪ Maintain water quality. ▪ Maintain of estuarine riparian habitat.					
Flow:					
PES	**nMAR (MCM)**		**pMAR (MCM)**		
B	**57.60**		**41.79**		
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).				
Sediment processes:					
C	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the				

PES:	C	REC:	C	TEC:	C

	estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.
Mouth state:	
C	Mouth open conditions should be maintained within the current range: 71% (± 10%).
Water quality: Salinity	
B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should be between 15 and 20 (to be confirmed).
Water quality: Other	

	Ecosystem health:	**Recreational use:**	Yes
C	▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l. ▪ DIP: Freshwater inflow, 50%ile < 0.025 mg/l. ▪ DO: Entire estuary, average ≥ 4 mg/l. ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Microbiology: Sufficient levels (DEA, 2012).	

Macrophytes (plants)	
C	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.
Inverts	
C	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by polychaetes but should include amphipods, isopods, tanaids, polychaetes and the crab *H. projectum.* Insect taxa should occur in the far upper reaches only. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Molluscan assemblage should include bivalves (including *E. paupercula*) and gastropods (including *Natica* spp.). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata*, *V. litterata, Macrophthalmus* sp., Sesarmidae and *Uca* sp. ▪ Invasive alien species do not dominate macrobenthos.
Fish	
C	As sampled by seine and gill net in open waters: ▪ 18 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of four species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* and *A. japonicas* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.

5.13 MVUZI RQOs

PES:	C	REC:	C	TEC:	C

Key components that require protection to maintain the TEC:
- Baseflows to estuary to maintain mouth state and salinity profile.
- Maintain water quality.
- Maintain of estuarine riparian habitat.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
B	1.65	1.55

Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).

Sediment processes:

D

- The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined).
- Changes in tidal amplitude of less than 20% from present (to be determined).
- Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

C Mouth open conditions should be maintained within the current range: 23% (± 5%).

Water quality: Salinity

B The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 5 (to be confirmed).

Water quality: Other

C

Ecosystem health:	Recreational use: N/A
▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l. ▪ DIP: Freshwater inflow, 50%ile < 0.025 mg/l. ▪ DO: Entire estuary, average ≥ 4 mg/l. ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Not identified as recreational area in stakeholder meeting.

Macrophytes (plants)

C

- Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries
- Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat.
- No invasive floating aquatic species present in the estuary e.g. water hyacinth.
- Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.
- Prevent further reed encroachment into the main water channel.

Inverts

C

As sampled by plankton net, grab and dip nets/traps (as appropriate):
- Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%.
- Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei.*
- Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab *H. projectum* and insect taxa.
- Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos.
- Penaeid and carid (Caridina and Macrobrachium) prawns should occur.
- Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed).

PES:	C	REC:	C	TEC:	C
	▪ Large brachyuran crabs (macrocrustacea) are dominated by *V. litterata*. ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.				
Fish					
C	As sampled by seine and gill net in open waters: ▪ 10 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of three species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

5.14 FAFA RQOs

PES:	C/D	REC:	C	TEC:	C
Components that require interventions to achieve the TEC: ▪ Restore estuarine habitat.					
Flow:					
PES	**nMAR (MCM)**		**pMAR (MCM)**		
C	**46.45**		**37.64**		
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).				
Sediment processes:					
D↑	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.				
Mouth state:					
C	Mouth open conditions should be maintained within the current range: 45% (± 10%).				
Water quality: Salinity					
B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should be between 10 and 15 (to be confirmed).				
Water quality: Other					
C	**Ecosystem health:**			**Recreational use:**	Yes
	▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l. ▪ DIP: Freshwater inflow, 50%ile < 0.025 mg/l. ▪ DO: Entire estuary, average ≥ 4 mg/l. ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009)			Microbiology: Sufficient levels (DEA, 2012).	
Macrophytes (plants)					
D↑	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different				

PES:	C/D	REC:	C	TEC:	C

	macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). In particular maintain the integrity of the swamp forest. ▪ Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat and sand mining in the upper reaches. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover <5% of total macrophyte area. ▪ Prevent further reed encroachment into the main water channel.
Inverts	
D	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.
Fish	
D	As sampled by seine and gill net in open waters: ▪ 13 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of four species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.

5.15 MDESINGANE RQOs

PES:	D	REC:	D	TEC:	D

Key components that require protection to maintain the TEC:
- Baseflows to estuary to maintain mouth state and salinity profile.
- Maintain water quality.
- Maintain of estuarine riparian habitat.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
A	**2.02**	**2.02**
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:	
E	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviates by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.
Mouth state:	

PES:	D	REC:	D	TEC:	D
D	Mouth open conditions should be maintained within the current range: 58% (± 10%).				
Water quality: Salinity					
B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 5 (to be confirmed).				
Water quality: Other					
E	**Ecosystem health:**			**Recreational use:**	N/A
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.5 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.125 mg/l (high risk). ▪ DO: Lower estuary, average ≥ 4 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 15 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).			Not identified as recreational area in stakeholder meeting.	
Macrophytes (plants)					
E	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Prevent further reed encroachment into the main water channel.				
Inverts					
E	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 50%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton occur. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Carid prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods.				
Fish					
E	As sampled by seine and gill net in open waters: ▪ Six species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of three species. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 30% frequency of occurrence. ▪ Pelagic piscivores should occur). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

5.16 SEZELA RQOs

PES:	C	REC:	C	TEC:	C
Key components that require protection to maintain the TEC: ▪ Baseflows to estuary to maintain mouth state and salinity profile. ▪ Maintain water quality. ▪ Maintain of estuarine riparian habitat.					
Flow:					

PES:	C	REC:	C	TEC:	C

PES	nMAR (MCM)	pMAR (MCM)
B	3.92	3.89

Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).

Sediment processes:

D

- The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined).
- Changes in tidal amplitude of less than 20% from present (to be determined).
- Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

B

Mouth open conditions should be maintained within the current range: 19% (± 5%).

Water quality: Salinity

B

The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 10 (to be confirmed).

Water quality: Other

E

Ecosystem health:	**Recreational use:** N/A
Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.25 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 4 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Not identified as recreational area in stakeholder meeting.

Macrophytes (plants)

D

- Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries).
- Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat.
- No invasive floating aquatic species present in the estuary e.g. water hyacinth.
- Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.
- Prevent algal blooms and reed encroachment that may become problematic due to nutrient enrichment from further proposed WWTW input.

Inverts

D

As sampled by plankton net, grab and dip nets/traps (as appropriate):

- Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%.
- Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei.*
- Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab *H. projectum* and insect taxa.
- Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos.
- Penaeid and carid (Caridina and Macrobrachium) prawns should occur.
- Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed).
- Large brachyuran crabs (macrocrustacea) are dominated by *V. litterata*.
- Molluscan assemblage should include bivalves and gastropods.
- Invasive alien species do not dominate macrobenthos.

Fish

D

As sampled by seine and gill net in open waters:

PES:	C	REC:	C	TEC:	C
	▪ 10 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of three species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

5.17 MKUMBANE RQOs

PES:	C	REC:	C	TEC:	C

Key components that require protection to maintain the TEC:
- Baseflows to estuary to maintain mouth state and salinity profile.
- Maintain water quality.
- Maintain of estuarine riparian habitat.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
	3.79	**3.54**
B	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:

D	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

B	Mouth open conditions should be maintained within the current range: 8% (± 5%).

Water quality: Salinity

B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 5 (to be confirmed).

Water quality: Other

	Ecosystem health:	**Recreational use:**	N/A
D	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.025 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 4 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009)	Not identified as recreational area in stakeholder meeting	

Macrophytes (plants)

D	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth.

PES:	C	REC:	C	TEC:	C
	▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Prevent further reed encroachment into the main water channel.				
Inverts					
D	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei.* ▪ Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab *H. projectum* and insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) are dominated by *V. litterata*. ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.				
Fish					
D	As sampled by seine and gill net in open waters: ▪ 10 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of three species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

5.18 UMUZIWEZINTO (MZINTO) RQOs

PES:	C/D	REC:	C/D	TEC:	C/D
Key components that require protection to maintain the TEC: ▪ Baseflows to estuary to maintain mouth state and salinity profile. ▪ Maintain water quality. ▪ Maintain of estuarine riparian habitat.					
Flow:					
PES	**nMAR (MCM)**		**pMAR (MCM)**		
C	**23.17**		**20.09**		
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).				
Sediment processes:					
D	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of 2 from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a 5 year average.				
Mouth state:					
C	Mouth open conditions should be maintained within the current range: 15% (± 5%).				
Water quality: Salinity					
C	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 5 (to be confirmed).				
Water quality: Other					

PES:	C/D	REC:	C/D	TEC:	C/D
D	**Ecosystem health:**			**Recreational use:**	N/A
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.025 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 4 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).			Not identified as recreational area in stakeholder meeting.	
Macrophytes (plants)					
D	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). In particular the freshwater mangrove, Barringtonia racemosa, swamp forest is important. ▪ Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.				
Inverts					
D	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei.* ▪ Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab *H. projectum* and insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) are dominated by *V. litterata*. ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.				
Fish					
D	As sampled by seine and gill net in open waters: ▪ 10 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of three species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

5.19 NKOMBA RQOs

PES:	B/C	REC:	B/C	TEC:	B/C
Key components that require protection to maintain the TEC: ▪ Baseflows to estuary to maintain mouth state and salinity profile. ▪ Maintain water quality. ▪ Maintain of estuarine riparian habitat.					
Flow:					

PES	nMAR (MCM)	pMAR (MCM)
A	**0.69**	**0.69**
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the	

PES:	B/C	REC:	B/C	TEC:	B/C
	Present (2015).				
Sediment processes:					
C	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.				
Mouth state:					
A	Mouth open conditions should be maintained within the current range: 10% (± 5%).				
Water quality: Salinity					
A	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 5 (to be confirmed).				
Water quality: Other					
D	**Ecosystem health:**		**Recreational use:**	N/A	
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.025 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 4 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).		Not identified as recreational area in stakeholder meeting.		
Macrophytes (plants)					
D	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.				
Inverts					
D	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 30%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*. ▪ Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab *H. projectum* and insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) are dominated by *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods (including *Melanoides tuberculata*). ▪ Invasive alien species should not occur in abundance.				
Fish					
C	As sampled by seine and gill net in open waters: ▪ 15 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of four species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 70% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur.				

PES:	B/C	REC:	B/C	TEC:	B/C
	▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

5.20 MZIMAYI RQOs

PES:	C/D	REC:	C/D	TEC:	C/D

Key components that require protection to maintain the TEC:
- Baseflows to estuary to maintain mouth state and salinity profile.
- Maintain water quality.
- Maintain of estuarine riparian habitat.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
	6.15	**4.55**
D	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:

C	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

D	Mouth open conditions should be maintained within the current range: 20% (± 5%).

Water quality: Salinity

C	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should be between 0 and 5 (to be confirmed).

Water quality: Other

	Ecosystem health:	**Recreational use:**	Yes
D	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.025 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 4 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Microbiology: Sufficient levels (DEA, 2012).	

Macrophytes (plants)

C	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Prevent further reed encroachment into the main water channel.

Inverts

D	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by

PES:	C/D	REC:	C/D	TEC:	C/D

	more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei.* ▪ Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab *H. projectum* and insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) are dominated by *V. litterata*. ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.
Fish	
C	As sampled by seine and gill net in open waters: ▪ 10 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of three species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.

5.21 MPAMBANYONI RQOs

PES:	C	REC:	C	TEC:	C

Key components that require protection to maintain the TEC:
- Baseflows to estuary to maintain mouth state and salinity profile.
- Maintain water quality.
- Maintain of estuarine riparian habitat.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
	60.06	**55.53**
B	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:

D	▪ The flood regime maintain the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow do not deviates by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

B	Mouth open conditions should be maintained within the current range: 78% (± 10%).

Water quality: Salinity

A	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should be between 10 and 15 (to be confirmed).

Water quality: Other

D	**Ecosystem health:**	**Recreational use:**	Yes
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.025 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 4 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events.	Scottborough Microbiology: Sufficient levels (DEA, 2012).	

PES:	C	REC:	C	TEC:	C
	Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).				
Macrophytes (plants)					
D	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat particularly by sugarcane cultivation. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.				
Inverts					
D	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by polychaetes but should include amphipods, isopods, tanaids, polychaetes and the crab *H. projectum.* Insect taxa should occur in the far upper reaches only. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Molluscan assemblage should include bivalves (including *E. paupercula*) and gastropods (including *Natica* spp.). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata*, *V. litterata, Macrophthalmus* sp., Sesarmidae and *Uca* sp. ▪ Invasive alien species do not dominate macrobenthos.				
Fish					
C	As sampled by seine and gill net in open waters: ▪ 18 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of four species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* and *A. japonicas* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ ▪ No fish kills should occur.				

6 CENTRAL CLUSTER IUA: ESTUARY RQOs

6.1 MAHLONGWA RQOs

PES:	C	REC:	B	TEC:	B

Components that require interventions to achieve the TEC:
- Protect baseflows to estuary to maintain mouth state and salinity profile.
- Improve water quality.
- Partial restoration estuarine riparian habitat.
- Control and reduce fishing pressure.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
B	13.76	13.18

Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).

Sediment processes:

D↑
- The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined).
- Changes in tidal amplitude of less than 20% from present (to be determined).
- Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

A: Mouth open conditions should be maintained within the current range: 22% (± 5%).

Water quality: Salinity

B: The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 10 (to be confirmed).

Water quality: Other

D↑

Ecosystem health:	**Recreational use:** Yes
Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (<10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Microbiology: Sufficient levels (DEA, 2012).

Macrophytes (plants)

C↑
- Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries).
- Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat.
- No invasive floating aquatic species present in the estuary e.g. water hyacinth.
- Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.
- Maintain present salinity regime to maintain reed and sedge habitats (< 50% loss of reed and sedge habitats in non-flood year).
- Improve salinity regime to encourage the reestablishment of mangrove habitat.

Inverts

C↑: As sampled by plankton net, grab and dip nets/traps (as appropriate):

PES:	C	REC:	B	TEC:	B

	▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 30%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*. ▪ Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab *H. projectum* and insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) are dominated by *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods (including *Melanoides tuberculata*). ▪ Invasive alien species should not occur in abundance.
Fish	
C↑	As sampled by seine and gill net in open waters: ▪ 15 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of four species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 70% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.

6.2 MAHLONGWANE RQOs

PES:	C	REC:	B	TEC:	B

Components that require interventions to achieve the TEC:
- Protect baseflows to estuary to maintain mouth state and salinity profile.
- Improve water quality.
- Partial restoration of estuarine riparian habitat.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
B	2.69	2.93
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:	
D↑	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.
Mouth state:	
B	Mouth open conditions should be maintained within the current range: 13% (± 5%).
Water quality: Salinity	
B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 10 (to be confirmed).
Water quality: Other	

D↑	**Ecosystem health:**	**Recreational use:**	Yes
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events.	Microbiology: Sufficient levels (DEA, 2012).	

PES:	C	REC:	B	TEC:	B
	Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).				
Macrophytes (plants)					
D↑	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). In particular the Barringtonia racemosa and *Hibiscus tiliaceus* swamp forest is important. ▪ Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Prevent further reed encroachment into the main water channel.				
Inverts					
C↑	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 30%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*. ▪ Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab *H. projectum* and insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) are dominated by *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods (including *Melanoides tuberculata*). ▪ Invasive alien species should not occur in abundance.				
Fish					
C↑	As sampled by seine and gill net in open waters: ▪ 15 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of four species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 70% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

6.3 uMKHOMAZI RQOs

PES:	C	REC:	B (Remove Weir)	TEC:	B/C (Leave weir)
Key components that require interventions to achieve the TEC: ▪ Remove sandmining from the upper reaches below the Sappi Weir. ▪ Restoration of vegetation in the upper reaches and along the northern bank in the middle and lower reaches. ▪ Curb recreational activities in lower reaches. ▪ Reduce/remove cast netting in the mouth area. To achieve the REC: ▪ Restore estuarine habitat through the relocation/removal of Sappi Weir. ▪ Restore baseflows to estuary. (Only possible by building of a dam).					

Component/ Indicator	TEC	RQO
Hydrology	C/D	Maintain the target EC (> 57%). Protection of estuarine ecosystem to achieve ECs and ROQs indicated for hydrodynamics, water quality, sediment dynamics and the various biotic components: River inflow distribution patterns differ by less than 5% from that of Scenario B (i.e. approved flow scenario for the uMkhomazi). ▪ Monthly river inflow > 1.0 m^3/s.

Component/ Indicator	TEC	RQO
		▪ Monthly river inflow > 2.0 m^3/s persists for longer than three months in a row. ▪ Monthly river inflow > 5.0 m^3/s for more than 30% of the time.
Hydrodynamics	**A**	Maintain the target EC (> 93%). Protection of estuarine ecosystem. ▪ Mouth closure occurs less than 2 - 3 weeks in a year. ▪ Mouth closure occurs for less than two years out of ten. ▪ Mouth closure does not occur between September and April.
Water quality	**C**	Maintain the target EC (> 63%). ROQs for water quality in **river inflow** to protect estuarine ecosystem, that is achieving the EC and ROQs indicated for the various biotic components: ▪ pH: 7.5 - 8.5. ▪ DO > 6 mg/L. ▪ Turbidity (low flow < 5 m^3/s): < 15 NTU. ▪ Turbidity (low flow > 5 m^3/s): Naturally turbid. ▪ Dissolved nutrients (low flow < 5 m^3/s): NO_x-N <150 µg/L;NH_3-N < 20 µg/L; PO_4-P < 10 µg/L. ▪ Dissolved nutrients (high flow > 5 m^3/s): NO_x-N <200 µg/L; NH_3-N < 20 µg/L; PO_4-P < 20 µg/L. ▪ Trace metals (to be determined). ▪ Pesticides/herbicides (to be determined).
		Minimum requirement for recreational use (DEA, 2012): ▪ *Enterococci*: Ninety percentile (90%ile) over a 12 month running period ≤ 185 counts per 100 ml. ▪ *E. coli*: Ninety percentile (90%ile) over a 12 month running period ≤ 500 counts per 100 ml.
		ROQs for water quality in **estuary** to protect estuarine ecosystems, that is achieving the EC and ROQs indicated for the various biotic components: ▪ Salinity: 0 in the upper reaches; > 20 middle reaches during the low flow season; freshwater dominated for 70% of the time. ▪ Turbidity (low flow < 5 m^3/s): Average < 10 NTU in any sampling survey. ▪ Turbidity (high flow > 5 m^3/s): Naturally turbid. ▪ pH: Average 7.0 - 8.5 in any sampling survey. ▪ Dissolved oxygen: Average > 6 mg/L in any sampling survey. ▪ Dissolved nutrients (low flow < 5 m^3/s): Average NO_x-N < 150 µg/L, NH_3-N < 20 µg/L and PO_4-P < 10 µg/L in any sampling survey. ▪ Dissolved nutrients (high flow > 5 m^3/s): Average NO_x-N < 300 µg/L, NH_3-N < 20 µg/L and PO_4-P < 20 µg/L in any sampling survey. ▪ Total metal concentrations in water not to exceed target values as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Total metal concentration in sediment not to exceed target values as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).
Sediment dynamics	**B**	Maintain the target EC (> 78%). Ensure that turbidity or clarity levels stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity during runoff events (Aquatic ecosystems: driver).
		Flood regime to protect estuarine ecosystem's sediment distribution patterns and aquatic habitat (instream physical habitat: ▪ River inflow distribution patterns (flood components) differ by less than 20% (in terms of magnitude, timing and variability) from that of the Present State (2013). ▪ Suspended sediment concentration from river inflow deviates by less than 20% of the sediment load-discharge relationship to be determined as part of baseline studies (Present State 2013). ▪ Findings from the bathymetric surveys undertaken as part of a monitoring programme indicate that no changes in the sedimentation and erosion patterns in the estuary have occurred (± 0.5 m). ▪ Intertidal and subtidal habitat in upper reaches below the weir are available for estuarine species (increase by > 20% from present).
		Changes in sediment grain size distribution patterns to maintain benthic invertebrates. ▪ The median bed sediment diameter deviates by less than a factor of two from levels to be determined as part of baseline studies (Present State 2013). ▪ Sand/mud distribution in middle and upper reaches change by less than 20% from Present State (2013). ▪ Changes in tidal amplitude at the tidal gauge of less than 20% from Present State (2013).
Microalgae	**B**	▪ Maintain the target EC (> 78%). Maintain current microalgae assemblages, specifically > 5 diatom species at a frequency > 3% of the total population in saline reaches (i.e. Zone A in low flow). ▪ Medium phytoplankton: > 5µg/L for more than 50% of the stations. ▪ Microphytobenthos (MPB): > 30 mg m^2 for more than 50% of the stations in the saline portion of the estuary.

Component/ Indicator	TEC	RQO
		▪ Observable bloom in the estuary.
Macrophytes	D	Maintain the target EC (> 43%). Maintain the 2015 distribution of macrophyte habitats: ▪ Maintain the integrity of the riparian zone particular where the sandmining no longer occurs. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ No sugarcane in the EFZ. ▪ No greater than 10% change in the area covered by different macrophyte habitats. ▪ No canalisation of lower reaches. ▪ No invasive plants (e.g. syringa berry, Spanish reed, black wattle, Brazilian pepper tree) largely absent from the riparian zone. ▪ No die-back of reeds and sedges in the lower reaches. ▪ No unvegetated, cleared areas along the banks. ▪ No floating invasive aquatics observed in the upper estuary reaches. ▪ No Sugarcane is present in the EFZ.
Invertebrates	B	Maintain the target EC (> 78%). Maintain current levels of zoobenthic abundance (including seasonal variation). Retain an invertebrate community assemblage in the estuary based on species diversity and abundance that includes a variety of indigenous species. This include the following: ▪ Species diversity (between 15 species in summer - 40 species in winter). ▪ Polychaetes, amphipods and tanaeids should numerically dominate during all seasons. However, abundance of all taxon groups should be higher during summer high flow periods and lower during winter low flow period. ▪ DOs should > 4 ppt in > 75% of the estuary. ▪ Less than 20% change in the intertidal and subtidal habitats. ▪ No occurrence of invertebrate alien species (e.g. Tarebia granifera). ▪ No decrease in abundance of zooplankton (> 20%) in terms of numbers per m-2 over entire estuarine area (three sample sites) over three years. ▪ No decrease in abundance of benthic macroinvertebrates. ▪ No occurrence of *Paratylodiplax blephariskios* in annual sample.
Fish	D	▪ Maintain the target EC (> 43%). The upper reaches below weir in its entirety acts as a nursery to a diversity of EDC2 species (EDC2a especially). An abundance (to be defined as an average with prediction limits) of EDC2a species as young juveniles occur in spring and early summer (Solea bleekeri, Acanthopagrus vagus, Ponmadasys comerssonnii, R. holubi). ▪ A good trophic basis exists for predatory estuarine dependant marine species (e.g. Agyrosomus japonicus, Carynx spp.), i.e. mullet occur throughout the system represented by a full array of size classes. ▪ Estuarine residents species represented by core group (G. spp., Oligolepis spp. Ambassis spp. and Gilchistella aestuaria) in two consecutive years. ▪ Oreochromis mossambicus limited to the upper reaches of one C in the low flow period, i.e. do not extend into middle reaches for more than two consecutive years. ▪ Species assemblage comprises indigenous species only, no alien fish species are caught in the system. ▪ Connectivity to a healthy transitional marine-estuary waters is maintained. No decline in nearshore linefish catches (A. japonicus) (not related to gear changes or bag limit restrictions).
Birds	C	Maintain the target EC (> 63%). The estuary should contain a rich avifaunal waterbird community, occurring at high densities (relative to available shorelength) that includes representatives of all the major groups, i.e. aerial (e.g. kingfishers), swimming (e.g. cormorants) and large wading piscivores (e.g. herons), small invertebrate-feeding waders, including migratory Palaearctic sandpipers, herbivorous waterfowl (e.g. ducks and geese) and roosting terns and gulls. ▪ The presence of a resident pair of African Fish Eagle that breed successfully. ▪ Pied Kingfishers, White-breasted Cormorants or Reed Cormorants are recorded on more than three consecutive counts spanning a period of 18 months or more. ▪ Numbers of waterbird species do drop below 10 for two consecutive counts.

6.4 NGANE RQOs

PES:	C	REC:	C	TEC:	C

Key components that require protection to maintain the TEC:
- Baseflows to estuary to maintain mouth state and salinity profile.
- Maintain water quality.
- Maintain of estuarine riparian habitat.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
B	3.83	4.30

Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).

Sediment processes:

D

- The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined).
- Changes in tidal amplitude of less than 20% from present (to be determined).
- Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

C — Mouth open conditions should be maintained within the current range: 54% (± 5%).

Water quality: Salinity

C — The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should be between 5 and 10 (to be confirmed).

Water quality: Other

C

Ecosystem health:	Recreational use: Yes
▪ DIN: Freshwater inflow, 50%ile <0.3 mg/l. ▪ DIP: Freshwater inflow, 50%ile <0.025 mg/l. ▪ DO: Entire estuary, average ≥ 4 mg/l. ▪ Turbidity: Estuary, clear (<10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Microbiology: Sufficient levels (DEA, 2012).

Macrophytes (plants)

D

- Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries).
- Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat.
- No invasive floating aquatic species present in the estuary e.g. water hyacinth.
- Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.
- Maintain some saline input to encourage the growth of mangroves (e.g. *Bruguiera gymnorrhiza*).
- Prevent disturbance and further reed encroachment into the main water channel.

Inverts

D

As sampled by plankton net, grab and dip nets/traps (as appropriate):
- Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%.
- Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant.
- Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa.

PES:	C	REC:	C	TEC:	C
	▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.				
Fish					
D	As sampled by seine and gill net in open waters: ▪ 13 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of four species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

6.5 UMGABABA RQOs

PES:	C	REC:	B	TEC:	B/C
Components that require interventions to achieve the TEC: ▪ Improve water quality. ▪ Partial restoration of estuarine habitat.					
Flow:					
PES	**nMAR (MCM)**		**pMAR (MCM)**		
C	10.56		9.58		
	Present base flows pose a risk to the REC. Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).				
Sediment processes:					
C	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.				
Mouth state:					
C	Mouth open conditions should be maintained within the current range: 46% (± 5%).				
Water quality: Salinity					
B	The system needs variability in salinity regime, with a measurable increase in salinity in the system during the low flow season. Mid-waters in the lower reaches should exceed 15, while the middle and upper reaches should exceed 10 and 5 respectively (to be confirmed).				
Water quality: Other					
C↑	**Ecosystem health:**		**Recreational use:**	Yes	
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (<10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed		Microbiology: Sufficient levels (DEA, 2012)		

PES:	C	REC:	B	TEC:	B/C
	targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).				
Macrophytes (plants)					
D↑	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). Submerged macrophytes (*Ruppia* and *Zostera*) used to occur in this estuary. The large *Juncus kraussii* stands are important. ▪ Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the important floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Maintain present salinity regime to maintain reed and sedge habitats (< 50% loss of reed and sedge habitats in non-flood year). ▪ Improve salinity regime to encourage the reestablishment of mangrove habitat.				
Inverts					
C↑	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 30%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species should not occur in abundance.				
Fish					
C↑	As sampled by seine and gill net in open waters: ▪ 18 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of five species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 80% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp.). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

6.6 MSIMBAZI RQOs

PES:	B	REC:	A	TEC:	B
Key components that require protection to maintain the TEC: ▪ Baseflows to estuary to maintain mouth state and salinity profile. ▪ Maintain water quality. ▪ Maintain of estuarine riparian habitat.					
Flow:					
PES	**nMAR (MCM)**		**pMAR (MCM)**		
A	**10.04**		**10.34**		
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).				
Sediment processes:					
C	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined).				

PES:	B	REC:	A	TEC:	B

	▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.
Mouth state:	
A	Mouth open conditions should be maintained within the current range: 36% (± 5%).
Water quality: Salinity	
B	The system needs variability in salinity regime, with a measurable increase in salinity in the system during the low flow season. Mid-waters in the lower reaches should exceed 15, while the middle and upper reaches should exceed 10 and 5 respectively (to be confirmed).
Water quality: Other	

C	**Ecosystem health:**	**Recreational use:**	Yes
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Microbiology: Sufficient levels (DEA, 2012).	

Macrophytes (plants)	
D	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Maintain present salinity regime to maintain reed and sedge habitats (< 50% loss of reed and sedge habitats in non-flood year). ▪ Improve the salinity regime to encourage the re-establishment of mangrove habitat.
Inverts	
B	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 30%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species should not occur in abundance.
Fish	
C	As sampled by seine and gill net in open waters: ▪ 18 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of five species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 80% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp.). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.

6.7 LOVU RQOs

PES:	C/D	REC:	B	TEC:	B/C

Components that require interventions to achieve the TEC:
- Improve water quality.
- Partial restoration of estuarine habitat.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
D	119.10	82.47

Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. Distribution patterns of the flood components differ by no more than 10% (magnitude, timing and variability) from that of the Present (2015). **The Present baseflows/ low flows poses a risk to the REC and should be elevated.**

Sediment processes:

D
- The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined).
- Changes in tidal amplitude of less than 20% from present (to be determined).
- Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

C Mouth open conditions should be maintained within the current range: 77% (± 5%).

Water quality: Salinity

C The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season.
PES: Mid-waters in the lower reaches should exceed 25, the middle reaches it should exceed 20, while the upper reaches should vary between 10 to 15.
REC: Mid-waters in the lower reaches should vary between 20 to 35, the middle reaches it should exceed 15, while the upper reaches should vary between 5 to 10.

Water quality: Other

	Ecosystem health:	**Recreational use:**	Yes
C↑	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Microbiology: Sufficient levels (DEA, 2012).	

Macrophytes (plants)

D↑
- Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). In particular the swamp forest habitat is important.
- Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat.
- No invasive floating aquatic species present in the estuary e.g. water hyacinth.
- Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.
- Improve the salinity regime to encourage the re-establishment of mangrove habitat.

Inverts

C As sampled by plankton net, grab and dip nets/traps (as appropriate):
- Population abundances of plankton and benthic assemblages (baselines to be set) not deviate by > 30%.
- Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant.
- Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include

PES:	C/D	REC:	B	TEC:	B/C
	isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species should not occur in abundance.				
Fish					
C	As sampled by seine and gill net in open waters: ▪ 25 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of five species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* and *A. japonicas* should be sampled with 80% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

6.8 LITTLE MANZIMTOTI RQOs

PES:	E	REC:	D	TEC:	EF
Components that require interventions to achieve the REC: ▪ Reduce some of the baseflows to estuary to improve mouth state and salinity profile. ▪ Significant improvement in water quality. ▪ Partial restoration of estuarine habitat. ▪ Prevent low oxygen events that results in fish kills.					
Water quality: Other					
E	**Recreational use:**				Yes
	Microbiology: Sufficient levels (DEA, 2012).				

6.9 aMANZIMTOTI RQOs

PES:	D/E	REC:	D	TEC:	D
Components that require interventions to achieve the REC: ▪ Protect baseflows to estuary to maintain mouth state and salinity profile. ▪ Improve catchment water quality. ▪ Maintain estuarine habitat. ▪ Prevent low oxygen events that results in fish kills.					
Flow:					
PES	**nMAR (MCM)**		**pMAR (MCM)**		
C	**5.30**		**6.75**		
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).				
Sediment processes:					
D	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.				
Mouth state:					
C	Mouth open conditions should be maintained within the current range: 44% (± 5%).				

PES:	D/E	REC:	D	TEC:	D

Water quality: Salinity

C	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 15, the middle reaches should exceed 10, while the upper reaches exceed 5.

Water quality: Other

F↑	**Ecosystem health:**	**Recreational use:**	Yes
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.5 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.125 mg/l (high risk). ▪ DO: Lower estuary, average ≥ 4 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 15 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Microbiology: Sufficient levels (DEA, 2012).	

Macrophytes (plants)

E↑	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). Maintain the integrity of the riparian zone. ▪ No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Area covered by invasive waterweeds (e.g. water hyacinth, *Azolla filiculoides*) and nuisance filamentous algae (e.g. Enteromorpha, Ulva, Cladophora) should cover < 50% of water surface area.

Inverts

F↑	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 50%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton occur. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Carid prawns should occur. ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods.

Fish

F↑	As sampled by seine and gill net in open waters: ▪ Six species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of three species. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 30% frequency of occurrence. ▪ Pelagic piscivores (e.g. *Caranx* spp.) should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.

6.10 MBOKODWENI RQOs

PES:	E	REC:	D	TEC:	EF
Water quality:					
F	**Recreational use:**				Yes
	Microbiology: Sufficient levels (DEA, 2012).				

6.11 SIPINGO RQOs

PES:	F	REC:	E	TEC:	EF
Water quality: Other					
F	**Ecosystem health:** Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.5 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.125 mg/l (high risk). ▪ DO: Lower estuary, average ≥ 4 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 15 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).			**Recreational use:** Microbiology: Sufficient levels (DEA, 2012).		Yes

6.12 DURBAN BAY RQOs FOR SHALLOW WATER AND INTERTIDAL AREAS

PES:	E	REC:	D	TEC:	D
Components that require interventions to restore functionality (not back to reference) to Durban Bay (achieve the REC/TEC): ▪ Protect baseflows to estuary to maintain mouth state and salinity profile. ▪ Improve water quality. ▪ Reduce fishing effort. ▪ Partial restoration of estuarine habitat in upper reaches. ▪ Prevent low oxygen events that results in fish kills.					
Flow:					
PES	**nMAR (MCM)**		**pMAR (MCM)**		
D	**36.33**		**63.44**		
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).				
Sediment processes:					
F	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.					
Hydrodynamics:					
E	Mouth open conditions should be maintained within the current range: 100%				
Water quality: Salinity					
E	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should be between 30 and 35, while the upper reaches should vary between 25 to 30.				
Water quality: Other					

PES:	E	REC:	D	TEC:	D

C↑	**Ecosystem health:**	**Recreational use:**	Yes
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.025 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 4 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). • Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009)	Microbiology: Sufficient levels (DEA, 2012).	

Macrophytes (plants)	
F↑	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). In particular the remnant intertidal mangrove areas are important. ▪ Prevent further disturbance and development of the riparian and floodplain habitat.

Inverts	
F↑	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 50%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton occur frequently. ▪ Macrobenthos should be abundant and dominated by polychaetes but should include amphipods, isopods, tanaids, and polychaetes. ▪ Chironomid larvae, oligochaetes and the polychaete *Capitella capitata* should not occur in abundance and should not dominate the benthos. ▪ Penaeid prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas throughout and should be abundant on the system's sandbanks in the lower reaches. ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata*, *Macrophthalmus sp., Portunus sanguinolentus,* Sesarmidae and *Uca* sp. ▪ Molluscan assemblage should include bivalves (including tellinids, *S. cylindraceus, E. paupercula, Dosinia hepatica*) and gastropods (including *N. kraussianus*, *Natica* spp. and *Polinices* sp.). ▪ Invasive alien species do not occur in the soft sediment macrobenthos.

Fish	
F↑	As sampled by seine and gill net in open waters: ▪ 30 species should occur to include estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of three species. ▪ *Liza dumerilli, Acathopagurs vagus, R. holubi, Sillago sihama, Gerres filamentosus, Ambassis* spp., *Leiognathus equula* and *P. commersonni* should be sampled with 100% frequency of occurrence (ie, every sampling trip). ▪ Pelagic piscivores should occur (including *Caranx* and *Sphyraena* spp.). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.

6.13 uMNGENI (MGENI) RQOs

PES:	D/E	REC:	D	TEC:	D

Components that require interventions to achieve the REC/TEC:
- Restore baseflows to estuary to improve mouth state and salinity profile and Implement flow allocation in an estuary friendly manner.
- A significant improvement in water quality needed.
- Restoration of macrophytes: removal of alien plant species, replanting/ reintroduction with indigenous species (some of which is already occurring).
- Wetland engineering (creation of new wetland habitats in close proximity to the uMngeni River banks.
- Review the current breaching policy that only requires breaching after 2 to 3 weeks, this poses a risk to plant communities and birds.
- Develop an Estuary Management Plan.
- Prevent low oxygen events that results in fish kills.

Flow:

PES:	D/E	REC:	D	TEC:	D

PES	nMAR (MCM)	pMAR (MCM)
D↑	671.30	208.46
	Present flows poses a risk to the REC/TEC. Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:

E↑	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

F↑	Mouth open conditions should be maintained within the current range: 95% (+5%).

Water quality: Salinity

F↑	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should be between 5 and 10 (to be confirmed).

Water quality: Other

	Ecosystem health:	**Recreational use:** Yes
D↑	▪ DIN: Freshwater inflow, 50%ile < 0.5 mg/l. ▪ DIP: Freshwater inflow, 50%ile < 0.125 mg/l. ▪ DO: Lower estuary, average ≥ 4 mg/l. ▪ Turbidity: Estuary, clear (< 15 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Microbiology: Sufficient levels (DEA, 2012).

Macrophytes (plants)

F↑	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). In particular the mangrove habitat is important. ▪ Maintain the integrity of the riparian zone. No additional bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Area covered by invasive waterweeds (e.g. water hyacinth, *Azolla filiculoides*) and nuisance filamentous algae (e.g. Enteromorpha, Ulva, Cladophora) should cover < 50% of water surface area.

F↑	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 50%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton occur frequently. ▪ Macrobenthos should be abundant and dominated by polychaetes but should include amphipods, isopods, tanaids, and the crab *H. projectum.* Insect taxa should occur in the far upper reaches only. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid prawns should occur. ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata*, *V. litterata, Macrophthalmus* sp., Sesarmidae and *Uca* sp. ▪ Molluscan assemblage should include bivalves and gastropods (including *N. kraussianus*, *Natica* spp.). ▪ Invasive alien species do not dominate macrobenthos in lower reaches.

Fish

PES:	D/E	REC:	D	TEC:	D
F↑	As sampled by seine and gill net in open waters: ▪ 12 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of three species. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* and *A. japonicas* should be sampled with 30% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp.). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

6.14 MHLANGA RQOs

PES:	D	REC:	B	TEC:	B

Ensure that the existing pumping scheme comes into operation so that the TEC can be achieved through the following:
- Restore baseflows to estuary to improve mouth state and salinity profile.
- A significant improvement in water quality needed.
- Partial restoration of estuarine habitat.
- Prevent low oxygen events that results in fish kills.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
D↑	**13.34**	**22.33**
	Present flows poses a risk to the REC. Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:

D	• The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). • Changes in tidal amplitude of less than 20% from present (to be determined). • Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

D↑	Mouth open conditions should be maintained within the current range: 48% (± 10%).

Water quality: Salinity

E↑	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should be between 5 and 10 (to be confirmed).

Water quality: Other

D↑	**Ecosystem health:**	**Recreational use:**	Yes
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Microbiology: Sufficient levels (DEA, 2012).	

Macrophytes (plants)

C	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). In particular the swamp forest habitat is important.

PES:	D	REC:	B	TEC:	B
	▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Improve salinity regime to encourage reestablishment of mangrove habitat.				
Inverts					
E↑	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 30%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species should not occur in abundance.				
Fish					
E↑	As sampled by seine and gill net in open waters: ▪ 18 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of five species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 80% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp.). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

6.15 uMDLOTI RQOs

PES:	D	REC:	C	TEC:	D*
Components that require interventions to achieve the TEC: ▪ Restore baseflows to estuary to improve mouth state and salinity profile. ▪ A significant improvement in water quality needed. ▪ Partial restoration of estuarine habitat. ▪ Prevent low oxygen events that results in fish kills.					
Flow:					

PES	nMAR (MCM)	pMAR (MCM)
	100.19	**85.03**
D	**Present flows poses a risk to the REC.** Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:	
C	• The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). • Changes in tidal amplitude of less than 20% from present (to be determined). • Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.
Mouth state:	
D	Mouth open conditions should be maintained within the current range: 40% (± 5%).
Water quality: Salinity	

PES:	D	REC:	C	TEC:	D*

B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should be between 5 and 10 (to be confirmed).

Water quality: Other

F↑	**Ecosystem health:**	**Recreational use:**	Yes
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.025 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 4 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: • Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). • Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Windsurfing Microbiology: Sufficient levels (DEA, 2012).	

Macrophytes (plants)

D↑	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). In particular the swamp forest habitat is important. ▪ Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Maintain present salinity regime to maintain reed and sedge habitats (< 50% loss of reed and sedge habitats in non-flood year).

Inverts

D↑	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 50%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton occur. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Carid prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods.

Fish

D↑	As sampled by seine and gill net in open waters: ▪ Six species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of three species. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 30% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.

* It was however recognised, based on the ecological evaluations of various scenarios that the ecological health rating for the uMdloti estuary could be improved by increasing the flow (discharging wastewater) - in the order of 50Ml/day.

6.16 uTHONGATHI RQOs

PES:	D	REC:	C	TEC:	D*

Key components that require protection to maintain the TEC:
- Baseflows to estuary to maintain mouth state and salinity profile.
- Maintain water quality.
- Maintain of estuarine riparian habitat.

Components that require interventions to achieve the REC include:
- Restore baseflows to estuary to improve mouth state and salinity profile.
- A significant improvement in water quality needed.
- Partial restoration of estuarine habitat.
- Remove weir/causeway in upper reaches.
- Prevent low oxygen events that results in fish kills.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
C	**70.79**	**79.21**

Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).

Present flows poses a risk to the REC.

Sediment processes:

D

- The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined).
- Changes in tidal amplitude of less than 20% from present (to be determined).
- Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

B Mouth open conditions should be maintained within the current range: 84% (± 10%).

Water quality: Salinity

C The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should be between 5 and 10 (to be confirmed).

Water quality: Other

F

Ecosystem health:	**Recreational use:** N/A
Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.5 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.125 mg/l (high risk). ▪ DO: Lower estuary, average ≥ 4 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 15 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Not identified as recreational area in stakeholder meeting.

Macrophytes (plants)

D

- Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries).
- Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. In particular by sugarcane cultivation in the EFZ.
- No invasive floating aquatic species present in the estuary e.g. water hyacinth.
- Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.

PES:	D	REC:	C	TEC:	D*
	▪ Maintain present salinity regime to maintain reed and sedge habitats (< 50% loss of reed and sedge habitats in non-flood year).				
Inverts					
E	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 50%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton occur frequently. ▪ Macrobenthos should be abundant and dominated by polychaetes but should include amphipods, isopods, tanaids, polychaetes and the crab *H. projectum.* Insect taxa should occur in the far upper reaches only. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata*, *V. litterata, Macrophthalmus* sp., Sesarmidae and *Uca* sp. ▪ Invasive alien species do not dominate macrobenthos in lower reaches.				
Fish					
E	As sampled by seine and gill net in open waters: ▪ 10 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of three species. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 30% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp.). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

* It must be noted that this improvement is linked to the indicrect re-use scenario to be implemented. To bridge this planning gap it is therefore proposed that treatment and discharge to the uThongathi take place over the short term which may reduce the EC of the estuary to an E.

7 NORTHERN CLUSTER IUA: ESTUARY RQOs

7.1 MHLALI RQOs

PES:	C/D	REC:	B/C	TEC:	D

Components that require interventions to achieve the TEC:
- Ensure that water quality is maintained so that fish kills do not occur.

Flow:

TEC	nMAR (MCM)	pMAR (MCM)
B	56.26	54.03

Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).

Present base flows poses a risk to the REC.

Sediment processes:

C/D

- The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined).
- Changes in tidal amplitude of less than 20% from present (to be determined).
- Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.
- Intertidal and subtidal habitat in Zone C and D are not available for estuarine species (increase by > 20% from present).

Mouth state:

B

Mouth open conditions should be maintained within the current range: 48% (± 5%). Breaching levels are < 3.0 m Mean Sea Level.

Water quality: Salinity

B

The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should be between 5 and 10 (to be confirmed).
Salinity values > 20 PSU in middle reaches during the low flow season
No 10 – 15 PSU zone detected in the estuary for two consecutive sampling event in a row.surveys.

Water quality: Other

E

Ecosystem health:

Water quality poses risk to REC/TEC, sufficiently reduced if:

River:
- 7.5 < pH > 8.5 consistently over two months.
- DO < 6 mg/l.
- Turbidity > 15 NTU (low flows), naturally turbid under high flows.
- NOx-N > 200 µg/l over two months.
- NH_3-N > 20 µg/l over two months.
- PO_4-P > 10 µg/l over two months.

Estuary:
- Average 7.0 < pH > 8.5 in a sampling survey.
- Average DO <6 mg/l in a sampling survey.
- Average turbidity > 10 NTU (low flows), naturally turbid under high flows.
- Average NOx-N > 200 µg/l in a sampling survey.
- Average NH_3-N > 20 µg/l in a sampling survey.
- Average PO_4-P > 10 µg/l in a sampling survey.

Toxic substances:
- Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995).
- Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).

Recreational use: Yes

Microbiology: Sufficient levels (DEA, 2012).

PES:	C/D	REC:	B/C	TEC:	D

Macrophytes (plants)

D	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). The swamp forest habitat is of particular importance. ▪ Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. In particular no further sugarcane cultivation in the EFZ. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Maintain present salinity regime to maintain reed and sedge habitats (< 50% loss of reed and sedge habitats in non-flood year).

Fish

D/E	As sampled by seine and gill net in open waters: ▪ 13 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of four species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.

7.2 BOBS STREAM RQOs

PES:	B/C	REC:	B/C	TEC:	B/C

Key components that require protection to maintain the TEC:
- Baseflows to estuary to maintain mouth state and salinity profile.
- Maintain water quality.
- Maintain of estuarine riparian habitat.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
A	**0.53**	**0.53**
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:

D	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined) . The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

A	Mouth open conditions should be maintained within the current range: 20% (± 5%).

Water quality: Salinity

A	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 5 (to be confirmed).

Water quality: Other

D	**Ecosystem health:**	**Recreational use:**	N/A
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk).	No identified as recreational area at stakeholder meeting.	

PES:	B/C	REC:	B/C	TEC:	B/C
	▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).				
Macrophytes (plants)					
C	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.				
Inverts					
B	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 30%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*. ▪ Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab *H. projectum* and insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) are dominated by *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods (including *Melanoides tuberculata*). ▪ Invasive alien species should not occur in abundance.				
Fish					
B	As sampled by seine and gill net in open waters: ▪ 15 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of four species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 30% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

7.3 SETENI RQOs

PES:	B/C	REC:	B/C	TEC:	B/C
Key components that require protection to maintain the TEC: ▪ Baseflows to estuary to maintain mouth state and salinity profile. ▪ Maintain water quality. ▪ Maintain of estuarine riparian habitat.					
Flow:					

PES	nMAR (MCM)	pMAR (MCM)
A	**1.42**	**1.42**
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:	
D	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present

PES:	B/C	REC:	B/C	TEC:	B/C

	sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.
Mouth state:	
A	Mouth open conditions should be maintained within the current range: 35% (± 5%).
Water quality: Salinity	
A	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 5 (to be confirmed).
Water quality: Other	

D	**Ecosystem health:**	**Recreational use:**	N/A
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	No identified as recreational area at stakeholder meeting.	

Macrophytes (plants)	
D	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). In particular the swamp forest habitat would be of importance. ▪ Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. In particular no further sugarcane cultivation should take place in the EFZ. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area.
Inverts	
B	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 30%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species should not occur in abundance.
Fish	
B	As sampled by seine and gill net in open waters: ▪ 18 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of five species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 80% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp.). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.

7.4 MVOTI RQOs

PES:	D	REC:	C	TEC:	C/D

Components that require interventions to achieve the TEC:
- Protect baseflows to estuary to improve mouth state and salinity profile.
- A significant improvement in water quality needed.
- Partial restoration of estuarine habitat.
- Prevent low oxygen events that results in invertabrate/fish kills.

Component/ Indicator	TEC	RQO
Hydrology	C/D	Maintain the target EC (> 57%). Protect the flow regime to create the required habitat for birds, fish, macrophytes, microalgae and water quality: ▪ River inflow distribution patterns differ by more than 5% from that of Scenario A (i.e. the recommended flow scenario for the Mvoti Estuary). ▪ Monthly river inflow > 1.0 m^3/s. ▪ Monthly river inflow > 2.0 m^3/s persists for longer than three months in a row. ▪ Monthly river inflow > 2.0 m^3/s for more than 50% of the time.
Hydrodynamics	A	Maintain the target EC (> 93%). Maintain a mouth conditions to protect estuarine ecosystems and the associated habitat for birds, fish, macrophytes, microalgae and water quality: ▪ Mouth closure occurs less than two - three weeks in a year. ▪ Mouth closure occurs for less than two years out of ten. ▪ Mouth closure does not occurs between November and June.
Water quality	C/D	Maintain the target EC (> 57%). RQOs for river inflow to protect estuarine ecosystem, that is achieving the EC and ROQs indicated for the various biotic components: ▪ pH: 7.0 - 8.5. ▪ DO > 4 mg/L. ▪ Turbidity (low flow): < 15 NTU. ▪ Turbidity (low flow): Naturally turbid. ▪ Dissolved nutrients: NO_x-N < 400 µg/L; NH_3-N < 30 µg/L; PO_4-P < 25 µg/L. ▪ Trace metals (to be determined). ▪ Pesticides/herbicides (to be determined).
		ROQs for water quality in **estuary** to protect estuarine ecosystem, that is achieving the EC and ROQs indicated for the various biotic components: ▪ Salinity: Salinity > 20 PSU one km from the mouth; Salinity < 1 PSU for > 50% of the time?? ▪ Turbidity (low flow): Average < 10 NTU in any sampling survey. ▪ Turbidity (high flow): Naturally turbid. ▪ pH: Average 7.0 - 8.5 in any sampling survey. ▪ Dissolved oxygen: Average > 4 mg/L in any sampling survey. ▪ Dissolved nutrients: Average NO_x-N < 400 µg/L, NH_3-N < 30 µg/L and PO_4-P < 25 µg/L in any sampling survey. ▪ Total metal concentrations in water not to exceed target values as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Total metal concentration in sediment not to exceed target values as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).
Sediment dynamics	B/C	Maintain the target EC (> 72%). Flood regime to protect estuarine ecosystems sediment distribution patterns and aquatic habitat (instream physical habitat): ▪ River inflow distribution patterns (flood components) differ by no more than 20% (in terms of magnitude, timing and variability) from that of the Present State (2013). ▪ Suspended sediment concentration from river inflow deviates by no more than 20% of the sediment load-discharge relationship to be determined as part of baseline studies (Present State 2013). ▪ Findings from the bathymetric surveys undertaken as part of a monitoring programme indicate no changes in the sedimentation and erosion patterns in the estuary have occurred (± 0.5 m). ▪ Changes in tidal amplitude at the tidal gauge of no more than 20% from Present State (2013)
		Changes in sediment grain size distribution patterns not to cause exceedance tolerance of benthic invertebrates. ▪ The median bed sediment diameter deviates by less than a factor of two from levels to be determined as part of baseline studies (Present State 2013). ▪ Sand/mud distribution in middle and upper reaches change by no more than 20% from Present State (2013).
Microalgae	B	Maintain the target EC (> 78%). Maintain current microalgae assemblages, specifically > five diatom species at a frequency > 3% of the total population in lower saline reaches: ▪ Medium phytoplankton: > 3µg/L for more than 50% of the stations.

PES:	D	REC:	C	TEC:	C/D
		▪ MPB: > 20 mg m^2 for more than 50% of the stations in the saline portion of the estuary. ▪ Observable bloom in the estuary.			
Macrophytes	D	▪ Maintain the target EC (> 43%). Maintain the distribution of macrophyte habitats, particularly the freshwater mangrove, *Barringtonia racemosa* stand at the mouth of the estuary so that there is no greater than 10% change in macrophyte habitat. ▪ Control the spread of hygrophilous grasses into open water area, i.e. no decrease in open water habitat to less than 16 ha. No increase in reeds and sedges and encroachment into main water channel due to nutrient enrichment, sedimentation and infilling of intertidal habitat. ▪ Prevent the spread of invasive plants, trees and shrubs as well as aquatic invasive plants. No invasive plants (e.g. syringa berry, Brazilian pepper tree) and aquatic invasives (e.g. water hyacinth) cover > 5% of total macrophyte area ▪ No sugarcane in the EFZ.			
Invertebrates	E	N/A			
Fish	D	Maintain the target EC (> 43%). Protect the estuarine ecosystems functioning as: ▪ A nursery for a limited diversity and abundance of estuarine dependant marine fishes, which use the system through to their late juvenile and adult life stages. ▪ Habitat for a limited diversity and abundance of estuarine resident fishes which complete their life cycles in the estuary. ▪ Habitat for a limited diversity and abundance of freshwater fishes. ▪ A migration corridor for facultative catadromous eels. ▪ This will require that there be no loss of the following: ▪ Any one of the following species *Mugil cephalus*, *M. capensis* from Zones A, B and C. ▪ Any two of the following species *Gilchristella aestuaria*, *Ambassis* spp., *G.* spp. from the estuary. ▪ Any one of the following species *Barbus* spp, *O. mossambicus* from Zones A, B and C. ▪ *Anguilla* spp. from upstream river habitats (this should be noted in ecological specifications in documentation pertaining to the EWR (river EcoSpecs and monitoring)).			
Birds	E	Maintain the target EC (> 23%). The estuary should contain a rich avifaunal waterbird community, occurring at high densities (relative to available shorelength) that includes representatives of all the major groups, i.e. aerial (e.g. kingfishers), swimming (e.g. cormorants) and large wading piscivores (e.g. herons), small invertebrate-feeding waders, including migratory Palaearctic sandpipers, herbivorous waterfowl (e.g. ducks and geese) and roosting terns and gulls. This means that the following will be observed: ▪ Presence of successful breeding by Collared Pratincoles and the resident pair of African. ▪ Fish Eagles. ▪ Numbers of bird species do not drops below 30 for three consecutive counts. ▪ Number of roosting terns recorded in mid-summer no fewer than 2000.			

7.5 MDLOTANE RQOs

PES:	B	REC:	A/B	TEC:	A/B
Interventions required to achieve the REC: ▪ Improve water quality. ▪ Partial restoration of estuarine habitat.					
Flow:					
PES	**nMAR (MCM)**		**pMAR (MCM)**		
A	**6.04**		**5.85**		
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).				
Sediment processes:					
B	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.				
Mouth state:					

PES:	B	REC:	A/B	TEC:	A/B
B	Mouth open conditions should be maintained within the current range: 14% (± 5%).				
Water quality: Salinity					
B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 10 (to be confirmed).				
Water quality: Other					
D↑	**Ecosystem health:** Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).		**Recreational use:** Microbiology: Sufficient levels (DEA, 2012).		Yes
Macrophytes (plants)					
B↑	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). In particular the swamp forest habitat is of importance. ▪ Maintain the integrity of the riparian zone. No bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Maintain present salinity regime to maintain reed and sedge habitats (< 50% loss of reed and sedge habitats in non-flood year).				
Inverts					
C↑	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 25%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei.* ▪ Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) are dominated by *V. litterata*. ▪ Molluscan assemblage should include bivalves (including *Hiatula lunulata*) and gastropods (including *Melanoides tuberculata*). ▪ Invasive alien species should not occur.				
Fish					
C↑	As sampled by seine and gill net in open waters: ▪ 18 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of four species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 70% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* spp.). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

7.6 NONOTI RQOs

PES:	C	REC:	C	TEC:	C
Key components that require protection to maintain the TEC: ▪ Baseflows to estuary to maintain mouth state and salinity profile.					

PES:	C	REC:	C	TEC:	C

- Maintain water quality.
- Maintain of estuarine riparian habitat.

Flow:

PES	nMAR (MCM)	pMAR (MCM)
B	34.74	34.74
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).	

Sediment processes:

C	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.

Mouth state:

B	Mouth open conditions should be maintained within the current range: 18% (± 5%).

Water quality: Salinity

B	The system needs variability in salinity regime, with a measurable increase in salinity in the lower and middle reaches during the low flow season. Mid-waters in the lower reaches should exceed 10 (to be confirmed).

Water quality: Other

D	**Ecosystem health:**	**Recreational use:**	Yes
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.3 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.025 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 4 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).	Microbiology: Sufficient levels (DEA, 2012)	

Macrophytes (plants)

D	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). ▪ Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. In particular no further sugarcane cultivation should take place within the EFZ. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Prevent macroalgal blooms and reed encroachment which are likely to become problematic due to nutrient enrichment from proposed further WWTW input.

Inverts

C	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 40%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei.* ▪ Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab *H. projectum* and insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (Caridina and Macrobrachium) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) are dominated by *V. litterata*.

PES:	C	REC:	C	TEC:	C
	▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species do not dominate macrobenthos.				
Fish					
E	As sampled by seine and gill net in open waters: ▪ 10 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of three species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 60% frequency of occurrence. ▪ Pelagic piscivores should occur. ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.				

7.7 ZINKWASI RQOs

PES:	B/C	REC:	A/B	TEC:	B
Components that require interventions to achieve the TEC: ▪ Protect baseflows to estuary to ensure mouth state and salinity regime. ▪ Improve water quality. ▪ Partial restoration of estuarine habitat.					
Flow:					
PES	**nMAR (MCM)**		**pMAR (MCM)**		
A	**14.49**		**14.04**		
	Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows should be upheld into estuary to maintain present mouth state and salinity regime. The distribution patterns of the flood components differ by no more than 10% (in terms of magnitude, timing and variability) from that of the Present (2015).				
Sediment processes:					
C	▪ The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat). The suspended sediment concentration from river inflow does not deviate by more than 20% of the present sediment load-discharge relationship (to be determined). The sedimentation and erosion patterns in the estuary do not differ significantly from present (± 0.5 m) (to be determined). ▪ Changes in tidal amplitude of less than 20% from present (to be determined). ▪ Changes in sediment grain size distribution patterns similar to present. The median bed sediment diameter deviates by less than a factor of two from present levels (to be determined). The sand/mud distributions in middle and upper reaches do not change by more than 20% from Present State over a five year average.				
Mouth state:					
A	Mouth open conditions should be maintained within the current range: 28% (± 5%).				
Water quality: Salinity					
B	The system needs variability in salinity regime. Mid-waters in the lower reaches should be between 20 to 15, while the middle reaches should vary between 10 to 15 and the upper reaches between 5 to 10.				
Water quality: Other					
C↑	**Ecosystem health:**			**Recreational use:**	Yes
	Water quality poses risk to REC/TEC, sufficiently reduced if: ▪ DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk). ▪ DIP: Freshwater inflow, 50%ile < 0.015 mg/l (high risk). ▪ DO: Entire estuary, average ≥ 6 mg/l (high risk). ▪ Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. Toxic substances: ▪ Substance concentrations in estuarine waters not to exceed targets as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995). ▪ Substance concentrations in estuarine sediment not to exceed targets as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009).			Microbiology: Sufficient levels (DEA, 2012).	
Macrophytes (plants)					

C↑	▪ Maintain the distribution of current macrophyte habitats (< 20% change in the area covered by different macrophyte habitats which accounts for natural changes due to the dynamic nature of estuaries). In particular the swamp forest habitat is of importance. ▪ Maintain the integrity of the riparian zone. No further bare patches or unvegetated, cleared areas along the banks. Prevent further disturbance and development of the floodplain habitat. No further sugarcane cultivation in the EFZ. ▪ No invasive floating aquatic species present in the estuary e.g. water hyacinth. ▪ Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. ▪ Maintain present salinity regime to maintain reed and sedge habitats (< 50% loss of reed and sedge habitats in non-flood year).
Inverts	
C↑	As sampled by plankton net, grab and dip nets/traps (as appropriate): ▪ Population abundances of plankton and benthic assemblages (baselines to be set) should not deviate by more than 30%. ▪ Zooplankton should be dominated by estuarine copepods *A. natalensis* and *P. hessei*, but include other groups such as mysids. Meroplankton are abundant. ▪ Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopods, tanaids and the crab *H. projectum and* insect taxa. ▪ Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. ▪ Penaeid and carid (*Caridina* and *Macrobrachium*) prawns should occur. ▪ Sandprawn *C. kraussi* should occur in sandy areas in the systems lower reaches (to be confirmed). ▪ Large brachyuran crabs (macrocrustacea) should include *S. serrata* and *V. litterata.* ▪ Molluscan assemblage should include bivalves and gastropods. ▪ Invasive alien species should not occur in abundance.
Fish	
C↑	As sampled by seine and gill net in open waters: ▪ 18 species should occur to include freshwater, estuarine resident and estuarine dependant marine fishes. ▪ Estuarine resident species should comprise a minimum of five species. ▪ Estuarine resident and estuarine dependant marine fishes should dominate catches by abundance. ▪ *Oligolepis keiensis, Oligolepis acutipennis, Gilchristella aestuaria, G. callidus, M. capensis* and *R. holubi* should occur with 100% frequency of occurrence (every sampling trip). ▪ *P. commersonni* should be sampled with 80% frequency of occurrence. ▪ Pelagic piscivores should occur (including *Caranx* and *Sphyraena* spp.). ▪ No alien fish species should occur. ▪ Fish should be free of lesions and other anomalies related to water quality. ▪ No fish kills should occur.

8 REFERENCES

Department of Environmental Affairs (DEA). 2012. South African water quality guidelines for coal marine waters. Volume 2: Guidelines for Recreational Use.

Department of Water Affairs and Forestry (DWAF) 1995. South African Water Quality Guidelines for Coastal Marine Waters. Volume 1: Natural Environment. Pretoria.

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

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

Department of Water Affairs (DWA), South Africa. 2009. Operationalise the Reserve: Rapid Habitat Assessment Model Manual. Prepared by Water for Africa. Authored by D Louw and CJ Kleynhans. Report no RDM/ Nat/00/CON/0707.

Department of Water Affairs (DWA), South Africa. 2010. Comprehensive Reserve Determination Study for Selected Water Resources (Rivers, Groundwater and Wetlands) in the Inkomati Water Management Area, Mpumalanga. Sabie and Crocodile Systems: EcoSpecs Report. Prepared by Water for Africa, edited by Louw, MD and Koekemoer, S. RDM Report no 26/8/3/10/12/012.

Department of Water Affairs (DWA), South Africa. 2011. Procedures to Develop and Implement Resource Quality Objectives - SUMMARY.

Department of Water Affairs (DWA), South Africa. 2012. Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Mzimkhulu Water Management Area: Inception Report. Prepared by: Rivers for Africa eFlows Consulting (Pty) Ltd. September 2012. DWA Report RDM/WMA11/00/CON/CLA/0112.

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

Department of Water and Sanitation (DWS), South Africa. 2014. Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: Water Resource Analysis Report. Prepared by: Rivers for Africa eFlows Consulting (Pty) Ltd. Authored by WRP Consulting Engineers. October 2014. DWS Report RDM/WMA11/00/CON/CLA/0414.

Department of Water and Sanitation (DWS), South Africa. 2015. Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: Volume 1: River RQOs. Prepared by: Rivers for Africa eFlows Consulting (Pty) Ltd. September 2015. Report Number: RDM/WMA11/00/CON/CLA/0315.

Dollar, E.S.J, Nicolson, C.R., Brown, C.A., Turpie, J.K., Joubert, A.R, Turton, A.R., Grobler, D.F. and Manyaka, S.M. 2010. The development of the South African Water Determination of Preliminary Ecological Reserve: Estuaries References Version 3 Oct 2010 Page 92.

Forbes, A.T. and Demetriades, N.T. 2009. Estuaries of Durban, KwaZulu-Natal, South Africa. Report for the Environmental Management Department, eThekwini Municipality. 224 pp.

Harrison, T.D., Cooper, J.A.G. and Ramm, A.E.L. 2000. Geomorphology, Ichthyofauna, Water Quality and Aesthetics of South African Estuaries. CSIR Report ENV-DC 2000-01, Environmentek, Congella (Prepared for Department of Environmental Affairs and Tourism, Pretoria).

Rogers, K.H. and Bestbier, R. 1997. Development of a protocol for the definition of the desired state of riverine systems in South Africa. Department of Environmental Affairs and Tourism, Pretoria.

UNEP/Nairobi Convention Secretariat and CSIR. 2009. Guidelines for the Establishment of Environmental Quality Objectives and Targets in the Coastal Zone of the Western Indian Ocean (WIO) Region, UNEP, Nairobi, Kenya, 169p.

Van Niekerk L and Turpie JK. (eds). 2012. National Biodiversity Assessment 2011: Technical Report. Volume 3: Estuary Component. CSIR Report Number CSIR/NRE/ECOS/ER/2011/0045/B. Council for Scientific and Industrial Research, Stellenbosch. Available at: http://bgis.sanbi.org/nba/project.asp.

Veldkornet, D. A. 2012. Morphological variation and species diversity of South African Estuarine macrophytes. Thesis Masters MSc. Nelson Mandela Metropolitan University Faculty of Science.

9 APPENDIX A: ESTUARINE HABITATS

Table 9.1 Area cover data for habitats in Mvoti to Umzimkulu WMA based on old and new (Veldkornet, 2012; Cowie 2015) data

(Source: NMMU Estuary Botanical data base).

It must be noted that historical data sources did not map the macrophyte habitat within the entire EFZ of estuaries.

Estuary	Data source	Intertidal salt marsh	Supratidal salt marsh	Submerged	Reeds and Sedges	Mangroves	Sand/mud banks	Open water (channel)	Swamp forest	Total Area
Mtamvuna	**2014**	**0**	**0**	**0**	**7.1**	**0.3**	**11.6**	**76.9**	**0.1**	**96**
Zolwane	Historical	0	0	0	0	0	2	0.3	0	2.3
Sandlundlu	Historical	0	0	0	3.25	0	3	4	0.25	10.5
Ku-Boboyi	Historical	0	0	0	3	0	1	1.1	0	5.1
Tongazi	Historical	0	0	0	0	0	3	0.78	3	6.78
Kandandhlovu	**2014**	**0**	**0**	**0**	**3.9**	**0**	**1**	**1.1**	**5.2**	**10.5**
Mpenjati	**2014**	**0**	**0**	**0**	**4.3**	**0**	**6.1**	**12.2**	**6**	**20.6**
Umhlangankulu	Historical	0	0	0	4	0.5	1.5	5.8	4	15.8
Kaba	**2014**	**0**	**0**	**0**	**1.1**	**0**	**0.3**	**2.6**	**1.1**	**5.1**
Mbizana	Historical	0	0	0	12	0	1	12.4	3	28.4
Mvutshini	Historical	0	0	0	0	0	3	0.88	0	3.88
Bilanhlolo	**2014**	**0**	**0**	**0**	**0.6**	**0**	**0.3**	**2.6**	**1.1**	**4.6**
Uvuzana	Historical	0	0	0	4.5	0	1	0.6	0	6.1
Kongweni	Historical	0	0	0	4	0.5	1	1.42	0.25	7.17
Vungu	Historical	0	0	0	0	0	6	1.13	0	7.13
Mhlangeni	Historical	0	0	0	8	0	4	3.6	0	15.6
Zotsha	Historical	0	0	0	13	0	4	7.3	5	29.3
Boboyi	Historical	0	0	0	9	0	4	1.3	0	14.3
Mbango	Historical	0	0	0	8	0	2	0.9	2	12.9
Mzimkulu	Historical	0	0	0	18	0	11	73.9	15	117.9
Mtentweni	Historical	0	0	0	5	0	1	7.98	4.5	18.48
Mhlangamkulu	Historical	0	0	0	69.9	0	0	30	0.2	100.1
Damba	Historical	0	0	0	6.25	0	2.7	1.7	9	19.65
Koshwana	Historical	0	0	0	10	0	1	1.18	6	18.18
Intshambili	Historical	0	0	0	1.5	0	1	1.7	6.25	10.45
Mzumbe	Historical	0	0	0	5	0	15	15.8	0	35.8
Mhlabatshane	Historical	0	0	0	4	0	1.5	2.27	11.5	19.27
Mhlungwa	Historical	0	0	1.5	7	0	4	3	1	16.5
Mfazazana	Historical	0	0	0	7.5	0	1	2.1	5	15.6
Kwa-Makosi	Historical	0	0	0	3.5	0	2	2.45	7	14.95
Mnamfu	Historical	0	0	0	6	0	3	1.28	4	14.28
Mtwalume	Historical	0	0	0	4	0	10	24.8	0	38.8
Mvuzi	Historical	0	0	0	15	0	2	0.8	0	17.8
Fafa	**2014**	**0**	**0**	**0**	**6.1**	**0**	**0.7**	**19.5**	**6.6**	**32.9**
Mdesingane	Historical	0	0	0.5	6	0	0.25	0.39	0	7.14
Sezela	Historical	0	0	0	18	0	1	9	0	28

Estuary	Data source	Intertidal salt marsh	Supratidal salt marsh	Submerged	Reeds and Sedges	Mangroves	Sand/mud banks	Open water (channel)	Swamp forest	Total Area
Mkumbane	Historical	0	0	0	7	0	5	0.25	0	12.25
Mzinto	Historical	0	0	0	14	0	4	7	4.5	29.5
Nkomba	No data									0
Mzimayi	**2012**	0	0.07	0	0.7	0	0.57	0.5	2.81	4.65
Mpambanyoni	Historical	0	0	0	3	0	7	2.32	0.25	12.57
Mahlongwa	Historical	0	0	0	7	0	1	5.9	0	13.9
Mahlongwana	Historical	0	0	3	5	0	2	6.84	4	20.84
uMkhomazi	**2013**	**0**	**0**	**0**	**4**	**1**	**9**	**64**	**10**	**88**
Ngane	Historical	0	0	0	3	0	4	1.36	0	8.36
Umgababa	**2014**	**0**	**0**	**0**	**39**	**0**	**0.7**	**19.4**	**2.6**	**61.7**
Msimbazi	Historical	0	0	0	12	0	3	13.2	0	28.2
Lovu	Historical	0	0	0	19	0	5	10.5	5	39.5
Little aManzimtoti	**2014**	**0**	**0**	**0**	**0.1**	**0**	**1.3**	**1.7**	**6.5**	**9.6**
aManzimtoti	Historical	0	0	0	5	0	7	6.67	2.5	21.17
Mbokodweni	Historical	0	0	0	8	0	2.5	7.24	0	17.74
Sipingo	Historical	0	3	0	2	3.8	1	0.8	16	26.6
Durban Bay	Historical	0	0	8	2	16	37	1080	5	1148
Mgeni	2011 RDM	8.4	0	1	2	31.68	8.46	55.75	0.5	83.3
Mhlanga	RDM	0	0	0	0	0	0.68	12	0.2	12.88
uMdloti	Historical	0	0	0	10	0	7.3	33	7.8	58.1
uThongathi	2007 RDM	0	0	0	18.5	0	0.8	14.6	3.5	37.4
Mhlali	Historical	0	0	0	6	0	8	21	7	42
Bobs Stream	No data									0
Seteni	Historical	0	0	0	0.25	0	2	1.13	4	7.38
Mvoti	**2013**	**0**	**0**	**0**	**87**	**0**	**6**	**16**	**2**	**111**
Mdlotane	Recent	0	0	0.71	6.03	0	0	6.35	12.33	25.42
Nonoti	Historical	0	0	2.5	2.5	0	3	18	1	27
Zinkwasi	Recent	0	0	0	39.51	0	0	20.37	11.28	71.16

10 APPENDIX B: ESTUARY SYNONYM LIST FOR KZN ESTUARIES

Source: Ezemvelo KZN Wildlife

Estuary synonym list for KZN estuaries (Source: B Escott, Ezemvelo KZN Wildlife)

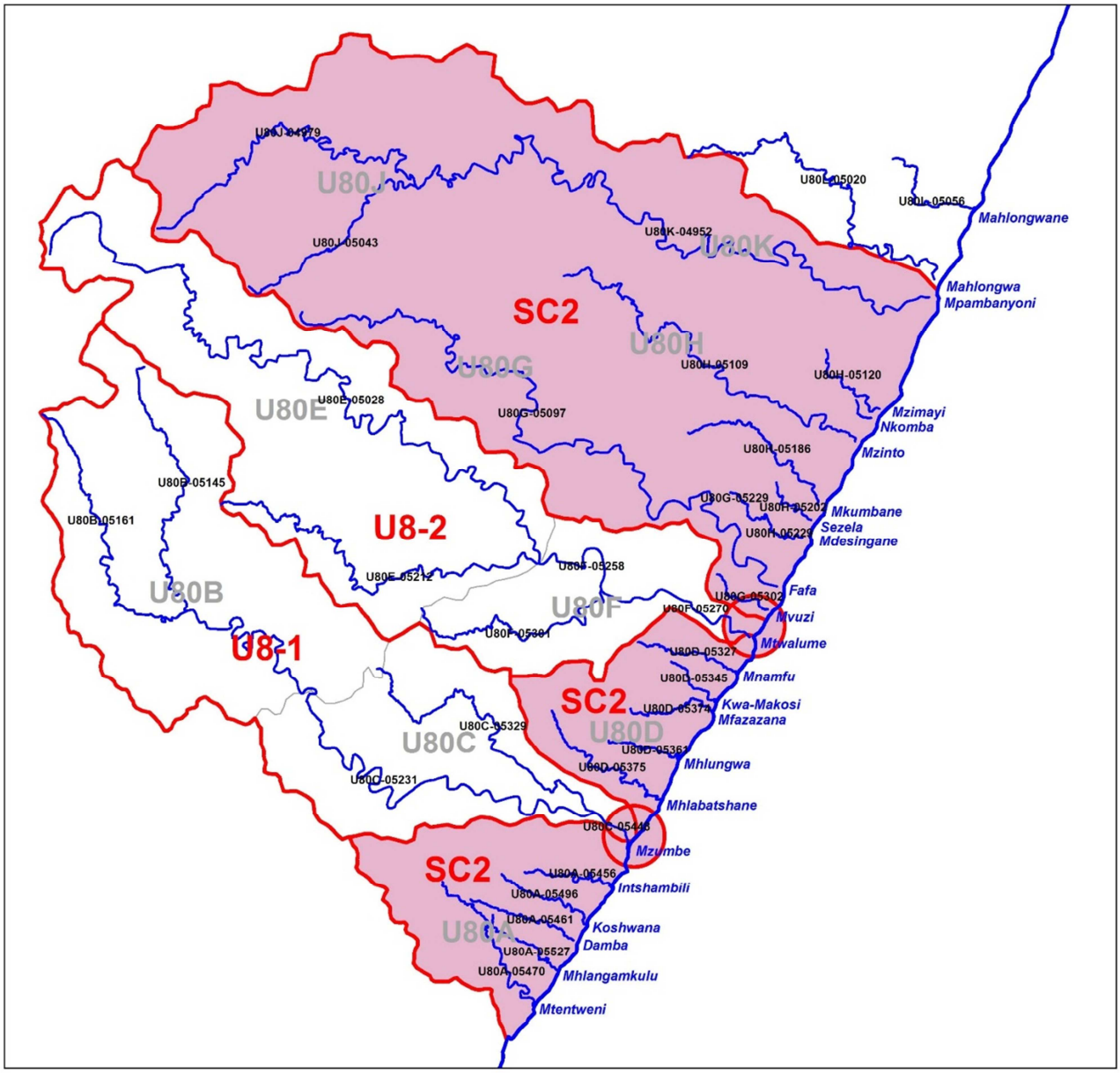
Estuary Name	Synonyms
Bilanhlolo	Ibilanhlolo; Big ibilanhlolo
Bobs Stream	Sharks Bay
Boboyi	Imboyboye
Damba	Domba
Durban Bay	Durban Bayhead
Fafa	iFafa
Intshambili	Ntshambili; Injambili
Isolwane	Zolwane
Kaba	Mkobi; Mkobe; Khaba
Kandandhlovu	Khandandlovu, Kandandlovu, Umkandanhlovu
Kongweni	Inkongweni
Koshwana	Ikotshwana
Kosi	
Ku-Boboyi	
Kwa-Makosi	Makosi
Little Manzimtoti	Little Amanzimtoti
Lovu	Illovu
Mahlongwa	Amahlanga, Amahlongwa
Mahlongwana	Amahlongwana
aManzimtoti	Manzimtoti
Matigulu/Nyoni	Amatikulu, (e) Matikulu, Inyoni
Mbango	Imbonga, Imbango
Mbizane	Mbizana
Mbokodweni	Umbogintwini, umbohodweni
Mdesingane	Mdezingane
Mdlotane	Ndlotane, (u)Mhlutini
uMdloti	Umdloti; Umhloti; Mhloti; Mdhloti
Mfazazana	Mfazazaan; Umfazaan; Umfazazane; Umfazaazan
uMfolozi	Mfolozi, Mfolosi
Mgababa	Umgubaba, Umgababa
uMngeni	Mngeni
Mgobozeleni	Mgobezeleni, Ngoboseleni; Ngobeseleni; Sodwana; Sordwana
Mhlabatashane (Mzimayi2)	Mhlabatshane
Mhlali	eMhlali, uMhlali
Mhlanga	Umhlanga, Ohlanga, Umslanga
Mhlangamkulu	
Mhlangeni	
Mhlatuzane	
Mhlatuze	Mhlathuze, Umhlatuze

Estuary Name	Synonyms
Mhlungwa	Umhlungwa
Mkumbane	Inkombane, Umkombana
Mlalazi	Umlalazi
Mnamfu	Unamfu
Mpambanyoni	Mpanbanyoni, Mpambonyoni, Umpambinyoni, Umpambumyani
Mpenjati	
Msimbazi	uMzimbasi, Umzimbezi
Mtentweni	Mtentwana, Ententweni
Mtwalume	Umtwalumi, Mtwalumi
Mvoti	Umvoti
Mvutshini	Little iBilanhlolo
Mvuzi	Uvuzi
Mzimayi	Umzimai
Mzimkulu	Mzimkhulu, Umzimkulu
Mzingazi	
Mzinto	Umzinto
Ngane	Ingane, iNgane
Nhlabane	Hlobane
Nkomba	
Nonoti	
Qhubu	
Reunion (Canal)	
Richards Bay	
Sandlundlu	Inhlanhlinhlu
Seteni	
Sezela	Isizela
Shazibe	
Sipingo	Isipingo
Siyaya	Siaya, Siyani, Siyaní, Siyai
St Lucia	
uThongathi	Tongaat; Tongaati; Thongathi; Umtongate; Tongati
Tongazi	Thongazi, Intongazi
Tugela	Thukela, Tukela
Umhlangankulu (South)	Mhlangankulu
uMkhomazi	Mkomazi, Umkomaas, Mkomanzi
Umlazi	Mlazi
Umtamvuna	Mtamvuna, Mthamvuna
Umzumbe	Umzumbe, Mzumba, Mzamba, Mzumbe
Unknown	aManzimnyama canal
Uvuzana	
Vungu	Uvongo
Zinkwazi	Zinkwasi, Sinquasi; Sinkwazi
Zotsha	Izotsha

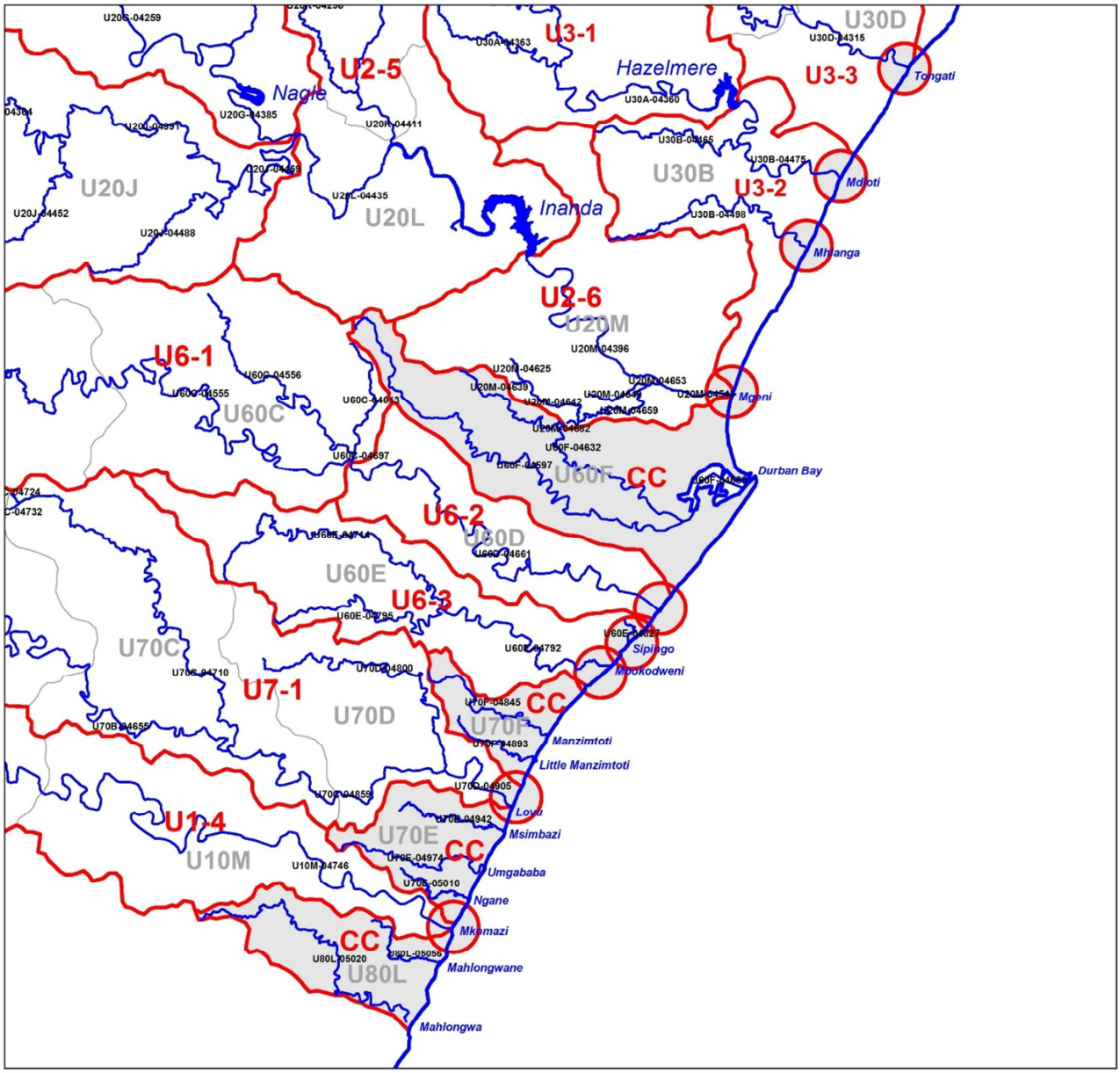
11 APPENDIX C: ESTUARY IUAs

11.1 SOUTHERN CLUSTER 1 IUA

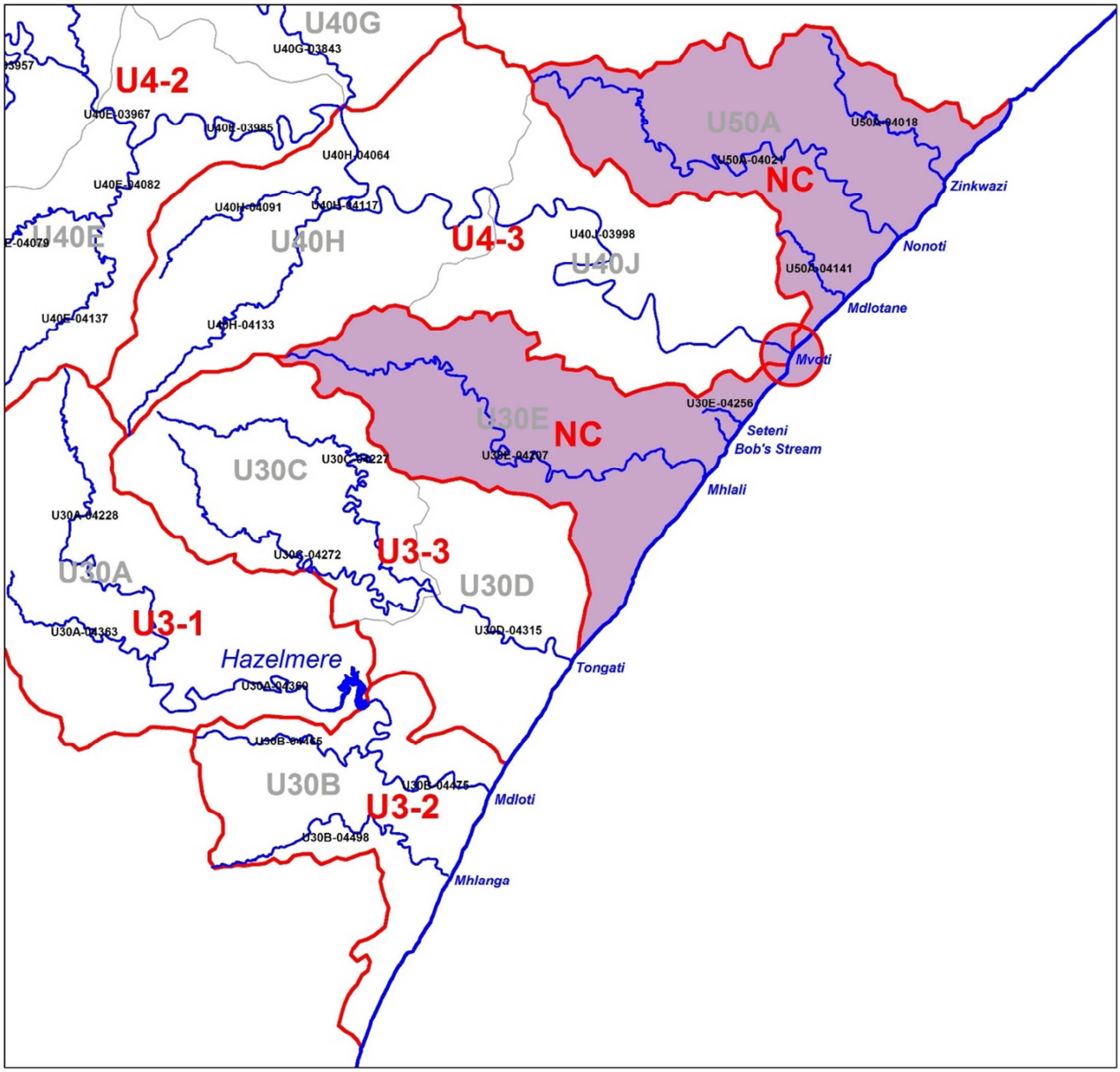
11.2 SOUTHERN CLUSTER 2 IUA



11.3 CENTRAL CLUSTER IUA



11.4 NORTHERN CLUSTER IUA



12 APPENDIX D: REPORT COMMENTS

Page / Section	Report statement	Comments	Changes made?	Author comment
Mmaphefo Thwala (DWS)				
1	Report Number: RDM/WMA11/00/CON/CLA/0614.	Ensure the report number on the front page is consistent with the one on the following page and document index.	Yes	Report Number: RDM/WMA11/00/CON/CLA/0615.
2-2	RQOs are set for the the following components.	Provide time-frames for the RQOs, over what period of time are they applicable.	Yes	Added on page 2-2: RQOs are set for the short-to medium term (5 to 10 year period) for the the following components..
1-1	Chief Directorate: Water Ecosystems.	Chief Directorate is now Water Ecosystems and not RDM, please maintain the name (CD:WE) .	Yes	Was correct.
6-39, 6-41	TEC: EF	For all the estuaries with E/F TEC (Little aManzimtoti, Mbokodweni, Isipingo) indicate the phased approach (time periods) to realising RQOs. It is strongly being argued as to why are we aiming so low for the future? Indicate other options that can be explored over time, indirect reuse options? Also provide extensive explanation/motivation for the E/F TEC.	Yes	Not certain re the statement. There is no phased approach to realizing RQOs if the TEC is an EF. The phased approach is relevant at uMdloti and uThongait where indirect reuse is recommended and where the EC will go down and then up after indirect reuse is implemented. No timing can be added to this as it depends whether the decision is made to implement indirect reuse. Regarding the EF explanations, this comment is relevant for the WRC report which recommends the TEC. This report is just a response to the WRCs. This comment was made as well in that report and will be addressed there.
Bill Pfaff (eThekwini Municipality), (Item references are according to the document with the title: "Ethekwini Water and Sanitation Unit, 28 October 2015. The following is in response to the request for comments on the three reports, volumes				
		In addition three substantial impacts on the functioning of the estuary are omitted from the text (Report volume 2 D, 6.1 *et al.*). - Illegal sandwinning - The 'illegal' SAPPI weir referred to above (any authorisation appears to be for a weir upstream of the existing structure) - Limiting of recreational activities The work done under the eThekwini project identified that unless all three impacts are addressed then the REC will not be achieved even if all wastewater is removed.	Yes	Table 9.8 of this report lists all of this information in this report as well as in more detail in the technical report (index number 8.2b which is the detailed report on the uMkhomazi Estuary EWR and scenario consequences. It is assumed that reference here pertains to the Estuary RQO report (numbers of reports have changed). However reference is made in table 6.3 to most of the ommitments referred to. Adjustments have been made to the RQO report to ensure that it matches the recommendations in the WRC report. Please note that there has been no recommendation made for existing waste water to be removed.
		Also the RQO comment" a scenario that includes more wastewater to a specific limit must be investigated as this could achieve the TEC " needs to be corrected as per the underlined section above as the investigation has take place.	Yes	Has been addressed in the RQO report.

Page / Section	Report statement	Comments	Changes made?	Author comment
		In addition volume 4, item 8.3 correctly records that "the pressures for urban development in the uThongathi catchment requires wastewater management and disposal facilities in the short term. To bridge this planning gap it is therefore proposed that treatment and discharge to the uThongathi take place over the short term which may reduce the Ecological Category (E C) of the estuary to an E." The section underlined above needs to be included in the RQOs but with the proviso that the understanding of "short term" would cover the full period to the commissioning of any infrastructure mitigation measure.	Yes	Addressed in the RQO report already but adjusted according to underlined statement.
6-46	Partial restoration of estuarine habitat	The RQO should be corrected to read " only scenario Aiii , coupled with the removal of the illegal causeway and dredging of build up in the area of the causeway , will improve the estuary ".	Yes	Was included in statement "Partial restoration of estuarine habitat". Have now added a bullet that address this explicitly in RQO report : "Remove weir/causeway in upper reaches". Refer to statement in Consequanses report "The removal of the weir midway up the uThonghati Estuary will restore some intertidal and water column habitat, but if the water quality conditions do not improve this is effectively "environmental accounting" in which habitat is made available, but is not viable for use. This expenditure is not recommended unless water quality is improved in the system to allow for use of the restored habitat. This is especially the case in the future scenarios where increased WWTW volume and nutrient loading will further increase eutrophication and related risk of low oxygen events."
		The only proviso to the above being that the estuary complies with "all required health standards'. This expression needs to be clarified such that it refers to tertiary treatment with 'disinfectant to a reasonable level' , and NOT to a contact recreation standard.	No	The RQO definition of "all required health standards" is appropriate based on the recreation use of the water resource. Specific treatment options need to be evaluated in further planning investigations by eTHekwini and as part of the required EIA processes. The RQO is based on a legal requirement in line with the recommended targets proposed for South Africa's coastal marine waters (DEA, 2012). The RQOs for recreational use are specified as risk-based ranges for intestinal enterococci and E. coli (microbiological indicator organisms). The report is not specific on how these needs to be achieved as it may require multiple interventions depending on the WW and catchment quality.