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









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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

Report Number: RDM/WMA11/00/CON/CLA/0615

SEPTEMBER 2015

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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:

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

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- 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
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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 km² 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 m³/s Monthly river inflow > 2.0 m³/s persists for longer than three months in a row. Monthly river inflow > 5.0 m³/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 $< 5m^3/s$): NO _X -N <150 µg/L; NH ₃ -N < 20 µg/L; PO ₄ -P < 10 µg/L. 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): <i>Enterococci</i> : Ninety percentile (90%ile) over a 12 month running period \leq 185 counts per 100 ml. <i>E. coli</i> : Ninety percentile (90%ile) over a 12 month running period \leq 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 (high flow > 5): Naturally turbid. PH: Average 7.0 - 8.5 in any sampling survey. Dissolved nutrients (low flow < 5m ³ /s): Average < 10 NTU 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 (low 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	В	 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 in the particular and participant and	
		 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	В	 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 m² 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	В	 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. <i>Tarebia granifera</i>). 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 occurrence of <i>Paratylodiplax blephariskios</i> 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 (<i>Solea bleekeri, Acanthopagrus vagus, Ponmadasys comerssonnii, Rhabdosargus holubi</i>). A good trophic basis exists for predatory estuarine dependant marine species (e.g. <i>Agyrosomus japonicus, Carynx</i> spp.), i.e. mullet occur throughout the system represented by a full array of size classes. Estuarine residents species represented by core group (<i>Glossogobius</i> spp., <i>Oligolepis</i> spp. <i>Ambassis</i> spp. and <i>Gilchistella aestuaria</i>) in two consecutive years. <i>Oreochromis mossambicus</i> 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 (<i>A. japonicus</i>) (not related to gear changes or bag limit restrictions). 	
Birds	С	 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	
 Maintain the target EC (> 57%). Protect the flow regime to create the required birds, fish, macrophytes, microalgae and water quality: River inflow distribution patterns differ by more than 5% from that of Scenari recommended flow scenario for the Mvoti Estuary). Monthly river inflow > 1.0 m³/s. Monthly river inflow > 2.0 m³/s for more than 50% of the time. 		 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 m³/s. Monthly river inflow > 2.0 m³/s persists for longer than three months in a row. Monthly river inflow > 2.0 m³/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 lune 	
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; NH₃-N < 30 µg/L; PO₄-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 nutrients: Average NO_x-N < 400 µg/L, NH₃-N < 30 µg/L and PO₄-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 quidelines (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	В	 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 m² 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, <i>Barringtonia racemosa</i> stand at the mouth of the estuary so that there is no greater than 10% change in macrophyte habitat. 	

Component/ Indicator	ent/ 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 <i>Mugil cephalus</i>, <i>Myxus capensis</i> from Zones A, B and C Any two of the following species <i>Barbus</i> spp, <i>O. mossambicus</i> from Zones A, B and C. Any one of the following species <i>Barbus</i> spp, <i>O. mossambicus</i> from Zones A, B and C. <i>Anguilla</i> 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	NationI 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.

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.

Table 1.1Integrated study steps

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 inte	egrated in the Integrated	Classification Steps
		U U	

	Integrated steps	RQO steps	Comment
1	Delineate the units of analysis and Resource Units (RUs),	1. Delineate Integrated Units of Analysis (IUAs) and define RUs.	RUs are defined at a broad level on a sub-quaternary (SQ) basis.
1	the water resource(s) (completed).	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).	 Establish a vision for the catchment and key elements for the IUAs. 	Undertaken during Step 1 above.
	Quantify the Ecological Water	3. Prioritise and select RUs for RQO determination.	More detailed RUs defined for high priority rivers.
3	Requirements (EWRs) and changes in non-water quality ecosystem.	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 Nation 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 available information. The benefit of this is that it allows for alignment between legislation and the incorporation of the RQOs in the estuary management planning process under the ICM Act.

Priority estuaries for evaluating RQOs against montoring results were identified as part of the estuary hotspot assessment and include (DWA, 2013a):

Mvuzi

Sezela

Mzinto

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Mhlabatshane

Mfazazana

Kwa-Makosi

Mkumbane

Mahlongwa

uMkhomazi

Mahlongwane

- Zolwane
- Ku-Boboyi
- Tongazi
- Kandandhlovu
- Mpenjati
- Kaba
- Mvutshini
- Vungu
- Zotsha
- Boboyi
- Mbango
- Mzimkulu
- Koshwana
- Intshambili

- Umgababa Lovu
- Mbokodweni

Ngane

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

- Sipingo
- Durban Bay
- Mgeni
- Mhlanga
- uMdloti
- uThongathi
- Mhlali
- Bob's Stream
- Seteni
- Mvoti

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- Mdlotane
- Zinkwasi

(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 $\pm 5\%$ 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 $\pm 10\%$ 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 2.1Proposed RQOs for water quality associated with ecosystem health for the
estuaries in WMA 11

Variable	Health Category								
variable	А	В	С	D	E	F			
Dissolved oxygen (DO)	Average <u>></u> 6	in estuary mg/l	Average in estuary <u>></u> 4 mg/l	Avera	Average in lower estuary <u>> </u> 4 mg/l				
Turbidity	Estuary: Clear	stuary: Clear (< 10 NTU) accept during high flows flows				lear (< 15 ring high			
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	509	%ile < 0.12	5 mg/l			
Toxic substances	 Substance cond Western Indian Secretariat and Substance cond Quality Guidelin Forestry (DWAI 	centrations in estuari Ocean (WIO) Regio CSIR, 2009). centrations in estuari nes for coastal marin F,1995).	ne sediment not to e n guidelines (UNEP/I ne waters not to exc e waters Departmen	xceed ta Nairobi (eed targ t of Wate	argets as po Convention ets as per s er Affairs a	er SA Water nd			

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
	enterod	cocc	i and <i>E. coli</i> (micro	obiological	indi	icator organ	isms) (D	EA, 2	2012)

Cotogony	Estimated rick per expective	Enterococci	E. coli
Calegory	Estimated fisk per exposure	(Count per 100 ml)	(Count per 100 ml)
Excellent	2.9% gastrointestinal (GI)	≤ 100	≤ 250
	illness risk	(95 percentile)	(95 percentile)
Good	5% GI illness risk	≤ 200 (95percentile)	≤ 500 (95 percentile)
Sufficient or Fair	8.5% GI illness risk	≤ 185	≤ 500
(minimum requirement)		(90 percentile)	(90 percentile)
Poor	> 8.5% GI illness risk	> 185	> 500
(unacceptable)		(90 percentile)	(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).

Estuary	REC	PES	TEC motivation	TEC
Mtamvuma	A/B	В	 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	В	В	TEC set to maintain the PES and REC and is immediately applicable.	В
Sandhlunlu	С	С	TEC set to maintain the PES and REC and is immediately applicable.	С
Kuboyoyi	В	В	TEC set to maintain the PES and REC and is immediately applicable.	В
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	В	В	TEC set to maintain the PES and REC and is immediately applicable.	В
Mpenjati	В	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. 	В
Umhlangankulu	С	С	TEC set to maintain the PES and REC and is immediately applicable.	С
Kaba	С	С	TEC set to maintain the PES and REC and is immediately applicable.	С
Mbizana	В	В	TEC set to maintain the PES and REC and is immediately applicable.	В
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	С	С	TEC set to maintain the PES and REC and is immediately applicable.	С
Umvazana	С	С	TEC set to maintain the PES and REC and is immediately applicable.	С
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	В	В	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.	В
Mhlangeni	С	С	TEC set to maintain the PES and REC and is immediately applicable.	С
Zotsha	В	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.	В
Boboyi	B/C	B/C	TEC set to maintain the PES and REC and is immediately applicable.	B/C
Mbango	D	Е	Interventions required to maintain the REC:	EF

		<i>e</i>	• • • •	
Table 3.1	SC 1: Detailed catchment	configuration,	interventions and	IEC motivations

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	В	В	 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. 	В

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

Estuary	REC	PES	TEC motivation	TEC
Mtentwini	С	С	TEC set to maintain the PES and REC and is immediately applicable.	С
Mhlangamkulu	С	С	TEC set to maintain the PES and REC and is immediately applicable.	С
Domba	С	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	В	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. 	С
Intshambili	В	С	 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. 	с
Mzumbe	С	C/D		С
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. 	В
Mhlungwa	С	С	TEC set to maintain the PES and REC and is immediately applicable.	С
Mfazazana	В	С	Interventions required to achieve the REC:	С

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	В	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. 	В
Mnamfu	С	С	TEC set to maintain the PES and REC and is immediately applicable.	С
Mtwalume	С	С	TEC set to maintain the PES and REC and is immediately applicable.	С
Mvuzi	С	С	TEC set to maintain the PES and REC and is immediately applicable.	С
Fafa	С	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. 	с
Mdesingane	D	D	TEC set to maintain the PES and REC and is immediately applicable.	D
Sezela	С	С	TEC set to maintain the PES and REC and is immediately applicable. Scenarios that comply with the TEC are acceptable.	С
Mkumbane	С	С	TEC set to maintain the PES and REC and is immediately applicable.	С
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	С	С	TEC set to maintain the PES and REC and is immediately applicable.	С

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

Estuary	REC	PES	TEC motivation	TEC
Mahlongwa	В	С	 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. 	В
Mahlangwana	В	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. 	В
uMkhomazi	В	С	 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	С	С	TEC set to maintain the PES and REC and is immediately applicable.	С

Estuary	REC	PES	TEC motivation	TEC
Umgababa	В	С	 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 	B/C
			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. Interventions required to achieve the REC:	
Msimbazi	A	В	 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. 	В
Lovu	В	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	Е	 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	Е	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	В	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. 	В
uMdloti	С	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	С	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 MI/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	С	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	В	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	С	С	TEC set to maintain the PES and REC and is immediately applicable.	С
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. 	В

4 SOUTHERN CLUSTER 1 IUA: ESTUARY RQOs

4.1 MTAMVUNA RQOs

PES:	В	REC:		A/B		TEC:	F	VВ		
Compor Rest Red Prot	 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:	-low:									
PES	nMAR (M	CM)			рN	IAR (MCM)				
	275.19	9				239.49				
В	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).									
Sedime	ent processes:									
в	 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:									
Α	Mouth open conditions should	be maintained within t	he cu	urrent range: 7	8% (± 10)%).				
Water c	uality: Salinity									
В	The system needs variability in reaches during the low flow se	salinity regime, with a ason. Mid waters in th	a mea 1e lov	asurable increater ver reaches sh	ase in sa Iould be	linity in the lobetween 10	ower and and 15.	middle		
Water c	uality: Other									
	Ecosystem health					Recreation	al use	Yes		
В	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)					nt levels				
Macrop	ohytes (plants)									
В↑	 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). 									
Inverte	brates									
В	 As sampled by plankton net, g Population abundances of more than 25%. Zooplankton should be dor but include other groups st 	ab and dip nets/traps plankton and benthic a ninated by estuarine c uch as mysids. Merop	(as a assen opep lankto	ppropriate): nblages (basel ods <i>Acartia na</i> on are abunda	lines to b <i>italensis</i> nt.	be set) shoul and <i>Pseudo</i>	d not dev diaptomu	iate by Is hessei,		

	 Macrobenthos should be abundant and dominated by polychaetes but should include amphipods, isopods, tanaids and the crab <i>Hymenosoma projectum</i>. 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 <i>Callichirus kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>Scylla serrata, Varuna litterata, Macrophthalmus</i> sp., Sesarmidae and <i>Uca</i> sp. Molluscan assemblage should include bivalves (including tellinids, <i>Solen cylindraceus and Eumarcia paupercula</i>) and gastropods (including <i>Nassarius kraussianus, Natica</i> spp. and <i>Polinices</i> sp.). Invasive alien species should not occur.
Fish	
¢↑	 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.

No fish kills should occur.

4.2 ZOLWANE RQOs

PES:		В	REC:		В	-	TEC: B				
Key con Base Mair Mair	 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:	Flow:										
PES		nMAR (MC	CM)			рN	IAR (MCM)				
		2.19					2.31				
A	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).										
Sedime	nt process	es:									
В	 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 										
Mouth s	state:										
Α	Mouth oper	n conditions should b	e maintained within	the c	urrent range: 87	1% (± 5%	%).				
Water q	uality: Sali	nity									
Α	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 q	uality: Oth	er									
В	Ecosystem DIN: Fre DIP: Fre DO: Ent Turbidit	health: eshwater inflow, 50% eshwater inflow, 50% tire estuary, average y: Estuary, clear (<1	bile < 0.2 mg/l. bile < 0.015 mg/l. ≥6 mg/l. 0 NTU) accept during	g higł	inflow events.		Recreation u Microbiology (DEA, 2012)	use: /: Sufficient I).	Yes evels		
PES:		В	REC:	В	TEC:	В					
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	 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). 										
Macrop	ohytes (plar	nts)									
в	 Maintai macrop Maintai Preven No inva Control Spanis Preven Waste 	in the distribution of or obyte habitats which a in the integrity of the t further disturbance asive floating aquatic I the spread of invasi h reed, black wattle, t reed encroachment Water Treatment Wo	current macrophyte h accounts for natural riparian zone. No ba and development of species present in th ve plants in the ripar Brazilian pepper tree that may become por rks (WWTW) input.	habitats (< 20% chang changes due to the d are patches or unveg the floodplain habita he estuary e.g. water ian zone. Invasive p e) cover < 5% of total roblematic due to nut	ge in the area cover lynamic nature of es etated, cleared area t. hyacinth. lants (e.g. syringa b macrophyte area. trient enrichment fro	red by different stuaries). as along the banks. perry, Casuarina, om proposed future					
Inverte	brates										
В	 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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum</i>. 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i>, <i>V. litterata</i>, <i>Macrophthalmus</i> sp., Sesarmidae and <i>Uca</i> sp. Molluscan assemblage should include bivalves (including <i>S. cylindraceus</i>, <i>E. paupercula</i>) and gastropods (including <i>N. kraussianus</i>, <i>Natica</i> spp., <i>Polinices</i> sp.). 										
Fish		•									
с	As sample 30 spec Estuari Estuari <i>G. calli</i> trip). <i>P. com</i> Pelagic No alie Fish sh No fish	d by seine and gill ne cies should occur to ne resident species s ne resident and estu <i>dus, M. capensis</i> and <i>mersonni</i> and <i>A. japo</i> piscivores should or n fish species should ould be free of lesior kills should occur.	et in open waters: include freshwater, e should comprise a m arine dependant man d <i>R. holubi</i> should oc <i>onicas</i> should be san ccur (including <i>Carar</i> l occur. hs and other anomali	estuarine resident and inimum of six species rine fishes should do cur with 100% freque npled with 80% frequ nx spp and <i>Sphyraen</i> es related to water q	d estuarine dependa s. minate catches by a ency of occurrence a spp.). uality.	ant marine fishes. abundance. (every sampling					

4.3 SANDLUNDLU RQOs

PES:		С	REC:	C TEC: C						
Key con ■ Prot ■ Mair ■ Mair	 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				
Α	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).									
Sedime	Sediment processes:									

PES:		С	REC:	С	TEC:	С				
с	 The floo The sus sedimer estuary Change Change deviates middle a 	d regime maintains pended sediment co nt load-discharge rel do not differ signific s in tidal amplitude o s in sediment grain by less than a facto and upper reaches o	the sediment distribution oncentration from rive ationship (to be deter antly from present (± of less than 20% from size distribution patter or of two from present lo not change by mo	ution patterns and aq er inflow does not de ermined). The sedim to 0.5 m) (to be detern m present (to be deter erns similar to preser nt levels (to be deterr re than 20% from Pre	uatic habitat (instreativiate by more than 2 entation and erosior nined). ermined). nt. The median bed nined). The sand/m esent State over a fi	am physical habitat). 20% of the present a patterns in the sediment diameter and distributions in ve year average.				
Mouth s	state:									
Α	Mouth open	conditions should b	be maintained within	the current range: 60	0% (± 10%).					
Water q	uality: Salir	nity								
В	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 q	uality: Othe	er								
	Ecosystem	health:			Recreation u	ise: N/A				
В	 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). 									
Macrop	hytes (plan	ts)								
с	 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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum and</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i> and <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. 									
Fish										
Е	As sampled 18 spec Estuarin Estuarin <i>G. callid</i> trip). <i>P. comr</i> Pelagic No alien Fish sho No fish I	I by seine and gill ne ies should occur to i ie resident species s ie resident and estu- <i>lus, M. capensis</i> and <i>nersonni</i> and <i>A. japo</i> piscivores should oc i fish species should ould be free of lesior kills should occur.	et in open waters: include freshwater, e should comprise a m arine dependant ma d <i>R. holubi</i> should oc onicas should be sar ccur (including <i>Carai</i> l occur. hs and other anomal	estuarine resident and inimum of four specie rine fishes should do ccur with 100% freque mpled with 60% frequ <i>nx</i> spp). ies related to water q	d estuarine dependa es. minate catches by a ency of occurrence (uency of occurrence. uality.	int marine fishes. bundance. every sampling				

4.4 KU-BOBOYI RQOs

F	PES:	В	REC:	В	TEC:	В					
Key con	nponents that	at require protection	to maintain the TEC: tain mouth state and s	salinity profile.							
MairMair	ntain water c	quality. arine riparian habitat									
Flow:											
PES		nMAR (MC	CM)		pMAR (MCM)						
		1.00			0.99						
Α	Flows shou should be u the flood co Present (20	Id not exceed natura upheld into estuary to omponents differ by r 015).	al and seasonal distrib o maintain present mo no more than 10% (in	ution should not be uth state and salinit terms of magnitude	compromised. Cur y regime. The distri , timing and variabili	rent baseflows ibution patterns of ity) from that of the					
Sedime	ent process	es:									
 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	Mouth state:										
B Mouth open conditions should be maintained within the current range: 53% (± 5%).											
Water o	uality: Sali	nity									
Α	The system reaches du	n needs variability in ring the low flow sea	salinity regime, with a son. Mid-waters in th	measurable increase e lower reaches sho	se in salinity in the leaded of the second second second second second second second second second second second	ower and middle be confirmed).					
Water o	uality: Oth	er									
	Ecosystem	n health:			Recreation use:	N/A					
В	 DIN: Fre DIP: Fre DO: Eni Turbidit Toxic substar Substar as per S (DWAF Substar targets Secreta 	eshwater inflow, 50% eshwater inflow, 50% tire estuary, average y: Estuary, clear (< 1 tances: nce concentrations ir SA Water Quality Gu , 1995). nce concentrations ir as per WIO Region g iriat and CSIR, 2009	6ile < 0.2 mg/l. 6ile < 0.015 mg/l. $2 \ge 6$ mg/l. 10 NTU) accept during 10 estuarine waters not 10 idelines for coastal main 10 estuarine sediment r 10 guidelines (UNEP/Nain 10).	high inflow events. to exceed targets arine waters not to exceed robi Convention	Not identified as recreational area in stakeholder meeting.						
Macrop	hytes (plan	its)									
 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 penper tree) cover < 5% of total macrophyte area 											
Inverts											
В	 Spanish reed, black wattle, Brazilian pepper tree) cover < 5% of total macrophyte area. nverts 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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum and</i> insect taxa. Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. 										

	PES:	В	REC:	В	TEC:	В						
	 Sandprawn <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i> and <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. Invasive alien species do not dominate macrobenthos. 											
Fish												
С	As sampled 13 spec Estuarir Estuarir <i>G. callid</i> trip). <i>P. comi</i> Pelagic No alier Fish sho	by seine and gill ne ites should occur to i ne resident species s the resident and estua dus, <i>M. capensis</i> and <i>mersonni</i> should be s piscivores should occur fish species should buld be free of lesion kills should occur.	t in open waters: nclude freshwater, e should comprise a m arine dependant mar I <i>R. holubi</i> should oc sampled with 60% fre ccur. occur. s and other anomali	estuarine resident and inimum of four specie rine fishes should do cur with 100% freque equency of occurrence es related to water q	d estuarine dependa es. minate catches by al ency of occurrence (ce. uality.	nt marine fishes. bundance. every sampling						

4.5 TONGAZI RQOs

F	PES:	B/C	REC:		B/C		TEC:	В	/C
Key con ■ Prote ■ Main ■ Main	nponents th ect baseflov ntain water c ntain of estu	at require protection vs to estuary to main quality. arine riparian habitat	to maintain the TEC: tain mouth state and t.	salir	nity profile.				
Flow:									
PES		nMAR (MO	CM)			pN	MAR (MCM)		
		7.00			7.32				
Α	Flows shou should be u the flood co Present (20	uld not exceed natura upheld into estuary to omponents differ by 1 015).	al and seasonal distri o maintain present m no more than 10% (ir	butic outh n terr	n should not be state and salin ns of magnitude	e compro ity regim e, timing	omised. Curr ne. The distri and variabili	rent basef bution pat ty) from th	lows tterns of hat of the
Sediment processes:									
В	 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 s	state:								
В	Mouth ope	n conditions should b	be maintained within	the c	urrent range: 9	1% (± 5	%).		
Water q	uality: Sali	nity							
Α	The systen reaches du	n needs variability in Iring the low flow sea	salinity regime, with ason. Mid-waters in t	a me he lo	easurable increatives wer reaches sh	ase in sa nould ex	alinity in the lo ceed 10 (to b	ower and e confirm	middle ed).
Water q	uality: Oth	er							
	Ecosystem	health:					Recreation	al use:	Yes
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).							nt levels	

	PES:	B/C	REC:	B/C	TEC:	B/C				
Macro	ohytes (plar	its)								
С	 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. 									
Inverta	,									
с	 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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum</i>. 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i>, <i>V. litterata</i>, <i>Macrophthalmus</i> sp., Sesarmidae and <i>Uca</i> sp. Molluscan assemblage should include bivalves (including <i>S. cylindraceus</i>, <i>E. paupercula</i>) and gastropods (including <i>N. kraussianus</i>, <i>Natica</i> spp., <i>Polinices</i> sp.). 									
Fish										
D	As sample 30 spec Estuarii <i>G. callid</i> trip). <i>P. com</i> Pelagic No aliei Fish sh	d by seine and gill ne cies should occur to i ne resident species s ne resident and estua dus, M. capensis and mersonni and A. japo piscivores should oc n fish species should ould be free of lesion	et in open waters: nclude freshwater, e should comprise a m arine dependant man d <i>R. holubi</i> should oc onicas should be san ccur (including <i>Carar</i> l occur. as and other anomali	stuarine resident and inimum of six species rine fishes should do cur with 100% freque npled with 80% freque nx spp and <i>Sphyraen</i> es related to water q	d estuarine dependa s. minate catches by a ency of occurrence (nency of occurrence. a spp.).	nt marine fishes. bundance. every sampling				

No fish kills should occur.

4.6 KANDANDHLOVU RQOs

I	PES: B REC: B TEC: B										
Key cor Prot Mair Mair	 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:	Flow:										
PES	nMAR (MCM) pMAR (MCM)										
	1.53 1.60										
А	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).										
Sedime	ent process	es:									
С	 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 										

F	PES:	В	REC:	В	TEC:	В			
	middle	and upper reaches d	o not change by mo	re than 20% from Pro	esent State over a fi	ve year average.			
Mouth s	state:								
Α	Mouth oper	n conditions should b	e maintained within	the current range: 54	4% (± 5%).				
Water q	uality: Sali	nity							
В	The system reaches du	n needs variability in Iring the low flow sea	salinity regime, with son. Mid-waters in tl	a measurable increa ne lower reaches sho	ase in salinity in the l ould exceed 5 (to be	ower and middle confirmed).			
Water q	uality: Oth	er							
	Ecosysten	n health:			Recreational use	: N/A			
С	Water quali DIN: Fr DIP: Fr DO: En Turbidit Toxic substar as per S (DWAF Substar targets Secreta	Not identified as re stakeholder meetir	ereational area in						
Macrop	hytes (plan	nts)							
В	 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									
В	 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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum and</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i> and <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. 								
Fish									
с	As sampled 18 spec Estuarir Estuarir <i>G. callid</i> trip). <i>P. comi</i> Pelagic No alier Fish sho No fish	d by seine and gill ne cies should occur to i ne resident species s ne resident and estua <i>dus, M. capensis</i> and <i>mersonni</i> should be s piscivores should oc n fish species should ould be free of lesior kills should occur.	t in open waters: nclude freshwater, e should comprise a m arine dependant mai I <i>R. holubi</i> should oc sampled with 80% fro ccur (including <i>Carar</i> occur. Is and other anomali	stuarine resident and inimum of five specie rine fishes should do cur with 100% freque equency of occurren ax spp.). es related to water q	d estuarine dependa es. minate catches by a ency of occurrence (ce. uality.	nt marine fishes. bundance. every sampling			

4.7 MPENJATI RQOs

I	PES:	B/C	REC:		В	TEC:		В	
Compor	nents that re	equire interventions to a impact of sand mini	o achieve the TEC:						
 Impl Dec 	rove water of	quality.	ng.						
 Res Prot 	tore estuari tect baseflo	ne riparian nabitat. ws to estuary to main	tain mouth state and	l sali	nity profile.				
Flow:									
PES		nMAR (MO	CM)			pMAR (MCM)			
		23.61				23.77			
А	Flows sho should be the flood c Present (2	uld not exceed natura upheld into estuary to components differ by r 015).	al and seasonal distri o maintain present m no more than 10% (ir	butio outh n teri	on should not be state and salini ms of magnitude	compromised. Cur ty regime. The distr e, timing and variabil	rent base ibution pa ity) from t	flows atterns of that of the	
Sedime	ent process	ses:							
 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:									
В	Mouth ope	en conditions should b	be maintained within	the o	current range: 7	0% (± 5%).			
Water o	quality: Sal	inity							
А	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 o	quality: Oth	ner						T	
	Ecosyste	m health:				Recreational uses	:	N/A	
C↑	Water qua DIN: FI DIP: FI DO: Er Turbidi Toxic subst Substa as per (DWAF Substa targets Secret	lity poses risk to REC reshwater inflow, 50% reshwater inflow, 50% ntire estuary, average ity: Estuary, clear (< 1 stances: unce concentrations ir SA Water Quality Gu F, 1995). unce concentrations ir as per WIO Region of ariat and CSIR, 2009	C/TEC, sufficiently re- file < 0.2 mg/l (high risk). file < 0.015 mg/l (high risk). IONTU) accept during the estuarine waters no idelines for coastal m the estuarine sediment guidelines (UNEP/Na).	TEC, sufficiently reduced if: lle < 0.2 mg/l (high risk). le < 0.015 mg/l (high risk). ≥ 6 mg/l (high risk). DNTU) accept during high inflow events. estuarine waters not to exceed targets delines for coastal marine waters estuarine sediment not to exceed uidelines (UNEP/Nairobi Convention					
Macrop	ohytes (pla	nts)							
 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 sample Popula more tl	ed by plankton net, gra ition abundances of p han 30%.	ab and dip nets/traps lankton and benthic	s (as asse	appropriate): mblages (basel	ines to be set) shoul	d not dev	viate by	

PES:	B/C	REC:	В	TEC:	В					
	 Zooplankton should be dominated by estuarine copepods <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum</i>. 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Molluscan assemblage should include bivalves (including <i>E. paupercula</i>) and gastropods (including <i>N. kraussianus, Natica</i> spp.). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata, V. litterata, Macrophthalmus</i> sp., Sesarmidae and <i>Uca</i> sp. Invasive alien species should not occur in abundance. 									
Fish										
As s	 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. 									

4.8 UMHLANGANKULU RQOs

I	PES:	С	REC:		С	TEC:		С		
 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 (MO	CM)		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).									
Sedime	ent process	es:								
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:									
Α	Mouth oper	n conditions should b	be maintained within	the cu	rrent range: 3	3% (± 10%).				
Water of	quality: Sali	nity								
В	The system reaches du	n needs variability in rring the low flow sea	salinity regime, with son. Mid-waters in t	a mea the low	surable increa ver reaches sh	se in salinity in the loog of	ower a e conf	nd middle ïrmed).		
Water o	quality: Oth	er								
	Ecosystem health: Recreational use: N/A							N/A		
E	Water quali DIN: Fro DIP: Fro DO: En	ity poses risk to REC eshwater inflow, 50% eshwater inflow, 50% tire estuary, average	C/TEC, sufficiently re- foile < 0.3 mg/l (high to foile < 0.025 mg/l (high to ~ 4 m	duced risk). h risk)	if:	Not identified as re stakeholder meetir	creationg.	onal area in		

F	PES:	С	REC:	С	TEC:	С			
	 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). 								
Macrop	Macrophytes (plants)								
С	 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									
Е	 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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum and</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i> and <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. 								
Fish									
D	As sample 13 spe Estuari <i>G. calli</i> trip). <i>P. com</i> Pelagic No alie Fish sh No fish	d by seine and gill ne cies should occur to ne resident species s ne resident and estu idus, <i>M. capensis</i> and <i>mersonni</i> should be piscivores should or n fish species should nould be free of lesior kills should occur.	et in open waters: include freshwater, e should comprise a m arine dependant mar d <i>R. holubi</i> should oc sampled with 60% fre ccur. d occur. hs and other anomali	stuarine resident and inimum of four specie rine fishes should dor cur with 100% freque equency of occurrenc es related to water qu	l estuarine dependa es. ninate catches by a ency of occurrence (ee.	nt marine fishes. bundance. every sampling			

4.9 KABA RQOs

PES:		С	REC:	С	TEC:	С			
Key con Prot Mair Mair	 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:	Flow:								
PES	nMAR (MCM)				pMAR (MCM)				
	3.15				3.07				
Α	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:									
С	C • The flood regime maintains the sediment distribution patterns and aquatic habitat (instream physical habitat).								

Classification, Reserve and RQOs in the Mvoti to Umzimkulu WMA

PES:		С	REC:	С	TEC:	С			
	The sus sedimer estuary Change Change deviates middle a	pended sediment co nt load-discharge rela do not differ significa s in tidal amplitude c s in sediment grain s s by less than a facto and upper reaches d	ncentration from rive ationship (to be dete antly from present (± of less than 20% from size distribution patte or of two from presen o not change by mor	er inflow does not de rmined). The sedime 0.5 m) (to be determ n present (to be deter erns similar to presen at levels (to be detern re than 20% from Pre	viate by more than 2 entation and erosion ined). rmined). t. The median bed nined). The sand/m esent State over a fiv	20% of the present patterns in the sediment diameter ud distributions in /e year average.			
Mouth s	state:					.,			
Α	Mouth oper	n conditions should b	e maintained within	the current range: 27	′% (± 10%).				
Water q	uality: Sali	nity							
В	The system reaches du	needs variability in ring the low flow sea	salinity regime, with son. Mid-waters in t	a measurable increa he lower reaches sho	se in salinity in the le ould exceed 5 (to be	ower and middle confirmed).			
Water q	uality: Othe	er							
	Ecosystem	health:			Recreational use:	N/A			
Е	Water quali DIN: Fre DIP: Fre DO: Ent Turbidit Toxic substar as per S (DWAF, Substar targets a Secreta	ty poses risk to REC eshwater inflow, 50% eshwater inflow, 50% ire estuary, average y: Estuary, clear (< 1 ances: ace concentrations in SA Water Quality Gui 1995). ace concentrations in as per WIO Region o riat and CSIR, 2009)	/TEC, sufficiently red sile < 0.3 mg/l (high r sile < 0.025 mg/l (high \geq 4 mg/l (high risk) 5 NTU) accept during estuarine waters no delines for coastal n estuarine sediment guidelines (UNEP/Na	duced if: risk) h risk) ng high inflow events. of to exceed targets narine waters not to exceed airobi Convention	Not identified as recreational area in stakeholder meeting.				
Macrop	hytes (plan	ts)							
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 <i>A. natalensis</i> and <i>P. hessei</i>. Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab <i>H. projectum</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) are dominated by <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. Invasive align species do not dominate macrobenthos 								
Fish									
D	As sampled 10 spec Estuarir <i>G. callic</i> trip). <i>P. comr</i> Pelagic No alier Fish sho No fish	I by seine and gill ne ies should occur to in ne resident species s ne resident and estua <i>lus, M. capensis</i> and <i>mersonni</i> should be s piscivores should oc n fish species should puld be free of lesion kills should occur.	t in open waters: nclude freshwater, e hould comprise a mi arine dependant mar <i>R. holubi</i> should oc campled with 60% fre cur. occur. s and other anomalia	stuarine resident and inimum of three spec ine fishes should dor cur with 100% freque equency of occurrenc es related to water qu	l estuarine dependa ies. ninate catches by al ency of occurrence (ce. uality.	nt marine fishes. bundance. every sampling			

4.10 MBIZANA RQOs

	PES: B	REC:	В	TEC:	В					
Key cor	mponents that require protection	to maintain the TEC:	salinity profile							
 Mair Mair 	ntain water quality.	st	samity prome.							
Flow:		at.								
PES	nMAR (N	CM)		pMAR (MCM)						
	36.30			35.52						
А	Flows should not exceed nature should be upheld into estuary the flood components differ by Present (2015).	al and seasonal distrib to maintain present mo no more than 10% (in	oution should not be outh state and salinit terms of magnitude	compromised. Cur ty regime. The distr e, timing and variabil	rent baseflows ibution patterns of ity) from that of the					
Sedime	ent processes:									
 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	Mouth state:									
Α	Mouth open conditions should	be maintained within th	he current range: 54	4% (± 5%).						
Water o	Water quality: Salinity									
А	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 to 10 (to be confirmed).									
Water o	quality: Other									
	Ecosystem health:			Recreational uses	: N/A					
С	 Water quality poses risk to RE DIN: Freshwater inflow, 50 DIP: Freshwater inflow, 50 DO: Entire estuary, averag Turbidity: Estuary, clear (< Toxic substances: Substance concentrations as per SA Water Quality G (DWAF, 1995). Substance concentrations targets as per WIO Region Secretariat and CSIR, 200 	C/TEC, sufficiently red %ile < 0.2 mg/l (high ris %ile < 0.015 mg/l (high $e \ge 6$ mg/l (high risk). 10NTU) accept during in estuarine waters not uidelines for coastal m in estuarine sediment r guidelines (UNEP/Nai 9).	uced if: sk). risk). high inflow events. to exceed targets arine waters not to exceed robi Convention	Not identified as re stakeholder meetir	ecreational area in ng.					
Macrop	ohytes (plants)									
с	 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										
С	 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 <i>A. natalensis</i> and <i>P. hessei</i>, but include other groups such as mysids. Meroplankton are abundant. Macrobenthos should be abundant and dominated by amphipods and polycheates, but should include isopeds, tanaids and the grap <i>H. projectum</i> and insect taxa. 									

I	PES:	В	REC:	В	TEC:	В			
	 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i> and <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. Invasive alien species should not occur in abundance. 								
Fish									
с	As sampled 18 spec Estuarir Estuarir <i>G. callic</i> trip). <i>P. comr</i> Pelagic No alier Fish sho No fish	d by seine and gill ne ies should occur to i ne resident species s dus, <i>M. capensis</i> and <i>mersonni</i> should be s piscivores should oc n fish species should puld be free of lesion kills should occur.	t in open waters: nclude freshwater, e hould comprise a m arine dependant man <i>R. holubi</i> should oc sampled with 80% fro ccur (including <i>Carar</i> occur. s and other anomali	estuarine resident and inimum of five specie rine fishes should do cur with 100% freque equency of occurrent nx spp.). es related to water q	d estuarine dependa es. minate catches by a ency of occurrence (ce. Juality.	nt marine fishes. bundance. every sampling			

4.11 MVUTSHINI RQOs

PES:		B/C	REC:	l	B/C	TEC:		B/C		
Key con Prote Mair Mair	 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 (M	CM)			pMAR (MCM)				
		1.66				1.63				
A	should hot exceed natural and seasonal distribution should not be compromised. Current basenows 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).									
Sedime	ent process	es:								
В	 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 s	state:									
В	Mouth oper	n conditions should l	be maintained within	the curre	nt range: 42	2% (± 5%).				
Water o	uality: Sali	nity								
В	The system reaches du	n needs variability in ring the low flow sea	salinity regime, with a son. Mid-waters in t	a measu he lower	rable increa reaches sho	se in salinity in the ould exceed 5 (to b	lower e con	and middle firmed).		
Water o	uality: Oth	er								
	Ecosysten	n health:				Recreational use	:	Yes		
D	Water quali DIN: Fro DIP: Fro DO: En Turbidit Toxic substar Substar as per S (DWAF	ity poses risk to REC eshwater inflow, 50% eshwater inflow, 50% tire estuary, average y: Estuary, clear (< tances: nce concentrations in SA Water Quality Gu , 1995).	C/TEC, sufficiently rec %ile <0.2 mg/l (high ri %ile <0.015 mg/l (high $\geq _6$ mg/l (high risk). 10NTU) accept during n estuarine waters no sidelines for coastal m	duced if: sk). n risk). g high inf nt to exce narine wa	low events. ed targets aters	Ramsgate (Blue F Microbiology: Exc 2012).	lag) ellent	levels (DEA,		

PES:			B/C		REC:	B/C	TEC:	B/C
	■ : t	Substar targets a Secreta	nce concentr as per WIO riat and CSI	ations in Region g R, 2009).	estuarine sediment uidelines (UNEP/Na	not to exceed airobi Convention		
Macrop	ohyte	s (plan	ts)					
С	 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								
с	 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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum and</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i> and <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. 							d not deviate by ut include other hould include inate the benthos. confirmed).
Fish								
С	As s	samplec 18 spec Estuarir Estuarir <i>G. callic</i> trip). <i>P. comr</i> Pelagic No alier Fish sho No fish	d by seine ar ies should o ne resident s ne resident a <i>dus, M. cape</i> <i>mersonni</i> sho piscivores s n fish species buld be free kills should o	ad gill net ccur to in pecies sh nd estua nsis and puld be sa hould occ s should occ s should oc of lesions poccur.	in open waters: include freshwater, e nould comprise a m rine dependant ma <i>R. holubi</i> should oc ampled with 80% fr cur (including <i>Cara</i> occur. and other anomal	estuarine resident and inimum of five specie rine fishes should do ccur with 100% freque equency of occurrent nx spp.).	d estuarine dependa es. minate catches by a ency of occurrence (ce. uality.	int marine fishes. bundance. every sampling

4.12 BILANHLOLO RQOs

F	PES:	С	REC:		С	TEC:	С		
Key con Prote Main Main	 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:	Flow:								
PES	nMAR (MCM)					pMAR (MCM)			
	5.02				4.98				
Α	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).								
Sedime	nt process	es:							
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). 								

F	PES:	С	REC:	С	TEC:	С				
	 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	Mouth state:									
Α	Mouth oper	n conditions should b	e maintained within	the current range: 47	7% (± 10%).					
Water o	quality: Salii	nity								
В	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				
D	Water quality poses risk to REC/TEC, sufficiently reduced if: Iter quality poses risk to REC/TEC, sufficiently reduced if: DIN: Freshwater inflow, 50%ile < 0.2 mg/l (high risk).					[`] lag) ellent levels (DEA,				
Macrop	Macrophytes (plants)									
Е	 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, Species present in the estuary e.g. water hyacinth. 									
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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum and</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i> and <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. 									
Fish										
D	As sampled 13 spec Estuarir <i>Estuarir</i> <i>G. callid</i> trip). <i>P. comr</i> Pelagic No alier Fish sho No fish	by seine and gill ne ies should occur to in ne resident species s ne resident and estua <i>dus, M. capensis</i> and <i>mersonni</i> should be s piscivores should oc n fish species should puld be free of lesion kills should occur.	t in open waters: nclude freshwater, e hould comprise a m arine dependant man <i>R. holubi</i> should oc campled with 60% fre- ccur. occur. s and other anomali	estuarine resident and inimum of four specie rine fishes should don cur with 100% freque equency of occurrenc es related to water q	d estuarine dependar es. minate catches by al ency of occurrence (e ce. uality.	nt marine fishes. bundance. every sampling				

4.13 UVUZANA RQOs

F	PES:	С	REC:	С	TEC:	С			
Key con	nponents the	at require protection	to maintain the TEC:						
 Prot Mair 	ect baseflow ntain water c	vs to estuary to main quality.	tain mouth state and	salinity profile.					
 Mair 	ntain of estu	arine riparian habitat	t						
Flow:									
PES		nMAR (MO	CM)		pMAR (MCM)				
		1.05			1.05				
A	Flows shou should be u the flood co Present (20	uld not exceed natura upheld into estuary to omponents differ by r 015).	al and seasonal distrik o maintain present mo no more than 10% (in	oution should not be outh state and salinit terms of magnitude	compromised. Cur y regime. The distri , timing and variabili	rent baseflows ibution patterns of ity) from that of the			
Sedime	nt process	es:							
с	 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 s	state:					,			
Α	Mouth oper	n conditions should b	be maintained within t	he current range: 32	2% (± 10%).				
Water o	uality: Sali	inity		-					
Α	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 o	uality: Oth	er							
	Ecosystem	n health:			Recreational use:	N/A			
F	Water quali DIN: Fro DIP: Fro DO: Ent Turbidit Toxic substar as per S (DWAF Substar targets Secreta	ity poses risk to REC eshwater inflow, 50% eshwater inflow, 50% tire estuary, average ty: Estuary, clear (<1 tances: nce concentrations ir SA Water Quality Gu , 1995). nce concentrations ir as per WIO Region g ariat and CSIR, 2009	C/TEC, sufficiently red 6 = 0.3 mg/l (high ri 6 = 0.025 mg/l (high 2 = 4 mg/l (high risk). 5 NTU accept during 1 = 0.025 mg/l 1 = 0.025	luced if: isk). n risk). g high inflow events. t to exceed targets harine waters not to exceed irobi Convention	Not identified as re stakeholder meetir	ecreational area in ng.			
Macrop	hytes (plan	nts)							
с	 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 <i>A. natalensis</i> and <i>P. hessei</i>. Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab <i>H. projectum</i> and insect taxa. Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. 								
				,	-				

PES:	С	REC:	С	TEC:	С				
 Sandprawn <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) are dominated by <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. Invasive alien species do not dominate macrobenthos. 									
Fish									
As sample 10 spe Estuar <i>G. call</i> trip). <i>P. con</i> Pelagi No alie Fish sł No fisł	d by seine and gill ne cies should occur to i ne resident species s idus, <i>M. capensis</i> and <i>mersonni</i> should be piscivores should oc in fish species should be free of lesior kills should occur.	et in open waters: nclude freshwater, e should comprise a mi arine dependant mar d <i>R. holubi</i> should oc sampled with 60% fre ccur. l occur. hs and other anomali	stuarine resident and inimum of three spec rine fishes should do cur with 100% freque equency of occurren es related to water q	d estuarine dependa cies. minate catches by a ency of occurrence (ce. juality.	Int marine fishes. bundance. every sampling				

4.14 KONGWENI RQOs

P	PES:	E	REC:	D	TEC:	EF			
Water quality: Salinity									
 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 q	uanty. Oth								
	Recreational use: Yes								
F	Major holiday destination Microbiology: Sufficient levels (DEA, 2012).								

4.15 VUNGU RQOs

PES:	ES: B REC: B TEC: B								
Key cor • Prot • Mair • Mair	 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:	Flow:								
PES		nMAR (MO	CM)			pMAR (MCM)			
		27.79				28.88			
В	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).								
Sedime	Sediment processes:								
В	 The floo The sus sedime estuary Change Change deviate middle 	od regime maintains spended sediment co nt load-discharge rel do not differ signific es in tidal amplitude o es in sediment grain s by less than a facto and upper reaches o	the sediment distribution oncentration from rive ationship (to be dete antly from present (± of less than 20% from size distribution patte or of two from presen lo not change by mod	ution er inf rmin 0.5 i n pre erns erns t lev re tha	patterns and aq low does not de ed). The sedim m) (to be detern sent (to be deter similar to preser els (to be deterr an 20% from Pre	uatic habitat (instrea viate by more than 2 entation and erosion nined). ermined). nt. The median bed nined). The sand/m esent State over a fiv	m physical habitat). 20% of the present patterns in the sediment diameter ud distributions in /e year average.		
Mouth	state:								
В	Mouth ope	n conditions should b	e maintained within	the c	current range: 9	5% (± 5%).			
Water o	quality: Sali	nity							
В	The systen reaches du	n needs variability in Iring the low flow sea	salinity regime, with son. Bottom waters	a me shou	easurable increauld exceed 20 (t	use in salinity in the lo o be confirmed).	ower and middle		

Water o	quality: Other						
	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). 							
Macrop	hytes (plants)						
В	 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. 						
lverts							
С	 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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>S. serrata</i> and <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. 						
Fish							
С	 As sampled by seine and gill net in open waters: 30 species should occur to include freshwater, estuarine resident and Estuarine resident species should comprise a minimum of six species Estuarine resident and estuarine dependant marine fishes should dor <i>G. callidus, M. capensis</i> and <i>R. holubi</i> should occur with 100% freque trip). <i>P. commersonni</i> and <i>A. japonicas</i> should be sampled with 80% freque Pelagic piscivores should occur (including <i>Caranx</i> spp). No alien fish species should occur. Fish should be free of lesions and other anomalies related to water que No fish kills should occur. 	estuarine dependant mari ninate catches by abundar ncy of occurrence (every s ency of occurrence.	ine fishes. nce. sampling				

4.16 MHLANGENI RQOs

F	PES:	С	REC:	С	TEC:	С		
 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 (MO	CM)		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).							

I	PES:	С	REC:	С	TEC:	С	
Sedime	ent process	es:	•				
 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:						
В	Mouth ope	n conditions should b	be maintained within	the current range: 55	i% (± 10%).		
Water o	quality: Sali	inity					
В	The systen reaches du confirmed)	n needs variability in uring the low flow sea	salinity regime, with ason. Mid-waters in t	a measurable increa the lower reaches sho	se in salinity in the lo ould be between 10	ower and middle and 15 (to be	
Water o	quality: Oth	er					
	Ecosyster	n health:			Recreational use:	N/A	
С	 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). 						
Macrop	ohytes (plar	nts)					
D	 Macrophytes (plants) 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 						
lverts							
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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum and</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i> and <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. 						
Fish		· · ·					
D	As sample 13 spec Estuari Estuari <i>G. calli</i> trip). <i>P. com</i>	d by seine and gill ne cies should occur to ne resident species s ne resident and estu dus, <i>M. capensis</i> and <i>mersonni</i> should be	et in open waters: include freshwater, e should comprise a m arine dependant mar d <i>R. holubi</i> should oc sampled with 60% fre	stuarine resident and inimum of four specie rine fishes should dor cur with 100% freque equency of occurrence	l estuarine dependar es. ninate catches by at ency of occurrence (e ce.	nt marine fishes. oundance. every sampling	

PES:	С	REC:	С	TEC:	С
 Pelagi No alio Fish s No fisl 	c piscivores should or en fish species should hould be free of lesior n kills should occur.	ccur. l occur. is and other anomali	es related to water q	juality.	

4.17 ZOTSHA RQOs

F	PES:	B/C	REC:	В	TEC:	В		
Compor	nents that re	quire interventions to	o achieve the TEC:					
 Rest Impr 	ove water q	uality.	ilal.					
Flow:								
PES		nMAR (MC	CM)		pMAR (MCM)			
		15.74			16.25			
В	Flows shou should be u the flood co Present (20	ld not exceed natura ipheld into estuary to omponents differ by r 015).	al and seasonal distril o maintain present mo no more than 10% (ir	bution should not be outh state and salinit a terms of magnitude	compromised. Curr y regime. The distri , timing and variabili	ent baseflows bution patterns of ty) from that of the		
Sedime	nt process	es:						
 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 s	state:							
С	Mouth oper	n conditions should b	e maintained within	the current range: 76	6% (± 5%).			
Water q	uality: Sali	nity						
D	The system reaches du confirmed).	n needs variability in ring the low flow sea	salinity regime, with a son. Mid-waters in t	a measurable increa he lower reaches sho	se in salinity in the le ould be between 5 a	ower and middle nd 10 (to be		
Water q	uality: Oth	er			T			
	Ecosystem	n health:			Recreational use:	N/A		
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 							
Macrop	hytes (plan	ts)						
 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	A	d been land at the	- hand all and the					
C∱	As sampled Populat	t by plankton net, gra ion abundances of p	ab and dip nets/traps lankton and benthic a	(as appropriate): assemblages (baseli	nes to be set) shoul	d not deviate by		

Р	ES:	B/C	REC:	В	TEC:	В		
	 More than 40%. Zooplankton should be dominated by estuarine copepods <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum</i>. 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Molluscan assemblage should include bivalves (including <i>E. paupercula</i>) and gastropods (including <i>Natica</i> spp.). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i>, <i>V. litterata</i>, <i>Macrophthalmus sp.</i>, Sesarmidae and <i>Uca</i> sp. Invasive alien species do not dominate macrobenthos. 							
Fish								
В	 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. <i>G. callidus, M. capensis</i> and <i>R. holubi</i> should occur with 100% frequency of occurrence (every sampling trip). <i>P. commersonni</i> and <i>A. japonicas</i> should be sampled with 60% frequency of occurrence. Pelagic piscivores should occur (including <i>Caranx</i> spp). No alien fish species should occur. Fish should be free of lesions and other anomalies related to water quality. 							

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 (MO	CM)			pMAR (MCM)		
	8.25					8.07		
В	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:								
с	 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 							
Mouth	state:							
Α	Mouth ope	n conditions should b	be maintained within t	the cur	rrent range: 95	5% (± 5%).		
Water o	quality: Sali	nity						
Α	The systen reaches du	n needs variability in Iring the low flow sea	salinity regime, with a son. Mid-waters in the	a meas he low	surable increa er reaches sh	se in salinity in the l ould exceed 5 (to be	ower ar e confirr	nd middle med).
Water o	quality: Oth	er						
	Ecosystem	n health:				Recreational use		N/A
С	Water qual DIN: Fr DIP: Fr	ity poses risk to REC eshwater inflow, 50% eshwater inflow, 50%	C/TEC, sufficiently rec 6ile < 0.2 mg/l (high r 6ile < 0.015 mg/l (higl	duced i isk). h risk).	if:	Not identified as recreational area in stakeholder meeting.		

F	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)									
с	 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									
В	 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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum</i>. 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i>, <i>V. litterata, Macrophthalmus sp., Sesarmidae</i> and <i>Uca sp,</i> Molluscan assemblage should include bivalves (including <i>E. paupercula</i>) and gastropods (including <i>N. kraussianus Natica</i> sp.) 								
Fish		•							
с	As sample 25 spec Estuari <i>G. calli</i> trip). <i>P. com</i> Pelagic No alie Fish sh No fish	d by seine and gill ne cies should occur to ne resident species s ne resident and estu <i>dus, M. capensis</i> and <i>mersonni</i> and <i>A. japo</i> piscivores should oc n fish species should ould be free of lesior kills should occur.	et in open waters: include freshwater, e should comprise a m arine dependant man d <i>R. holubi</i> should oc onicas should be san ccur (including <i>Carar</i> I occur. ns and other anomali	stuarine resident and inimum of five specie rine fishes should dor cur with 100% freque npled with 60% frequ nx spp and <i>Sphyraen</i> es related to water qu	l estuarine dependa s. ninate catches by a ency of occurrence (ency of occurrence. a spp.).	nt marine fishes. bundance. every sampling			

4.19 MBANGO RQOs

	PES:	E	REC:	D	TEC:	EF		
Water quality: Salinity								
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 o	quality: Oth	er						
Е	Recreation	Recreational use: N/A						
	Not identified as recreational area in stakeholder meeting.							

4.20 UMZIMKULU RQOs

F	PES:	В	REC:	В	TEC:	В			
Compor	nents that re	quire interventions to	o counteract the dow	nwards trajectory and	d meet the TEC:				
 Erac Rem 	 Eradicate invasive alien vegetation. Remove derelict, redundant and old quays, jetties, wharfs and revetments rehabilitate banks. 								
 Proh Man 	nibit dredge	spoil dumping in inap	opropriate areas.	nent					
	trol/reduce a	and control fishing pr	essure.	nent.					
Flow:									
PES		nMAR (MC	CM)		pMAR (MCM)				
		1452.49)		1175.14				
В	Flows shou should be u the flood co Present (20	Id not exceed natura upheld into estuary to omponents differ by r 015).	וl and seasonal distri maintain present m הס more than 10% (ii	ibution should not be outh state and salinit n terms of magnitude	compromised. Curi y regime. The distri , timing and variabili	ent baseflows bution patterns of ity) from that of the			
Sedime	Sediment processes:								
 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:								
В	Mouth oper	n conditions should b	e maintained within	the current range: 97	% (± 3%).				
Water o	Water quality: Salinity								
В	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 o	quality: Oth	er			1				
	Ecosystem	n health:			Recreational use:	Yes			
В	 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 				cient levels (DEA,				
Macrop	hytes (plan	its)							
В	 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									
С	As sampled Populat more th Zooplar	d by plankton net, gra ion abundances of p an 30%. hkton should be dom	ab and dip nets/traps lankton and benthic inated by estuarine (s (as appropriate): assemblages (baselin copepods <i>A. natalens</i>	nes to be set) shoul	d not deviate by			

F	PES:	В	REC:	В	TEC:	В		
	 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 <i>H. projectum</i>. 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i>, <i>V. litterata</i>, <i>Macrophthalmus</i> sp., Sesarmidae and <i>Uca</i> sp. Molluscan assemblage should include bivalves (including <i>S. cylindraceus</i>, <i>E. paupercula</i>) and gastropods (including <i>N. kraussianus</i>, <i>Natica</i> spp., <i>Polinices</i> sp.). Invasive alien species should not occur in abundance. 							
Fish								
В	 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. <i>G. callidus, M. capensis</i> and <i>R. holubi</i> should occur with 100% frequency of occurrence (every sampling trip). <i>P. commersonni</i> and <i>A. japonicas</i> should be sampled with 80% frequency of occurrence. Pelagic piscivores should occur (including <i>Caranx</i> spp and <i>Sphyraena</i> spp.). No alien fish species should occur. Fish should be free of lesions and other anomalies related to water quality. 							

5 SOUTHERN CLUSTER 2 IUA: ESTUARY RQOs

5.1 UMTHENTE (MTENTWENI) RQOs

PES:		С	REC:		С	TEC:		C
Key con Prote Main Main	nponents the ect baseflow ntain water contain of estu	at require protection vs to estuary to main quality. arine riparian habitat	to maintain the TEC: tain mouth state and	salir	nity profile.			
Flow:								
PES		nMAR (MC	CM)			pMAR (MCM)		
С	Flows shou should be u the flood co Present (20	12.07 Ild not exceed natura upheld into estuary to omponents differ by r 015).	al and seasonal distril o maintain present me no more than 10% (in	butic outh n terr	n should not be state and salini ns of magnitude	11.14 compromised. Cur ty regime. The distr e, timing and variabil	rent base ibution pa ity) from t	flows atterns of that of the
Sedime	nt process	es:						
 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 s	state:							
В	Mouth oper	n conditions should b	e maintained within t	the c	urrent range: 40	0% (± 10%).		
Water q	uality: Sali	nity						
В	The system reaches du	n needs variability in ring the low flow sea	salinity regime, with a son. Mid-waters in the	a me he lo	easurable increa	se in salinity in the l ould exceed 5 (to be	ower and confirme	middle ad).
Water q	uality: Oth	er						
	Ecosysten	n health:				Recreational uses	:	Yes
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).						∍ls (DEA,	
Macrop	hytes (plan	its)						
 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								
С	As sampled Populat more th Zooplar	d by plankton net, gra ion abundances of p an 40%. nkton should be dom	ab and dip nets/traps lankton and benthic a inated by estuarine c	asse (as	appropriate): mblages (baseli pods <i>A. natalen</i>	ines to be set) shoul sis and <i>P. hessei</i> , bu	d not dev it include	riate by other

PES:		С	REC:	С	TEC:	С		
	 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 <i>H. projectum and</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i> and <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. Invasive alien species do not dominate macrobenthos. 							
Fish	-							
С	As samplec 13 spec Estuarin <i>G. callic</i> trip). <i>P. comr</i> Pelagic No alier Fish sho No fish	by seine and gill ne ies should occur to i ne resident species s are resident and estu- dus, <i>M. capensis</i> and <i>mersonni</i> should be piscivores should or n fish species should build be free of lesior kills should occur.	et in open waters: include freshwater, e should comprise a m arine dependant man d <i>R. holubi</i> should oc sampled with 60% fr ccur. l occur. hs and other anomali	estuarine resident and inimum of four speci rine fishes should do ccur with 100% freque equency of occurren ies related to water q	d estuarine dependa es. minate catches by a ency of occurrence (ce. juality.	nt marine fishes. bundance. every sampling		

5.2 MHLANGAMKULU RQOs

PES:		С	REC:	С	TEC:	С			
 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:	Flow:								
PES		nMAR (M	CM)		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)								
Sedime	ent process	es:							
С	 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:								
С	Mouth oper	n conditions should l	be maintained within	the current range: 19	9% (± 10%).				
Water o	quality: Sali	nity							
С	The system reaches du	n needs variability in Iring the low flow sea	salinity regime, with a son. Mid-waters in t	a measurable increas he lower reaches sho	se in salinity in the loould exceed 5 (to be	ower and middle e confirmed).			
Water o	quality: Oth	er							
	Ecosysten	n health:			Recreational use:	: Yes			
D	Water qual DIN: Fr DIP: Fr DO: En Turbidit Toxic subs Substar	ity poses risk to REC eshwater inflow, 50% eshwater inflow, 50% tire estuary, average y: Estuary, clear (< 7 tances: nce concentrations in	C/TEC, sufficiently rec 6 = 0.3 mg/l (high r 6 = 0.025 mg/l (high 2 = 4 mg/l (high risk). 10 NTU) accept durin 10 estuarine waters no	duced if: isk). h risk). g high inflow events. t to exceed targets	San Lameer Microbiology: Suffi 2012).	cient levels (DEA,			

PES:		С	REC:	С	TEC:	С			
	as per (DWAF Substa targets Secreta	SA Water Quality Gu -, 1995). Ince concentrations ir as per WIO Region ariat and CSIR, 2009	idelines for coastal r n estuarine sediment guidelines (UNEP/Na)	narine waters not to exceed airobi Convention					
Macrop	hytes (pla	nts)			-				
с	 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									
С	 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 <i>A. natalensis</i> and <i>P. hessei</i>. Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab <i>H. projectum</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) are dominated by <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. 								
Fish									
с	As sample 10 spe Estuari <i>G. calli</i> trip). <i>P. com</i> Pelagio No alie Fish st	d by seine and gill ne cies should occur to i ine resident species s ine resident and estu- idus, <i>M. capensis</i> and <i>mersonni</i> should be c piscivores should or in fish species should be free of lesior	et in open waters: include freshwater, e should comprise a m arine dependant mai d <i>R. holubi</i> should oc sampled with 60% fro ccur. d occur. hs and other anomali	estuarine resident and inimum of three spect rine fishes should do cur with 100% freque equency of occurrence es related to water q	d estuarine dependa ites. minate catches by a ency of occurrence ce. uality.	ant marine fishes. abundance. (every sampling			

• No fish kills should occur.

5.3 DAMBA RQOs

Г

F	PES:	D	REC:	С	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. 								
Howeve The deg	er, it may be gree to which	possible to elevate t this is achievable n	he TEC by improving needs to be evaluate	g water quality and ro d as part of an Estua	estoring baseflows a iry Management Pla	nd riparian habitat. n.		
Flow:								
FIOW.								
PES		nMAR (MC	CM)		pMAR (MCM)			
PES		nMAR (MC 4.56	CM)		pMAR (MCM) 3.85			
PES D	Flows shou should be u the flood co Present (20	nMAR (MC 4.56 Id not exceed natura pheld into estuary to mponents differ by r 15).	CM) al and seasonal distr o maintain present m no more than 10% (ii	ibution should not be nouth state and salini n terms of magnitude	pMAR (MCM) 3.85 compromised. Curr ty regime. The distri e, timing and variabili	rent baseflows ibution patterns of ity) from that of the		
PES D Sedime	Flows shou should be u the flood co Present (20 ent processe	nMAR (MC 4.56 Id not exceed natura pheld into estuary to mponents differ by r 15). es:	CM) al and seasonal distr o maintain present m no more than 10% (i	ibution should not be nouth state and salini n terms of magnitude	pMAR (MCM) 3.85 compromised. Curr ty regime. The distri e, timing and variabili	rent baseflows ibution patterns of ity) from that of the		

F	PES:	D	REC:	С	TEC:	D					
D	 The hood 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 s	state:		• •								
D	Mouth ope	n conditions should b	e maintained within	the current range: 28	3% (± 10%).						
Water o	uality: Sali	nity		-							
С	The system reaches du	n needs variability in Iring the low flow sea	salinity regime, with son. Mid-waters in t	a measurable increa the lower reaches she	se in salinity in the le ould exceed 5 (to be	ower and middle confirmed).					
Water quality: Other											
	Ecosyster	n 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) 											
Macrop	hytes (plar	nts)									
D	 Macrophytes (plants) 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 <i>Barringtonia racemosa</i>. 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 (<i>Cardiospermum grandiflorum</i>), castor oil bush (<i>Ricinis communis</i>), Spanish Gold (<i>Sesbania punicea</i>) and Triffid weed (<i>Chromolaena odorata</i>) cover < 5% of total macrophyte area. 										
Inverts											
с	 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 <i>A. natalensis</i> and <i>P. hessei</i>. Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab <i>H. projectum</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) are dominated by <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. Invasive alien species do not dominate macrobenthos. 										
Fish											
D	As sample 10 spec Estuari Estuari <i>G. calli</i> trip). <i>P. com</i>	d by seine and gill ne cies should occur to i ne resident species s ne resident and estua dus, <i>M. capensis</i> and mersonni should be s	et in open waters: nclude freshwater, e should comprise a m arine dependant man d <i>R. holubi</i> should oc sampled with 60% fre	estuarine resident and inimum of three spec rine fishes should dor ocur with 100% freque equency of occurrenc	d estuarine dependa iles. minate catches by a ency of occurrence (ce.	nt marine fishes. bundance. every sampling					
	- Pelagic	piscivores snoula oc	Juli.								

Classifica	ation, Reserve and RC	20s in the Mivor	ti to Umzimkulu WMA					
I	PES:	D	REC:	С	TEC:	D		
	 No alien fish s Fish should be No fish kills sh 	pecies should free of lesion ould occur.	l occur. Is and other anomalie	es related to water q	uality.			
5.4	KOSHWANA	RQOs						
PES:		C/D	REC:	В	TEC:	С		
Compor Mair Part Prev	nents that require ir ntain water quality. ial restoration of es vent low oxygen eve	iterventions to tuarine habita ents that resu	o achieve the TEC: at. Its in fish kills.					
Flow:								
PES		nMAR (MC	CM)		pMAR (MCM)			
		2.06			2.05			
В	Present flows po be compromised. regime. The distri timing and variabil	se a risk to the Current base bution pattern ity) from that	he REC. Flows shou flows should be uphe as of the flood comport of the Present (2015)	Id not exceed natura eld into estuary to ma nents differ by no ma	al and seasonal distr aintain present mout ore than 10% (in terr	ibution should not h state and salinity ms of magnitude,		
Sedime	ent 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:							
В	Mouth open condi	tions should b	be maintained within t	he current range: 26	6% (± 5%).			
Water o	uality: Salinity							
В	The system needs reaches during the	variability in low flow sea	salinity regime, with a son. Mid-waters in the	a measurable increa ne lower reaches sh	se in salinity in the lo ould exceed 10 (to b	ower and middle be confirmed).		
Water o	quality: Other							
	Ecosystem healt	h:			Recreational use:	Yes		
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).							
Macrop	ohytes (plants)							
D♠	 Maintain the di macrophyte ha Maintain the in banks. Prever Area covered balgae (e.g. Ent algae (e.g. Ent Control the spr Spanish reed, Prevent algal balance 	stribution of c bitats which a tegrity of the it further distu- y invasive wa eromorpha, L ead of invasiv black wattle, I blooms and re m further WW	current macrophyte ha accounts for natural c riparian zone. No fur urbance and developr aterweeds (e.g. water Jlva, Cladophora) sho ve plants in the riparia Brazilian pepper tree) eed encroachment wh /TW input.	abitats (< 20% chang thanges due to the d ther bare patches or nent of the floodplair r hyacinth, <i>Azolla filit</i> buld cover < 50% of an zone. Invasive pl) cover < 5% of total ich are likely to beco	ge in the area covere lynamic nature of es r unvegetated, cleare n habitat. <i>culoides</i>) and nuisar water surface area. lants (e.g. syringa be macrophyte area.	ed by different tuaries). ed areas along the ice filamentous erry, Casuarina, e to nutrient		

Inverts

PES:		C/D	REC:	В	TEC:	С		
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 <i>A. natalensis</i> and <i>P. hessei.</i> Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab <i>H. projectum</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) are dominated by <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. Invasive alien species do not dominate macrobenthos. 							
Fish								
D	As samplec 10 spec Estuarir G. callic trip). P. comr Pelagic No alier	I by seine and gill ne ies should occur to i ne resident species s ine resident and estua dus, M. capensis and mersonni should be s piscivores should oc n fish species should	et in open waters: nclude freshwater, e should comprise a m arine dependant mai d <i>R. holubi</i> should oc sampled with 60% fr ccur.	estuarine resident an inimum of three spea rine fishes should do cur with 100% frequ equency of occurren	d estuarine dependa cies. ominate catches by a ency of occurrence (ice.	nt marine fishes. bundance. every sampling		

- Fish should be free of lesions and other anomalies related to water quality. No fish kills should occur. -
- .

5.5 **INTSHAMBILI RQOs**

F	PES:	С	REC:		В	TEC:		С		
Compor Impr Parti Prev Howeve The deg	 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 (MC	CM)			pMAR (MCM)				
		6.48				4.86				
Е	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).									
Sedime	ent process	es:								
С	 The floo The sus sedime estuary Change deviate middle 	od regime maintains spended sediment co nt load-discharge rel do not differ significa es in tidal amplitude o es in sediment grain s s by less than a facto and upper reaches d	the sediment distribution oncentration from rive ationship (to be dete antly from present (± of less than 20% from size distribution patte or of two from preser lo not change by more	ution er inf rmin 0.5 n pre erns erns nt lev re tha	patterns and aq low does not de ed). The sedim m) (to be detern esent (to be deter similar to preser els (to be deterr an 20% from Pre	uatic habitat (instrea viate by more than 2 entation and erosion nined). mined). nt. The median bed nined). The sand/m esent State over a fin	im phy 20% of patte sedim ud dis /e yea	vsical habitat). f the present rns in the ent diameter stributions in ar average.		
Mouth s	state:									
D	Mouth oper	n conditions should b	e maintained within	the c	current range: 42	2% (± 5%).				
Water o	uality: Sali	nity								
В	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 o	uality: Oth	er								
	Ecosysten	n health:				Recreational use:		Yes		
с т	Water qual	ity poses risk to REC	C/TEC, sufficiently re	duce	d if:	Microbiology: Suffi	cient l	evels (DEA,		

F	PES:	С	REC:	В	TEC:	С				
	 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). 									
Macrop	Macrophytes (plants)									
с	 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										
В	 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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum and</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i> and <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. 									
Fish										
с	As sample 13 spec Estuari <i>Estuari</i> <i>G. calli</i> trip). <i>P. com</i> Pelagic No alie Fish sh No fish	d by seine and gill ne cies should occur to i ne resident species s ne resident and estu- dus, <i>M. capensis</i> and <i>mersonni</i> should be piscivores should oc n fish species should ould be free of lesior kills should occur.	et in open waters: include freshwater, e should comprise a mi arine dependant mar d <i>R. holubi</i> should oc sampled with 60% fre ccur. I occur. hs and other anomali	stuarine resident and inimum of four specie ine fishes should dor cur with 100% freque equency of occurrence es related to water qu	d estuarine dependa es. minate catches by a ency of occurrence (ce. uality.	nt marine fishes. bundance. every sampling				

5.6 MZUMBE RQOs

F	PES:	C/D	REC:		С	TEC:	С			
Components that require interventions to achieve the TEC: Restore estuarine riparian habitat.										
Flow:										
PES		nMAR (MC	CM)		pMAR (MCM)					
	58.53				52.78					
В	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).									
Sedime	Sediment processes:									

P	ES:	C/D	REC:	С	TEC:	С					
D	 The floo The sus sedime estuary Change deviate middle 	od regime maintains spended sediment co nt load-discharge rel do not differ significa es in tidal amplitude o es in sediment grain s by less than a facto and upper reaches d	the sediment distribution oncentration from river ationship (to be deter antly from present (± of less than 20% from size distribution patter or of two from present o not change by mo	ution patterns and aq er inflow does not de rmined). The sedime c 0.5 m) (to be determ n present (to be deter erns similar to presen nt levels (to be detern re than 20% from Pre	uatic habitat (instrea viate by more than 2 entation and erosion nined). rmined). t. The median bed nined). The sand/m esent State over a fiv	im physical habitat). 20% of the present patterns in the sediment diameter ud distributions in ve year average.					
Mouth st	tate:										
C	Mouth ope	n conditions should b	e maintained within	the current range: 74	4% (± 10%).						
Water qu	uality: Sali	nity									
В	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 qu	Water quality: Other										
I	Ecosysten	n health:			Recreational use:	Yes					
 Ecosystem nearth: 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 ORE) 											
Macroph	nytes (plan	nts)									
E∱	 Macrophytes (plants) 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. 										
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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum</i>. 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Molluscan assemblage should include bivalves (including <i>E. paupercula</i>) and gastropods (including <i>Natica</i> spp.). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i>, <i>V. litterata</i>, <i>Macrophthalmus</i> sp., Sesarmidae and <i>Uca</i> sp. 										
Fish											
D	As sampled 18 spec Estuarin Estuarin <i>G. callid</i> trip). <i>P. com</i>	d by seine and gill ne cies should occur to i ne resident species s ne resident and estua dus, <i>M. capensis</i> and <i>mersonni</i> and <i>A. japo</i> pisciyores should op	t in open waters: nclude freshwater, e hould comprise a m arine dependant man <i>R. holubi</i> should oc onicas should be san ccur (including <i>Cara</i>)	stuarine resident and inimum of four specie rine fishes should dor cur with 100% freque npled with 60% frequ x spp).	d estuarine dependa es. minate catches by a ency of occurrence (ency of occurrence.	nt marine fishes. bundance. every sampling					
	. ciugio		carding Cardi								

F	PES:	C/D	REC:	С	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	MHLAE	BATSHANE RQC	Ds						
F	PES:	B/C	REC:	A/B	TEC:	В			
Components that require interventions to achieve the TEC: Improve water quality. Partial restoration of estuarine riparian habitat. 									
Flow:	W:								
PES		nMAR (MO	CM)		pMAR (MCM)				
		6.46			6.48				
В	Present band not be com present mo than 10% (ase flows pose a ris promised. Current b puth state and salinity in terms of magnitud	sk to the REC. Flow baseflows should be y regime. The distrib le, timing and variabi	s should not exceed upheld, where possib ution patterns of the lity) from that of the F	natural and seasona ble improved, to the flood components d Present (2015).	al distribution should estuary to maintain iffer by no more			
Sedime	ent process	es:							
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 s	state:								
В	Mouth oper	n conditions should b	be maintained within	the current range: 50	9% (± 5%).				
Water o	quality: Sali	nity							
В	The system reaches du reaches ex	n needs variability in Iring the low flow sea ceed 10 (to be confi	salinity regime, with ason. Mid-waters in t rmed).	a measurable increas he lower reaches sho	se in salinity in the loould exceed 20 and	ower and middle that of the middle			
Water o	quality: Oth	er							
	Ecosysten	n 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). 								
Macrop	ohytes (plan	its)							
¢↑	 Macrophytes (plants) 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							
¢∱	 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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum and</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i> and <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. 								
Fish									
C↑	As sampled 18 spec Estuarin <i>G. callid</i> trip). <i>P. comi</i> Pelagic No alier Fish sho No fish	d by seine and gill ne cies should occur to ne resident species s ne resident and estu <i>dus, M. capensis</i> and <i>mersonni</i> should be piscivores should or n fish species should ould be free of lesior kills should occur.	et in open waters: include freshwater, e should comprise a mi arine dependant mar d <i>R. holubi</i> should oc sampled with 80% fre ccur (including <i>Carar</i> d occur. hs and other anomali	stuarine resident and inimum of five specie ine fishes should do cur with 100% freque equency of occurrent ox spp.). es related to water q	d estuarine dependa es. minate catches by al ency of occurrence (ce. juality.	nt marine fishes. bundance. every sampling			

5.8 MHLUNGWA RQOs

	PES:	С	REC:		С	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	PES nMAR (MCM) pMAR (MCM)								
	5.78 5.67								
В	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).								
Sedime	ent process	es:							
ш	 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:								
В	Mouth oper	n conditions should b	e maintained within	the c	urrent range: 2	9% (± 10%).			
Water o	quality: Sali	nity							
В	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 o	quality: Othe	er							
	Ecosystem	n health:				Recreational use	:	Yes	
С	 DIN: Fre DIP: Fre DO: Ent 	eshwater inflow, 50% eshwater inflow, 50% tire estuary, average	bile < 0.3 mg/l. bile < 0.025 mg/l. <u>> 4</u> mg/l.			Microbiology: Suff 2012).	icient leve	⊎ls (DEA,	

PES:		С	REC:	С	TEC:	С				
	 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). 									
Macrop	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, Spanich read, black wattle, Brazilian penner 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 <i>A. natalensis</i> and <i>P. hessei</i>. Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab <i>H. projectum</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) are dominated by <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. 									
Fish										
D	As sample 10 spec Estuari Estuari <i>G. calli</i> trip). <i>P. com</i> Pelagic No alie Fish sh No fish	d by seine and gill ne cies should occur to i ne resident species s ne resident and estua dus, <i>M. capensis</i> and <i>mersonni</i> should be s piscivores should oc n fish species should ould be free of lesion kills should occur	et in open waters: include freshwater, e should comprise a m arine dependant mar d <i>R. holubi</i> should oc sampled with 60% fre ccur. l occur. is and other anomali	stuarine resident and inimum of three spec ine fishes should dor cur with 100% freque equency of occurrenc es related to water qu	estuarine dependa ies. ninate catches by a ncy of occurrence (e. uality.	nt marine fishes. bundance. every sampling				

5.9 MFAZAZANA RQOs

F	PES:	С	REC:	В	TEC:	С		
 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:								
	nMAR (MCM) pMAR (MCM)							
PES	_	nMAR (MC	SM)		PMAR (MCM)			
PES		nMAR (MC 2.77	SM)		рмак (мсм) 2.57			
B	Present ba not be comp salinity regin magnitude,	nMAR (MC 2.77 se flows pose a ris promised. Current b me. The distribution timing and variability	CM) Isk to the REC. Flows baseflows should be to a patterns of the flood y) from that of the Pro-	s should not exceed upheld into estuary t components differ l esent (2015).	pMAR (MCM) 2.57 natural and seasona o maintain present n by no more than 10%	al distribution should nouth state and 6 (in terms of		

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F	PES:	С	REC:	В	TEC:	С				
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 s	Mouth state:									
С	C Mouth open conditions should be maintained within the current range: 24% (\pm 5%).									
Water o	Water quality: Salinity									
В	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 o	uality: Oth	er								
	Ecosysten	n health:			Recreational use:	Yes				
D	Water qual DIN: Fr DIP: Fr DO: En Turbidit Toxic subst Substan as per S (DWAF Substan targets Secreta	ity poses risk to REC eshwater inflow, 50% eshwater inflow, 50% tire estuary, average y: Estuary, clear (< 1 tances: nce concentrations in SA Water Quality Gu , 1995). nce concentrations in as per WIO Region g triat and CSIR, 2009	TEC, sufficiently re 5ile < 0.2 mg/l (high is) $ile < 0.015 mg/l (high isk).0 NTU)$ accept during a estuarine waters not idelines for coastal ro- a estuarine sediment guidelines (UNEP/Nat) 0	duced if: risk). h risk). ng high inflow events. of to exceed targets narine waters not to exceed airobi Convention	Microbiology: Suffi 2012).	cient levels (DEA,				
Macrop	hytes (plan	nts)								
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 <i>A. natalensis</i> and <i>P. hessei</i>. Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab <i>H. projectum</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) are dominated by <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. Invasive alien species do not dominate macrobenthos. 									
Fish										
D	As sampled 10 spec Estuarin Estuarin <i>G. callid</i> trip). <i>P. comi</i> Pelagic No alier Eisb sh	d by seine and gill ne cies should occur to i ne resident species s ne resident and estua <i>dus, M. capensis</i> and <i>mersonni</i> should be s piscivores should oc n fish species should ould be free of lesion	t in open waters: nclude freshwater, e should comprise a m arine dependant man <i>R. holubi</i> should oc sampled with 60% fre ccur. occur.	stuarine resident and inimum of three spec rine fishes should dor cur with 100% freque equency of occurrence es related to water of	l estuarine dependa ies. minate catches by a ency of occurrence (ce.	nt marine fishes. bundance. every sampling				

Classification, Reserve and RQOs in the MVoti to Umzimkulu WMA										
	PES:	С	REC:	В	TEC:	С				
	 No fish 	kills should occur.								
5.10 KWA-MAKOSI RQOs										
	PES:	B/C	REC:	В	TEC:	В				
 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:	w:									
PES	nMAR (MCM) pMAR (MCM)									
		3.23			3.03					
в	Flows shou should be u the flood co Present (20	Id not exceed natura upheld into estuary to omponents differ by 1 015).	al and seasonal distril o maintain present me no more than 10% (in	oution should not be outh state and salinit terms of magnitude,	compromised. Curr y regime. The distri timing and variabili	ent baseflows bution patterns of ty) from that of the				
Sedim	ent process	es:								
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:									
В	Mouth oper	n conditions should b	be maintained within t	he current range: 37	% (± 5%).					
Water	quality: Sali	nity								
В	The system reaches du confirmed).	n needs variability in ring the low flow sea	salinity regime, with a son. Mid-waters in th	a measurable increas ne lower reaches sho	se in salinity in the lo buld be between 5 a	ower and middle nd 10 (to be				
Water	quality: Othe	er								
	Ecosystem	n 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). 									
Macro	phytes (plan	ts)								
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	6									
¢∱	As sampled Populat more th	d by plankton net, gra ion abundances of p an 30%.	ab and dip nets/traps lankton and benthic a	(as appropriate): assemblages (baselir	nes to be set) should	d not deviate by				
Р	ES:	B/C	REC:	В	TEC:	В				
------	--	--	--	--	---	--	--	--	--	--
	 Zooplankton should be dominated by estuarine copepods <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum and</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i> and <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. Invasive alien species should not occur in abundance. 									
Fish										
C♠	As sampled 18 spec Estuarir <i>G. callic</i> trip). <i>P. comr</i> Pelagic No alier	d by seine and gill ne ties should occur to the resident species s the resident and estu dus, M. capensis and mersonni should be piscivores should on thish species should on	et in open waters: nclude freshwater, e should comprise a m arine dependant mar d <i>R. holubi</i> should oc sampled with 80% fro ccur (including <i>Carar</i> l occur.	estuarine resident and inimum of five specie rine fishes should do cur with 100% freque equency of occurrence ax spp.).	d estuarine dependa es. minate catches by al ency of occurrence (ce.	nt marine fishes. bundance. every sampling				

- Fish should be free of lesions and other anomalies related to water quality.
- No fish kills should occur.

5.11 MNAMFU RQOs

	PES:	С	REC:	С	TEC:		С	
Key cor Bas Main Main	mponents th eflows to es ntain water o ntain of estu	at require protection tuary to maintain mo quality. arine riparian habita	to maintain the TEC: uth state and salinity	profile.				
Flow:								
PES		nMAR (MO	CM)		pMAR (MCM)			
		3.08			2.88			
В	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).							
Sedime	ent process	ses:						
С	 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:							
В	Mouth ope	n conditions should b	be maintained within	the current range: 42	2% (± 10%).			
Water of	quality: Sali	inity						
В	The system reaches du confirmed)	n needs variability in rring the low flow sea	salinity regime, with a son. Mid-waters in t	a measurable increa he lower reaches sho	se in salinity in the l ould be between 5 a	ower and ind 10 (to	l middle) be	
Water of	quality: Oth	er						
	Ecosyster	n health:			Recreational use	:	N/A	
D	Water qual DIN: Fr DIP: Fr DO: En	ity poses risk to REC eshwater inflow, 50% eshwater inflow, 50% tire estuary, average	C/TEC, sufficiently rec 6 = 0.3 mg/l (high r 6 = 0.025 mg/l (high 2 = 4 mg/l (high risk).	Juced if: isk). h risk). a high inflow events.	ced if: (). isk). Not identified as recreational area in stakeholder meeting.			

F	PES:	С	REC:	С	TEC:	С			
	Toxic subst Substa as per (DWAF Substa targets Secreta	itances: nce concentrations ir SA Water Quality Gu 7, 1995). nce concentrations ir as per WIO Region ariat and CSIR, 2009	n estuarine waters no idelines for coastal n n estuarine sediment guidelines (UNEP/Na).	ot to exceed targets narine waters not to exceed hirobi Convention					
Macrop	Macrophytes (plants)								
с	 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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum and</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i> and <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. 								
Fish									
D	As sample 13 spec Estuari Estuari <i>G. calli</i> trip). <i>P. com</i> Pelagic No alie Fish sh No fish	d by seine and gill ne cies should occur to ne resident species s ne resident and estu dus, <i>M. capensis</i> and <i>mersonni</i> should be piscivores should oc n fish species should ould be free of lesior kills should occur.	et in open waters: include freshwater, e should comprise a mi arine dependant mar d <i>R. holubi</i> should oc sampled with 60% fre ccur. I occur. hs and other anomali	stuarine resident and inimum of four specie ine fishes should dor cur with 100% freque equency of occurrenc es related to water qu	l estuarine dependa es. ninate catches by a ency of occurrence (ee. uality.	ant marine fishes. bundance. (every sampling			

5.12 MTWALUME RQOs

F	PES:	С	REC:		С	TEC:	С		
Key con Base Mair Mair	 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)				
	57.60					41.79			
В	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).								
Sedime	ent process	es:							
С	• 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								

F	PES:	С	REC:	С	TEC:	С			
	estuary Change Change Change deviates middle	do not differ significates in tidal amplitude of es in sediment grain s s by less than a facto and upper reaches d	antly from present (± of less than 20% fror size distribution patte or of two from preser to not change by mo	0.5 m) (to be determ n present (to be dete erns similar to preser nt levels (to be deterr re than 20% from Pre	nined). rmined). nt. The median bed nined). The sand/m esent State over a fiv	sediment diameter ud distributions in ve year average.			
Mouth	state:								
С	Mouth oper	n conditions should b	be maintained within	the current range: 71	I% (± 10%).				
Water o	quality: Sali	nity							
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 o	Water quality: Other								
	Ecosystem health: Recreational use: Yes								
с	 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). 								
Macrop	hytes (plan	its)							
с	 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, Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Control the spread of invasive plants in the riparian zone. Invasive plants (e.g. syringa berry, Casuarina, Control the spread backwards (e.g. syringa berry, Casuarina, Control the spread (e.g. syringa berry, Casuarina, Control the spread (e.g. syringa berry, Casuarina, Co								
Inverts									
С	 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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum</i>. 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Molluscan assemblage should include bivalves (including <i>E. paupercula</i>) and gastropods (including <i>Natica</i> spp.). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i>, <i>V. litterata</i>, <i>Macrophthalmus</i> sp., Sesarmidae and <i>Uca</i> sp. 								
Fish	-								
С	As sampled 18 spec Estuarir <i>G. callid</i> trip). <i>P. comr</i> Pelagic No alier Fish sho No fish	d by seine and gill ne- cies should occur to in the resident species so the resident and estua dus, M. capensis and mersonni and A. japo piscivores should oc in fish species should ould be free of lesion kills should occur.	et in open waters: include freshwater, e should comprise a m arine dependant man d <i>R. holubi</i> should oc conicas should be san ccur (including <i>Caran</i> d occur. ns and other anomali	estuarine resident and inimum of four specie rine fishes should do ccur with 100% freque npled with 60% frequ nx spp). ies related to water q	d estuarine dependa es. minate catches by a ency of occurrence (ency of occurrence. uality.	nt marine fishes. bundance. every sampling			

5.13 MVUZI RQOs

	PES:	С	REC:		С	TEC:	С		
Key co	mponents th	at require protection	to maintain the TEC:						
 Bas Mai 	eflows to es ntain water o	tuary to maintain mo quality.	outh state and salinity	profile.					
• Mai	ntain of estu	arine riparian habita	t.						
Flow:				_					
PES		nMAR (MO	CM)			pMAR (MCM)			
		1.65	al and account distrib	hution	hould not be	1.55	reat becefour		
В	should be the flood co Present (20	upheld into estuary to omponents differ by 015).	o maintain present mo no more than 10% (in	outh stant	ate and salini of magnitude	ty regime. The distr , timing and variabil	ibution patterns of ity) from that of the		
Sedim	ent process	es:							
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:								
С	Mouth ope	n conditions should b	pe maintained within t	the cur	ent range: 2	3% (± 5%).			
Water	quality: Sali	inity							
В	The systen reaches du	n needs variability in uring the low flow sea	salinity regime, with a son. Mid-waters in the	a meas he lowe	urable increa er reaches sh	ase in salinity in the l would exceed 5 (to be	ower and middle e confirmed).		
Water	quality: Oth	er				-			
С	 DIN: Fr DIP: Fr DO: En Turbidit Toxic subs Substatas per 3 (DWAF Substatatargets Secreta 	n health: eshwater inflow, 50% eshwater inflow, 50% tire estuary, average ty: Estuary, clear (< 1 tances: nce concentrations ir SA Water Quality Gu 5, 1995). nce concentrations ir as per WIO Region f ariat and CSIR, 2009	%ile < 0.3 mg/l. %ile < 0.025 mg/l. e ≥ 4 mg/l. 10 NTU) accept durin n estuarine waters no iidelines for coastal m n estuarine sediment guidelines (UNEP/Na).	ng high i ot to exc narine v not to e not to e	nflow events reed targets vaters exceed privention	Recreational use	: N/A		
Macro	ohytes (plar	nts)							
С	 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	;								
С	 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 <i>A. natalensis</i> and <i>P. hessei</i>. Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab <i>H. projectum</i> and insect taxa. Chironomid larvae and oligochaetes should not and Macrobrachium) prawns should occur. Sandprawn <i>C. kraussis</i> bould accur in sandu aroos is the sustant lower reaches (to be confirmed). 								

	PES:	С	REC:	С	TEC:	С				
	 Large brachyuran crabs (macrocrustacea) are dominated by <i>V. litterata.</i> Molluscan assemblage should include bivalves and gastropods. Invasive alien species do not dominate macrobenthos. 									
Fish	ish									
С	As sampled 10 spec Estuarir <i>G. callid</i> trip). <i>P. comi</i> Pelagic No alier Fish sho	d by seine and gill ne cies should occur to i ne resident species s dus, <i>M. capensis</i> and <i>mersonni</i> should be s piscivores should oc n fish species should ould be free of lesion kills should occur.	et in open waters: nclude freshwater, e should comprise a m arine dependant mai I <i>R. holubi</i> should oc sampled with 60% fre ccur.	estuarine resident and inimum of three spec rine fishes should do cur with 100% freque equency of occurrence es related to water q	d estuarine dependa cies. minate catches by al ency of occurrence (ce. uality.	nt marine fishes. oundance. every sampling				

5.14 FAFA RQOs

F	PES:	C/D	REC:		С	TEC:	C	;
Compor	nents that re	equire interventions to	o achieve the TEC:					
Flow:								
PES		nMAR (MO	CM)			pMAR (MCM)		
		46.45				37.64		
С	Flows shou should be u the flood co Present (20	uld not exceed natura upheld into estuary to omponents differ by i 015).	al and seasonal distri o maintain present m no more than 10% (ir	ibutic iouth n terr	on should not be state and salini ns of magnitude	compromised. Cur ty regime. The distr a, timing and variabil	rent basefl ibution pati ity) from th	ows terns of at of the
Sedime	ent process	es:						
 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:							
С	Mouth ope	n conditions should b	be maintained within	the c	current range: 4	5% (± 10%).		
Water c	quality: Sali	inity						
В	The systen reaches du confirmed)	n needs variability in ıring the low flow sea	salinity regime, with ason. Mid-waters in t	a me the lo	easurable increa ower reaches sh	se in salinity in the l ould be between 10	ower and r and 15 (to	niddle be
Water c	quality: Oth	er						
	Ecosystem	n health:				Recreational use		Yes
С	 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) 							
Macrop	hytes (plar	nts)						
D♠	 Maintai 	n the distribution of c	current macrophyte h	abita	ats (< 20% chan	ge in the area cover	ed by diffe	rent

	PES:	C/D	REC:	С	TEC:	С			
Inverts	 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. 								
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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum and</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i> and <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. 								
Fish									
D	As sample 13 spec Estuari Estuari <i>G. calli</i> trip). <i>P. com</i> Pelagic No alie Fish sh No fish	d by seine and gill ne cies should occur to i ne resident species s ne resident and estu- dus, <i>M. capensis</i> and <i>mersonni</i> should be s piscivores should oc n fish species should ould be free of lesior kills should occur.	t in open waters: nclude freshwater, e should comprise a m arine dependant mar I <i>R. holubi</i> should oc sampled with 60% fre ccur.	estuarine resident and inimum of four speci- rine fishes should do ccur with 100% freque equency of occurren- ies related to water q	d estuarine dependa es. minate catches by al ency of occurrence (ce. quality.	nt marine fishes. bundance. every sampling			

5.15 **MDESINGANE RQOs**

	PES:	D	REC:	D	TEC:	D				
Key cor Base Mair Mair	 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:	Flow:									
PES	ES nMAR (MCM) pMAR (MCM)									
	2.02 2.02									
А	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).									
Sedime	ent process	es:								
Е	 Sediment processes: 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 oper	n conditions should b	e maintained within	the current range: 58	3% (± 10%).			
Water o	quality: Sali	nity						
В	The system reaches du	n needs variability in ring the low flow sea	salinity regime, with son. Mid-waters in t	a measurable increa	se in salinity in the loould exceed 5 (to be	ower and middle e confirmed).		
Water o	quality: Othe	er						
	Ecosystem	n health:			Recreational use:	N/A		
E	Water quali DIN: Fre DIP: Fre DO: Lov Turbidity Toxic substar as per S (DWAF, Substar targets a Secreta	ity poses risk to REC eshwater inflow, 50% wer estuary, average y: Estuary, clear (< 1 tances: nce concentrations in SA Water Quality Gu , 1995). nce concentrations in as per WIO Region g riat and CSIR, 2009	Not identified as re stakeholder meetir	ecreational area in ng.				
Macrop	ohytes (plan	its)						
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								
Е	As samplec Populat more th: Zooplan groups : Macrobu isopods Chirono Carid pr Sandorr	d by plankton net, gra ion abundances of p an 50%. Ikton should be dom such as mysids. Mer enthos should be ab s, tanaids and the cra mid larvae and oligo rawn <i>C. kraussi</i> should occur.	ab and dip nets/traps lankton and benthic inated by estuarine of oplankton occur. undant and dominat b <i>H. projectum and</i> chaetes should not	s (as appropriate): assemblages (baseli copepods <i>A. natalens</i> ed by amphipods and insect taxa. occur in abundance a	ines to be set) shoul sis and <i>P. hessei</i> , bu d polycheates, but sl and should not domi	d not deviate by it include other hould include nate the benthos.		
	 Sandpra Large b 	rachyuran crabs (ma	crocrustacea) shoul	d include S. serrata a	and V. litterata.	ommed).		
	 Mollusc 	an assemblage shou	Ild include bivalves a	and gastropods.				
Fish	1.							
Е	As sampled Six spec Estuarir <i>G. callic</i> trip). <i>P. comr</i> Pelagic No alier Fish sho	d by seine and gill ne cies should occur to ne resident species s dus, <i>M. capensis</i> and <i>mersonni</i> should be s piscivores should oc n fish species should ould be free of lesion	t in open waters: include freshwater, o hould comprise a m <i>R. holubi</i> should oc sampled with 30% fr ccur). occur. s and other anomali	estuarine resident an inimum of three spec cur with 100% freque equency of occurrenc es related to water q	d estuarine dependa ties. ency of occurrence (ce. uality.	ant marine fishes. every sampling		

5.16 SEZELA RQOs

PES:	С	REC:	С	TEC:	С			
Key components tha Baseflows to est Maintain water of Maintain of estu-	at require protection tuary to maintain mo quality. arine riparian habitat	to maintain the TEC uth state and salinity	: y profile.					
Flow:								

F	PES:	С	REC:	С	TEC:	С			
PES		nMAR (MC	CM)		pMAR (MCM)				
		3.92			3.89				
в	Flows shou should be u the flood co Present (20	Id not exceed natura upheld into estuary to omponents differ by r 015).	al and seasonal distrib o maintain present mo no more than 10% (in	ution should not be uth state and salinit terms of magnitude	compromised. Curr y regime. The distri , timing and variabili	rent baseflows bution patterns of ity) from that of the			
Sedime	ent process	es:							
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:								
В	Mouth oper	n conditions should b	be maintained within th	ne current range: 19	% (± 5%).				
Water o	quality: Sali	nity							
В	The system reaches du	n needs variability in ring the low flow sea	salinity regime, with a son. Mid-waters in th	measurable increas e lower reaches sho	se in salinity in the lo ould exceed 10 (to b	ower and middle be confirmed).			
Water o	quality: Oth	er							
	Ecosystem	n health:			Recreational use:	N/A			
Е	 DIN: From DIP: Fr	ty poses risk to REC eshwater inflow, 50% eshwater inflow, 50% tire estuary, average y: Estuary, clear (< 1 tances: nce concentrations ir SA Water Quality Gu , 1995). nce concentrations ir as per WIO Region g riat and CSIR, 2009	71 EC, sufficiently real 6ile < 0.3 mg/l (high ris 6ile < 0.25 mg/l (high ris 6 \ge 4 mg/l (high risk). 10 NTU) accept during 6 estuarine waters not 6 idelines for coastal ma 7 estuarine sediment r 9 guidelines (UNEP/Naii 6).	iced IT: sk). high inflow events. to exceed targets arine waters to to exceed obi Convention	Not identified as re stakeholder meetir	creational area in Ig.			
Macrop	hytes (plan	ts)							
D	 Maintain macrop Maintain banks. No inva Control Spanish Prevent further p 	n the distribution of c hyte habitats which a n the integrity of the Prevent further distu sive floating aquatic the spread of invasin n reed, black wattle, i algal blooms and re proposed WWTW inp	surrent macrophyte ha accounts for natural ch riparian zone. No furt urbance and developm species present in the ve plants in the riparia Brazilian pepper tree) and encroachment that but.	bitats (< 20% chang hanges due to the dy her bare patches or ent of the floodplair e estuary e.g. water n zone. Invasive pla cover < 5% of total may become probl	ge in the area covern ynamic nature of es unvegetated, clear habitat. hyacinth. ants (e.g. syringa be macrophyte area. ematic due to nutrie	ed by different tuaries). ed areas along the erry, Casuarina, ent enrichment from			
Inverts	-								
D	As sampled Populat more th Zooplar Macrob polycha Chirono Penaeid Sandpra Large b Mollusc Invasive	d by plankton net, gra ion abundances of p an 40%. hkton should be dom enthos should be ab letes, the crab <i>H. pro</i> mid larvae and oligo d and carid (Caridina awn <i>C. kraussi</i> shoul rachyuran crabs (ma an assemblage shou e alien species do no	ab and dip nets/traps (lankton and benthic a inated by estuarine co undant and dominated ojectum and insect tax ochaetes should not oc and Macrobrachium) Id occur in sandy area acrocrustacea) are dor uld include bivalves ar ot dominate macroben	as appropriate): ssemblages (baselin pepods <i>A. natalens</i> d by amphipods, but a. ccur in abundance a prawns should occu s in the systems low ninated by <i>V. littera</i> id gastropods. thos.	nes to be set) shoul tis and <i>P. hessei.</i> t should include isop and should not domin ur. ver reaches (to be c <i>ta</i> .	d not deviate by oods, tanaids, nate the benthos. confirmed).			
Fish									
D	As sampled	d by seine and gill ne	et in open waters:						

PES:	С	REC:	С	TEC:	С
10 spec	ies should occur to i	nclude freshwater, e	stuarine resident and	d estuarine dependa	nt 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 same catches).
 - 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

I	PES:	С	REC:		С	TEC:	С		
Key cor Bas Main Main	nponents the eflows to est ntain water o ntain of estu	at require protection tuary to maintain mo quality. arine riparian habitat	to maintain the TEC: uth state and salinity	prof	ïle.				
Flow:									
PES		nMAR (MO	CM)			pMAR (MCM)			
		3.79				3.54			
В	Flows shou should be u the flood co Present (20	Id not exceed natura upheld into estuary to omponents differ by r 015).	al and seasonal distri o maintain present m no more than 10% (ir	butic outh n teri	on should not be state and salini ms of magnitude	e compromised. Cur ty regime. The distr e, timing and variabil	rent baseflov ibution patte ity) from that	ws rns of t of the	
Sedime	ent process	es:							
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:								
В	Mouth oper	n conditions should b	be maintained within	the o	current range: 89	% (± 5%).			
Water o	quality: Sali	nity							
В	The system reaches du	n needs variability in ring the low flow sea	salinity regime, with ison. Mid-waters in t	a me he lo	easurable increa	ase in salinity in the l ould exceed 5 (to be	ower and mi e confirmed)	ddle	
Water o	quality: Oth	er							
	Ecosysten	n health:				Recreational use	:	N/A	
D	Water quali DIN: Fr DIP: Fr DO: En Turbidit Toxic substar as per S (DWAF Substar targets Secreta	ity poses risk to REC eshwater inflow, 50% eshwater inflow, 50% tire estuary, average y: Estuary, clear (< 1 tances: nce concentrations ir SA Water Quality Gu , 1995). nce concentrations ir as per WIO Region g iriat and CSIR, 2009	C/TEC, sufficiently red 6ile < 0.3 mg/l (high risk) = 0.025 mg/l (high risk). 10 NTU) accept during 10 nTU) accept during 10 nTU accept during during 10 nTU accept during during duri	duce risk). h ris ng hig ot to narin not airob	d if: k). gh inflow events exceed targets e waters to exceed i Convention	Not identified as recreational area in stakeholder meeting			
Macrop	ohytes (plan	its)							
D	 Maintain macrop Maintain banks. No inva 	n the distribution of c hyte habitats which a n the integrity of the Prevent further distu sive floating aquatic	current macrophyte h accounts for natural o riparian zone. No fui urbance and developi species present in th	abita chan rther men ne es	ats (< 20% chan ges due to the c bare patches o t of the floodplai stuary e.g. water	ge in the area cover dynamic nature of es r unvegetated, clear n habitat. r hyacinth.	ed by differe stuaries). ed areas alo	nt ng the	

	DEC.	C	DEC.	C	TEC	C				
	PES:	U U	REC:	L L	IEC:	U				
	 Control Spanish Prevent 	the spread of invasion reed, black wattle, t further reed encroa	ve plants in the ripari Brazilian pepper tree chment into the mair	an zone. Invasive pl) cover < 5% of total) water channel.	lants (e.g. syringa be macrophyte area.	erry, Casuarina,				
Invert	nverts									
D	As sampled Populat more th Zooplar Macrob polycha Chirond Penaeid Sandpr Large b Mollusc	d by plankton net, gra ion abundances of p an 40%. hkton should be dom enthos should be ab letes, the crab <i>H. pro</i> omid larvae and oligo d and carid (Caridina awn <i>C. kraussi</i> shou rachyuran crabs (ma an assemblage shou e alien species do no	ab and dip nets/traps lankton and benthic inated by estuarine of undant and dominate ofectum and insect ta ochaetes should not of and Macrobrachium Id occur in sandy are acrocrustacea) are do uld include bivalves a ot dominate macrobe	assemblages (baseli copepods <i>A. natalens</i> ed by amphipods, bu xa. boccur in abundance a prawns should occ as in the systems low cominated by <i>V. littera</i> and gastropods. nthos.	ines to be set) shoul sis and <i>P. hessei.</i> It should include isop and should not domi our. wer reaches (to be c ata.	d not deviate by bods, tanaids, nate the benthos. confirmed).				
Fish										
D	As sampled 10 spec Estuarir <i>G. callic</i> trip). <i>P. comi</i> Pelagic No alier Fish shu	d by seine and gill ne cies should occur to i ne resident species s dus, <i>M. capensis</i> and <i>mersonni</i> should be s piscivores should oc n fish species should ould be free of lesior kills should occur.	et in open waters: nclude freshwater, e should comprise a mi arine dependant mar d <i>R. holubi</i> should oc sampled with 60% fre ccur. l occur. hs and other anomali	stuarine resident and inimum of three spec ine fishes should dor cur with 100% freque equency of occurrenc es related to water q	d estuarine dependa cies. minate catches by a ency of occurrence (ce. uality.	nt marine fishes. bundance. every sampling				

UMUZIWEZINTO (MZINTO) RQOs 5.18

I	PES:	C/D	REC:	C/D	TEC:	C/D			
Key cor ■ Bas ■ Mair ■ Mair	 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:	Flow:								
PES		nMAR (MO	CM)		pMAR (MCM)				
		23.17			20.09				
С	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).								
Sedime	ent process	es:							
D	 The floo The sus sedimel estuary Change deviates middle s 	od regime maintains spended sediment co nt load-discharge rel do not differ significa es in tidal amplitude o es in sediment grain s by less than a facto and upper reaches d	the sediment distribution oncentration from rive ationship (to be dete antly from present (± of less than 20% from size distribution patte or of 2 from present h o not change by more	tion patterns and ac er inflow does not de rmined). The sedim 0.5 m) (to be detern present (to be deter rns similar to preser evels (to be determine e than 20% from Pr	uatic habitat (instrea eviate by more than 2 entation and erosion nined). ermined). nt. The median bed ned). The sand/mud esent State over a 5	Im physical habitat). 20% of the present patterns in the sediment diameter distributions in year average.			
Mouth	state:								
С	Mouth oper	n conditions should b	e maintained within	the current range: 1	5% (± 5%).				
Water o	quality: Sali	nity							
С	The system reaches du	n needs variability in ring the low flow sea	salinity regime, with son. Mid-waters in t	a measurable increa he lower reaches sh	ase in salinity in the loould exceed 5 (to be	ower and middle confirmed).			
Water o	quality: Oth	er							

I	PES:	C/D	REC:	C/D	TEC:	C/D
	Ecosyster	n 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 <u>></u> 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). 						ecreational area in ng.
Macrop	ohytes (plai	nts)				
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 sample Popula more th Zoopla Macrob polycha Chiron Penaei Sandpi Large b Mollusa	d by plankton net, gra tion abundances of p nan 40%. nkton should be dom penthos should be ab aetes, the crab <i>H. pro</i> omid larvae and oligo id and carid (Caridina rawn <i>C. kraussi</i> shou prachyuran crabs (ma can assemblage shou re alien species do no	ab and dip nets/traps ilankton and benthic inated by estuarine of undant and dominate opectum and insect ta ochaetes should not of and Macrobrachium Id occur in sandy are acrocrustacea) are do uld include bivalves a ot dominate macrobe	(as appropriate): assemblages (baselin copepods <i>A. natalens</i> ed by amphipods, but xa. cocur in abundance a cocur in abundance a prawns should occur as in the systems low prinated by <i>V. littera</i> and gastropods. nthos.	nes to be set) shoul is and <i>P. hessei.</i> t should include isop nd should not domir ur. ver reaches (to be c <i>ta</i> .	d not deviate by bods, tanaids, nate the benthos. confirmed).
Fish						
D	As sample 10 spe Estuari <i>G. calli</i> trip). <i>P. com</i> Pelagio No alie Fish sh No fish	d by seine and gill ne cies should occur to i ine resident species s ine resident and estu- idus, <i>M. capensis</i> and <i>mersonni</i> should be c piscivores should oc in fish species should nould be free of lesior kills should occur.	et in open waters: nclude freshwater, e should comprise a m arine dependant mar d <i>R. holubi</i> should oc sampled with 60% fre ccur. l occur. hs and other anomali	stuarine resident and nimum of three speci ine fishes should dor cur with 100% freque equency of occurrenc es related to water qu	estuarine dependa ies. ninate catches by al ncy of occurrence (e. uality.	nt marine fishes. bundance. every sampling

5.19 NKOMBA RQOs

i	PES:	B/C	REC:	B/C	TEC:	B/C			
Key cor ■ Base ■ Mair ■ Mair	 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:	Flow:								
PES		nMAR (MO	CM)	pMAR (MCM)					
		0.69			0.69				
A	Flows shou should be u the flood co	Ild not exceed natura upheld into estuary to omponents differ by i	al and seasonal distri o maintain present m no more than 10% (ii	bution should not be outh state and salini n terms of magnitude	e compromised. Curr ty regime. The distri e, timing and variabili	rent baseflows ibution patterns of ity) from that of the			

	PES:	B/C	REC:	B/C	TEC:	B/C				
	Present (20	015).		·						
Sedime	Sediment processes:									
С	 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:					,				
Α	Mouth ope	n conditions should	be maintained within	the current range: 10	% (± 5%).					
Water o	quality: Sali	nity								
Α	The system reaches du	n needs variability in Iring the low flow sea	salinity regime, with ason. Mid-waters in t	a measurable increas he lower reaches sho	se in salinity in the lov ould exceed 5 (to be o	wer and middle confirmed).				
Water o	quality: Oth	er								
	Ecosyster	n health:			Recreational use:	N/A				
D	Water qual DIN: Fr DIP: Fr DO: En Turbidit Toxic subs Substa as per (DWAF Substa targets Secreta	ity poses risk to REG eshwater inflow, 509 eshwater inflow, 509 tire estuary, average ty: Estuary, clear (< tances: nce concentrations i SA Water Quality Gu , 1995). nce concentrations i as per WIO Region ariat and CSIR, 2009	C/TEC, sufficiently rec %ile < 0.3 mg/l (high r %ile < 0.025 mg/l (high $e \ge 4$ mg/l (high risk). 10 NTU) accept durin n estuarine waters no uidelines for coastal m n estuarine sediment guidelines (UNEP/Na)).	duced if: isk). h risk). g high inflow events. to exceed targets narine waters not to exceed irobi Convention	Not identified as rec stakeholder meeting	reational area in J.				
Macrop	ohytes (plar	nts)								
D	 Maintai macrop Maintai banks. No inva Control Spanisl 	n the distribution of hyte habitats which n the integrity of the Prevent further dist asive floating aquatic the spread of invasi h reed, black wattle,	current macrophyte h accounts for natural or riparian zone. No fur urbance and develop species present in the ive plants in the ripari Brazilian pepper tree	abitats (< 20% chang changes due to the dy rther bare patches or ment of the floodplair ne estuary e.g. water an zone. Invasive pla) cover < 5% of total	le in the area covered ynamic nature of estu unvegetated, cleared habitat. hyacinth. ants (e.g. syringa ber macrophyte area.	d by different uaries). d areas along the ry, Casuarina,				
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 <i>A. natalensis</i> and <i>P. hessei</i>. Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab <i>H. projectum</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) are dominated by <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods (including <i>Melanoides tuberculata</i>). 									
Fish										
с	As sample 15 spec Estuari Estuari <i>G. calli</i> trip). <i>P. com</i> Pelagic	d by seine and gill no cies should occur to ne resident species ne resident and estu <i>dus, M. capensis</i> and <i>mersonni</i> should be piscivores should o	et in open waters: include freshwater, es should comprise a mi iarine dependant mar d <i>R. holubi</i> should occ sampled with 70% fre ccur.	stuarine resident and nimum of four specie ine fishes should don cur with 100% freque equency of occurrenc	estuarine dependan s. ninate catches by abo ncy of occurrence (e e.	t marine fishes. undance. very sampling				

PES:	B/C	REC:	B/C	TEC:	B/C
Fish sho	ould be free of lesior	is and other anomali	es related to water q	uality.	

No fish kills should occur.

5.20 MZIMAYI RQOs

	PES:	C/D	REC:	C/D	TEC: C/D					
Key cor ■ Bas	nponents the	at require protection	to maintain the TEC: uth state and salinity	profile						
 Main Main 	ntain water of	quality. arine rinarian babitat	•	promo.						
Flow:	italii oi esta									
PES		nMAR (MO	CM)		pMAR (MCM)					
		6.15			4.55					
D	Flows shou should be u the flood co Present (20	Ild not exceed natura upheld into estuary to omponents differ by 015).	al and seasonal distri o maintain present m no more than 10% (ir	oution should not b outh state and salin terms of magnitud	e compromised. Curr hity regime. The distri le, timing and variabil	ent baseflows bution patterns of ity) from that of the				
Sedime	Sediment processes:									
С	 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 oper	n conditions should b	be maintained within	he current range: 2	20% (± 5%).					
Water o	quality: Sali	nity								
с	The system reaches du confirmed).	n needs variability in ring the low flow sea	salinity regime, with ason. Mid-waters in t	a measurable incre he lower reaches s	ase in salinity in the I hould be between 0 a	ower and middle and 5 (to be				
Water o	quality: Oth	er								
	Ecosysten	n health:			Recreational use	: Yes				
D	Water qual DIN: Fr. DIP: Fr. DO: En Turbidit Toxic substa as per S (DWAF Substan targets Secreta	ity poses risk to REC eshwater inflow, 50% eshwater inflow, 50% tire estuary, average y: Estuary, clear (< 7 tances: nce concentrations in SA Water Quality Gu , 1995). nce concentrations in as per WIO Region uriat and CSIR, 2009	C/TEC, sufficiently rec 6ile < 0.3 mg/l (high risk) = 2.4 mg/l (high risk). 10 NTU) accept durin 10 estuarine waters non- $10 estuarine sediment mestuarine sediment to 10 estuarine (UNEP/Na)10 estuarine (UNEP/Na)$	Juced if: isk). g high inflow event t to exceed targets harine waters not to exceed irobi Convention	s Microbiology: Suffi 2012).	cient levels (DEA,				
Macrop	ohytes (plan	its)								
С	 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 ■ Populat	d by plankton net, gr ion abundances of p	ab and dip nets/traps blankton and benthic	(as appropriate): assemblages (base	lines to be set) shoul	d not deviate by				

F	PES:	C/D	REC:	C/D	TEC:	C/D			
	 Zooplankton should be dominated by estuarine copepods <i>A. natalensis</i> and <i>P. hessei</i>. Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab <i>H. projectum</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) are dominated by <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. Invasive alien species do not dominate macrobenthos. 								
Fish									
с	As samplec 10 spec Estuarir Estuarir <i>G. callic</i> trip). <i>P. comr</i> Pelagic No alier Fish sho	d by seine and gill ne cles should occur to i ne resident species s ne resident and estua dus, <i>M. capensis</i> and <i>mersonni</i> should be s piscivores should oc n fish species should pould be free of lesior	t in open waters: nclude freshwater, e hould comprise a mi arine dependant mar <i>R. holubi</i> should oc sampled with 60% fre ccur. occur. s and other anomali	stuarine resident and inimum of three spec rine fishes should dor cur with 100% freque equency of occurrenc es related to water qu	I estuarine dependa ies. minate catches by al ency of occurrence (ce. uality.	nt marine fishes. oundance. every sampling			

Pish should be nee of lesions and our
 No fish kills should occur.

5.21 MPAMBANYONI RQOs

F	PES:	С	REC:	С	TEC:	C	;			
Key con Base Mair Mair	 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 (MO	CM)		pMAR (MCM)					
		60.06			55.53					
В	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).									
Sedime	ent process	es:								
D Mouth s	 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. 									
В	Mouth ope	en conditions should	be maintained within	the current range: 78	3% (± 10%).					
Water o	uality: Sali	nity			(, . , . , . , . , . , . , . , . ,					
А	The system reaches du confirmed).	n needs variability in iring the low flow sea	salinity regime, with a son. Mid-waters in the	a measurable increa ne lower reaches sho	se in salinity in the lo ould be between 10	ower and m and 15 (to	niddle be			
Water o	quality: Oth	er								
D	Ecosysten Water qual DIN: Fro DIP: Fro DO: En Turbidit	health: ity poses risk to REC eshwater inflow, 50% eshwater inflow, 50% tire estuary, average ty: Estuary, clear (< 1	C/TEC, sufficiently rec 6ile < 0.3 mg/l (high r 6ile < 0.025 mg/l (high ≥ 4 mg/l (high risk). 10 NTU) accept durin	luced if: isk). n risk). g high inflow events.	Recreational use: Scottborough Microbiology: Suffi 2012).	cient levels	Yes ; (DEA,			

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PE	S:	С	REC:	С	TEC:	С				
т. •	 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). 									
Macrophy	/tes (plar	nts)								
 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										
A D J	 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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum</i>. 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Molluscan assemblage should include bivalves (including <i>E. paupercula</i>) and gastropods (including <i>Natica</i> spp.). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i>, <i>V. litterata</i>, <i>Macrophthalmus</i> sp., Sesarmidae and <i>Uca</i> sp. 									
Fish										
 Fish 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. <i>G. callidus, M. capensis</i> and <i>R. holubi</i> should occur with 100% frequency of occurrence (every sampling trip). <i>P. commersonni</i> and <i>A. japonicas</i> should be sampled with 60% frequency of occurrence. Pelagic piscivores should occur (including <i>Caranx</i> spp). No alien fish species should occur. Fish should be free of lesions and other anomalies related to water quality. 										

6 CENTRAL CLUSTER IUA: ESTUARY RQOs

6.1 MAHLONGWA RQOs

I	PES:	С	REC:	В	TEC:	В				
Compor Prot Impr Part Con	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	pMAR (MCM) pMAR (MCM)									
	13.76 13.18									
В	Flows sho should be the flood c Present (2	uld not exceed natura upheld into estuary to omponents differ by r 015).	al and seasonal distril o maintain present me no more than 10% (in	bution should not be buth state and salin terms of magnitude	e compromised. Cur ity regime. The distr e, timing and variabil	rent baseflows ibution patterns of ity) from that of the				
Sedime	ent process	ses:								
D♠	 The flo The su sedime estuary Chang Chang deviate middle 	od regime maintains spended sediment oc ent load-discharge rel / do not differ significa es in tidal amplitude of es in sediment grain es by less than a factor and upper reaches of	the sediment distribut oncentration from river ationship (to be deter antly from present (± of less than 20% from size distribution patte or of two from presen to not change by mor	tion patterns and ac r inflow does not de mined). The sedim 0.5 m) (to be detern present (to be deter rns similar to prese t levels (to be detern e than 20% from Pr	quatic habitat (instrea eviate by more than 2 ientation and erosion nined). ermined). nt. The median bed mined). The sand/m esent State over a fi	am physical habitat). 20% of the present a patterns in the sediment diameter ud distributions in ve year average.				
Mouth	state:									
Α	Mouth ope	en conditions should b	be maintained within t	he current range: 2	2% (± 5%).					
Water o	quality: Sal	inity								
В	The system reaches du	n needs variability in uring the low flow sea	salinity regime, with a son. Mid-waters in th	a measurable increa ne lower reaches sh	ase in salinity in the I hould exceed 10 (to b	ower and middle be confirmed).				
water o		ier			Descretional					
D↑	Water qua DIN: FI DIP: FI DO: Er Turbidi Toxic subs Substa as per (DWAF Substa targets Secret	lity poses risk to REC reshwater inflow, 50% reshwater inflow, 50% ntire estuary, average ty: Estuary, clear (<1 stances: ince concentrations ir SA Water Quality Gu F, 1995). ince concentrations ir a sper WIO Region of ariat and CSIR, 2009	C/TEC, sufficiently rec $6ile < 0.2 mg/l (high r 6ile < 0.015 mg/l (high 2 \ge 6 mg/l (high risk).0 NTU) accept duringn$ estuarine waters no 1delines for coastal m n estuarine sediment guidelines (UNEP/Na).	luced if: isk). n risk). t high inflow events. t to exceed targets harine waters not to exceed irobi Convention	Microbiology: Suffi 2012).	cient levels (DEA,				
Macrop	ohytes (pla	nts)								
¢∱	 Mainta macrop Mainta Preven No inva Contro Spanis Mainta in non- Improv 	in the distribution of c obyte habitats which a in the integrity of the it further disturbance asive floating aquatic I the spread of invasi h reed, black wattle, in present salinity reg flood year). e salinity regime to e	current macrophyte ha accounts for natural of riparian zone. No ba and development of f species present in th ve plants in the riparia Brazilian pepper tree jime to maintain reed ncourage the reestab	abitats (< 20% chan changes due to the of re patches or unveg che floodplain habita e estuary e.g. wate an zone. Invasive p) cover < 5% of tota and sedge habitats lishment of mangro	nge in the area cover dynamic nature of es getated, cleared area at. r hyacinth. olants (e.g. syringa b I macrophyte area. 6 (< 50% loss of reed ve habitat.	ed by different tuaries). is along the banks. erry, Casuarina, and sedge habitats				
Inverts			-	0						
C∱	As sample	d by plankton net, gra	ab and dip nets/traps	(as appropriate):						

PES:	С	REC:	В	TEC:	В				
 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 <i>A. natalensis</i> and <i>P. hessei</i>. Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab <i>H. projectum</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) are dominated by <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods (including <i>Melanoides tuberculata</i>). Invasive alien species should not occur in abundance. 									
As sample ■ 15 spe ■ Estuar ■ Estuar ■ G. call trip).	ed by seine and gill ne cies should occur to i ine resident species s ine resident and estu <i>idus, M. capensis</i> and	et in open waters: include freshwater, e should comprise a mi arine dependant mar d <i>R. holubi</i> should oc sampled with 70% fre	stuarine resident and inimum of four specie ine fishes should do cur with 100% freque	d estuarine dependa es. minate catches by al ency of occurrence (ce	nt marine fishes. bundance. every sampling				

- Pelagic piscivores should occur.
- No alien fish species should occur.
 Fish should be free of lesions and compared to the state of the stat
- Fish should be free of lesions and other anomalies related to water quality.
- No fish kills should occur.

6.2 MAHLONGWANE RQOs

	PES:	С	REC:	В	TEC: B				
Compo Prot Imp Part	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 (MO	CM)		pMAR (MCM)				
		2.69			2.93				
В	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).								
Sedime	ent process	es:							
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 reacters do not change by more than 20% from Present State over a five year average. 								
Mouth	state:								
В	Mouth ope	n conditions should t	pe maintained within	the current range: 13	8% (± 5%).				
Water of	quality: Sali	inity							
В	The systen reaches du	n needs variability in uring the low flow sea	salinity regime, with a son. Mid-waters in t	a measurable increas he lower reaches sho	se in salinity in the lo ould exceed 10 (to b	ower and be confirm	middle ned).		
Water of	quality: Oth	er							
	Ecosystem	n health:			Recreational use:		Yes		
D♠	Water qual DIN: Fr DIP: Fr DO: En Turbidit	ity poses risk to REC eshwater inflow, 50% eshwater inflow, 50% itire estuary, average ty: Estuary, clear (<	2/TEC, sufficiently red 6ile < 0.2 mg/l (high r 6ile < 0.015 mg/l (hig' ≥ <u>> 6</u> mg/l (high risk). 10 NTU) accept durin	duced if: isk). h risk). ng high inflow events.	Microbiology: Sufficient levels (DEA, 2012).				

	PES:	С	REC:	В	TEC:	В		
 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). 								
Macrop	ohytes (pla	nts)						
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 <i>Hibiscus tiliaceus</i> 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 <i>A. natalensis</i> and <i>P. hessei</i>. Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab <i>H. projectum</i> and insect taxa. Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthor Penaeid and carid (Caridina and Macrobrachium) prawns should occur. Sandprawn <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) are dominated by <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods (including <i>Melanoides tuberculata</i>). 							
Fish								
¢	As sample 15 spe Estuari <i>G. calli</i> trip). <i>P. com</i> Pelagio No alie Fish sh No fish	d by seine and gill ne cies should occur to i ine resident species s ine resident and estu- idus, <i>M. capensis</i> and <i>mersonni</i> should be c piscivores should oc en fish species should hould be free of lesior hills should occur.	et in open waters: include freshwater, e should comprise a mi arine dependant mar d <i>R. holubi</i> should oc sampled with 70% fre ccur. I occur. hs and other anomali	stuarine resident and inimum of four specie rine fishes should dor cur with 100% freque equency of occurrenc es related to water q	d estuarine dependa es. minate catches by a ency of occurrence ce. uality.	ant marine fishes. Ibundance. (every sampling		

6.3 uMKHOMAZI RQOs

PES:	С	REC:	B (Remove Weir)	TEC:	B/C (Leave weir)						
Key components tha Remove sandmi Restoration of ve Curb recreationa	 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 To achieve the REC Restore estuarin Restore baseflow 	cast netting in the m : he habitat through the ws to estuary. (Only	nouth area. e relocation/removal possible by building	of Sappi Weir. 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 m³/s.

Component/ Indicator	TEC	RQO
		 Monthly river inflow > 2.0 m³/s persists for longer than three months in a row. Monthly river inflow > 5.0 m³/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	С	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. Trace metals (to be determined). Pesticides/herbicides (to be determined). Minimum requirement for recreational use (DEA, 2012): <i>Enterococci:</i> Ninety percentile (90%ile) over a 12 month running period ≤ 185 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): Naturally turbid. PH: Average 7.0 - 8.5 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 (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.
Sediment dynamics	в	 Total metal concentration in sediment not to exceed target values as per who Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009). 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).
Microalgae	в	 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 m² 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	в	 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 occurrence of <i>Paratylodiplax blephariskios</i> 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	с	 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

F	PES: C	REC:	С	TEC:	С						
Key cor	nponents that require prot	ection to maintain the TEC	: . profile								
 Dase Mair Mair 	 Maintain water quality. Maintain of estuarine riparian habitat. 										
Flow:											
PES	nM	AR (MCM)		pMAR (MCM)							
		3.83		4.30							
В	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).										
Sedime	ent 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 reachers do not depage by more than 20% from Present State over a five very endinger. 										
Mouth	state:										
С	Mouth open conditions s	nould be maintained within	the current range: 54	4% (± 5%).							
Water o	quality: Salinity										
с	The system needs varial reaches during the low fl confirmed).	ility in salinity regime, with ow season. Mid-waters in	a measurable increa the lower reaches sh	ise in salinity in the l ould be between 5 a	ower and middle and 10 (to be						
Water o	quality: Other										
	Ecosystem health:			Recreational uses	: Yes						
С	 DIN: Freshwater inflo DIP: Freshwater inflo DO: Entire estuary, a Turbidity: Estuary, cle Toxic substances: Substance concentra as per SA Water Qua (DWAF, 1995). Substance concentra targets as per WIO R Secretariat and CSIR 	w, 50%ile <0.3 mg/l. w, 50%ile <0.025 mg/l. verage \geq 4 mg/l. ar (<10 NTU) accept durin tions in estuarine waters ne lity Guidelines for coastal r tions in estuarine sediment egion guidelines (UNEP/N c, 2009).	ig high inflow events. ot to exceed targets marine waters t not to exceed airobi Convention	Microbiology: Suffi 2012).	Microbiology: Sufficient levels (DEA, 2012).						
Macrop	ohytes (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. <i>Bruguiera gymnorrhiza</i>). Prevent disturbance and further reed encroachment into the main water channel. 										
Inverts											
D	 As sampled by plankton Population abundance more than 40%. Zooplankton should be groups such as mysic Macrobenthos should isopods, tanaids and 	net, grab and dip nets/traps es of plankton and benthic be dominated by estuarine ds. Meroplankton are abur be abundant and dominat the crap <i>H. projectum and</i>	s (as appropriate): assemblages (baseli copepods <i>A. natalens</i> idant. red by amphipods and insect taxa.	ines to be set) shoul s <i>is</i> and <i>P. hessei</i> , bu d polycheates, but s	d not deviate by ut include other hould include						

	PES:	С	REC:	С	TEC:	С					
	 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i> and <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. Invasive alien species do not dominate macrobenthos. 										
Fish											
D	As sampled 13 spec Estuarir Estuarir <i>G. callid</i> trip). <i>P. comi</i> Pelagic No alier Fish sho No fish	d by seine and gill ne bies should occur to i ne resident species s dus, <i>M. capensis</i> and <i>mersonni</i> should be s piscivores should oc n fish species should ould be free of lesion kills should occur.	et in open waters: nclude freshwater, e should comprise a m arine dependant mai d <i>R. holubi</i> should oc sampled with 60% fre ccur. l occur. hs and other anomali	stuarine resident and inimum of four specie rine fishes should do cur with 100% freque equency of occurrence es related to water q	d estuarine dependa es. minate catches by al ency of occurrence (ce. uality.	nt marine fishes. bundance. every sampling					

6.5 UMGABABA RQOs

F	PES: C		REC:		В	B TEC: B/C					
Compor ■ Impr ■ Parti	Components that require interventions to achieve the TEC: Improve water quality. Partial restoration of estuarine habitat.										
Flow:	Flow:										
PES		nMAR (Me	CM)			pMAR (MCM)				
		10.56				9.58					
с	Present band not be com salinity reg magnitude,	ase flows pose a ris promised. Current b ime. The distributior , timing and variabilit	Sk to the REC. Flow baseflows should be a patterns of the flood y) from that of the Pr	s shou upheld d comp resent (ld not exceed into estuary t onents differ l (2015).	natural and season o maintain present by no more than 10	nal distribu mouth sta % (in tern	ution should ate and ns of			
Sedime	nt process	es:									
с	 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 over actions. 										
Mouth s	state:										
С	Mouth ope	n conditions should l	be maintained within	the cu	rrent range: 40	6% (± 5%).					
Water q	uality: Sali	inity									
В	The systen low flow se exceed 10	n needs variability in eason. Mid-waters in and 5 respectively (t	salinity regime, with the lower reaches s to be confirmed).	a mea hould e	surable increa exceed 15, wh	use in salinity in the ile the middle and	system d upper read	uring the ches should			
Water q	uality: Oth	er									
	Ecosysten	n health:				Recreational us	9:	Yes			
¢∱	Water qual DIN: Fr DIP: Fr DO: En Turbidit Toxic subs Substan as per S (DWAF Substan	ity poses risk to REC eshwater inflow, 50% eshwater inflow, 50% tire estuary, average ty: Estuary, clear (<1 tances: nce concentrations in SA Water Quality Gu , 1995). nce concentrations in	C/TEC, sufficiently re 6ile < 0.2 mg/l (high 6ile < 0.015 mg/l (high $2 \ge 6$ mg/l (high risk). 0 NTU) accept durin 10 = 1000 estuarine waters no 1000 idelines for coastal r 1000 estuarine sediment	duced risk). Jh risk). g high ot to ex narine t not to	if: inflow events. ceed targets waters exceed	Microbiology: Suf 2012)	ficient lev	els (DEA,			

	PES:	С	REC:	В	TEC:	B/C		
	targets Secreta	as per WIO Region (ariat and CSIR, 2009	guidelines (UNEP/Na).	irobi Convention				
Macrop	ohytes (plan	nts)			•			
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 (<i>Ruppia</i> and <i>Zostera</i>) used to occur in this estuary. The large <i>Juncus kraussii</i> 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	·		0	0				
C↑	As sampled Populat more th Zooplar groups Macrob isopods Chirono Penaeid Sandpr Large b Molluso Invasive	d by plankton net, gra tion abundances of p an 30%. hkton should be dom such as mysids. Mer enthos should be ab s, tanaids and the cra omid larvae and oligo d and carid (Caridina awn <i>C. kraussi</i> shou orachyuran crabs (ma can assemblage shou e alien species shou	ab and dip nets/traps lankton and benthic roplankton are abunc undant and dominate ab <i>H. projectum and</i> i pchaetes should not o and Macrobrachium Id occur in sandy are acrocrustacea) should uld include bivalves a Id not occur in abund	(as appropriate): assemblages (baseli copepods <i>A. natalens</i> lant. ed by amphipods and nsect taxa. occur in abundance a) prawns should occi as in the systems lov d include <i>S. serrata</i> a und gastropods. ance.	nes to be set) shoul sis and <i>P. hessei</i> , bu d polycheates, but sl and should not domi ur. wer reaches (to be c and <i>V. litterata</i> .	d not deviate by It include other hould include nate the benthos. confirmed).		
Fish								
¢∱	As sampled 18 spec Estuarin <i>G. callid</i> trip). <i>P. comi</i> Pelagic No alice	d by seine and gill ne cies should occur to i ne resident species s ne resident and estua dus, <i>M. capensis</i> and <i>mersonni</i> should be s piscivores should or n fish species should	et in open waters: nclude freshwater, e should comprise a mi arine dependant mar d <i>R. holubi</i> should occ sampled with 80% fre ccur (including <i>Caran</i> l occur.	stuarine resident and nimum of five specie ine fishes should dor cur with 100% freque equency of occurrenc ix spp.).	d estuarine dependa is. minate catches by a ency of occurrence (ce.	nt marine fishes. bundance. every sampling		

- Fish should be free of lesions and other anomalies related to water quality.
- No fish kills should occur.

6.6 MSIMBAZI RQOs

F	PES:	В	REC:		Α	TEC:	В			
Key con Base Mair Mair	 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:	Flow:									
PES		nMAR (MO	CM)			pMAR (MCM)				
	10.04				10.34					
Α	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).									
Sedime	nt process	es:								
с	 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					TEC:	В				
	 Change Change deviate middle 	es in tidal amplitude o es in sediment grain s s by less than a facto and upper reaches d	of less than 20% from size distribution patte or of two from preser o not change by mo	n present (to be deter erns similar to presen at levels (to be determ re than 20% from Pre	rmined). t. The median bed s nined). The sand/m sent State over a fiv	sediment diameter ud distributions in /e year average.				
Mouth s	state:									
Α	Mouth ope	n conditions should b	e maintained within	the current range: 36	i% (± 5%).					
Water quality: Salinity										
В	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										
	Ecosystem	n health:			Recreational use:	Yes				
C Water quality poses risk to REC/TEC, sufficiently reduced if: Iter outcome accident						cient levels (DEA,				
Macrop	hytes (plar	nts)								
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). 									
Inverts										
в	 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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum and</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i> and <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. Invasive alien species should not occur in abundance. 									
Fish	1									
С	As sample 18 spec Estuarii <i>G. callid</i> trip). <i>P. com</i> Pelagic No alie Fish sh No fish	d by seine and gill ne cies should occur to i ne resident species s ne resident and estua <i>dus, M. capensis</i> and <i>mersonni</i> should be s piscivores should oc n fish species should ould be free of lesion kills should occur.	et in open waters: nclude freshwater, e should comprise a m arine dependant mar I <i>R. holubi</i> should oc sampled with 80% fre ccur (including <i>Carar</i> occur. as and other anomali	stuarine resident and inimum of five specie ine fishes should dor cur with 100% freque equency of occurrenc ix spp.). es related to water qu	l estuarine dependa s. ninate catches by al ncy of occurrence (e. uality.	nt marine fishes. bundance. every sampling				

6.7 LOVU RQOs

	PES: C/D	REC:	В	TEC:	В	s/C		
Compo	onents that require interventions to	o achieve the TEC:						
■ Imp ■ Par	prove water quality. tial restoration of estuarine habita	ıt.						
Flow:								
PES	nMAR (MC	CM)		pMAR (MCM)				
	119.10			82.47				
D	Flows should not exceed natura should be upheld into estuary to flood components differ by no m The Present baseflows/ low flo	I and seasonal distribu o maintain present mou hore than 10% (magnitu ows poses a risk to th	tion should not be th state and salinit ude, timing and var the REC and shoul	compromised. Cur y regime. Distributi iability) from that of Id be elevated.	rent basef on pattern the Prese	lows is of the ent (2015).		
Sedime	ent 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:							
С	Mouth open conditions should b	e maintained within the	e current range: 77	% (± 5%).				
Water	quality: Salinity							
С	 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:			Recreationa	al use:	Yes		
C↑	 Water quality poses risk to REC DIN: Freshwater inflow, 50% DIP: Freshwater inflow, 50% DO: Entire estuary, average Turbidity: Estuary, clear (< 1 Toxic substances: Substance concentrations in SA Water Quality Guidelines Substance concentrations in per WIO Region guidelines (CSIR, 2009). 	C/TEC, sufficiently reduction E/TEC, sufficiently reduction E = 0.2 mg/l (high risk) $\ge 6 \text{ mg/l}$ (high risk). 0 NTU accept during language of the stuarine waters not the stuarine waters not the stuarine sediment not the stuarine sediment not (UNEP/Nairobi Convention)	ced if: (). (). (). (). (). (). (). (). (). ().	s per s as d	r: Sufficier	nt levels		
Macrop	phytes (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	5							
с	 As sampled by plankton net, gra Population abundances of p Zooplankton should be domi groups such as mysids. Me Macrobenthos should be aburdances 	ab and dip nets/traps (a lankton and benthic as inated by estuarine cop roplankton are abunda undant and dominated	as appropriate): semblages (baselii pepods <i>A. natalens</i> nt. by amphipods and	nes to be set) not de <i>is</i> and <i>P. hessei</i> , bu l polycheates, but s	eviate by > It include of hould inclu	> 30%. other ude		

	PES:	C/D	REC:	В	TEC:	B/C			
	 isopods, tanaids and the crab <i>H. projectum and</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i> and <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. Invasive alien species should not occur in abundance. 								
Fish									
С	As sampled 25 spec Estuarin G. callid trip). P. com/ Pelagic No alier Fish sho	I by seine and gill ne ises should occur to in the resident species s the resident and estua dus, M. capensis and mersonni and A. japo piscivores should oc th fish species should ould be free of lesior	t in open waters: nclude freshwater, e should comprise a m arine dependant mar l <i>R. holubi</i> should oc <i>pnicas</i> should be san ccur (including <i>Carar</i> occur. s and other anomali	stuarine resident and inimum of five specie rine fishes should do cur with 100% freque npled with 80% freque to spp). es related to water q	d estuarine dependa as. minate catches by a ency of occurrence (iency of occurrence. uality.	nt marine fishes. bundance. every sampling			

No fish kills should occur.

6.8 LITTLE MANZIMTOTI RQOs

	PES: E RE		REC:	D	TEC:	EF			
Compo Rec Sig Par Pre	 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: Othe	er							
E	Recreation	nal use:				Yes			
-	Microbiolog	y: Sufficient levels (l	DEA, 2012).						

6.9 aMANZIMTOTI RQOs

F	PES:	D/E	REC:	D	TEC:	D				
Compor Prot Impr Mair Prev	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:	Flow:									
PES	nMAR (MCM)				pMAR (MCM)					
		5.30			6.75					
с	c 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).									
Sedime	ent process	es:								
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:									
С	Mouth oper	n conditions should b	e maintained within th	e current range: 4	4% (± 5%).					

	PES:	D/E	REC:	D	TEC:	D				
Water	quality: Sali	nity								
С	The system reaches du should exce	n needs variability in iring the low flow sea eed 10, while the upp	salinity regime, with son. Mid-waters in toor reaches exceed	a measurable increa he lower reaches sh 5.	se in salinity in the lo ould exceed 15, the	ower and middle middle reaches				
Water	Water quality: Other									
	Ecosystem	n 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). 										
Macro	phytes (plan	its)								
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, <i>Azolla filiculoides</i>) and nuisance filamentous 									
Inverts	5									
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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum and</i> 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 <i>S. serrata</i> and <i>V. litterata</i>. 									
Fish										
F♠	As sampled Six sper Estuarin <i>G. callic</i> trip). <i>P. com</i> Pelagic No alier Fish sho No fish	d by seine and gill ne cies should occur to ne resident species s dus, <i>M. capensis</i> and <i>mersonni</i> should be s piscivores (e.g. <i>Cara</i> n fish species should ould be free of lesion kills should occur.	t in open waters: include freshwater, o hould comprise a m l <i>R. holubi</i> should oc sampled with 30% fro anx spp.) should occ occur. is and other anomali	estuarine resident an inimum of three spec cur with 100% freque equency of occurrenc ur. es related to water q	d estuarine dependa ies. ancy of occurrence (ce. uality.	ant marine fishes. every sampling				

6.10 MBOKODWENI RQOs

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

6.11 SIPINGO RQOs

PE	S:	F	REC:	E	TEC:		EF
Water qua	ality: Othe	er					
E	cosystem	health:	Recreational use		Yes		
F	Ater quali DIN: Fre DIP: Fre DO: Low Turbidity Substar as per S (DWAF, Substar targets a Secreta	ty poses risk to REC eshwater inflow, 50% eshwater inflow, 50% wer estuary, average y: Estuary, clear (< 1 ances: nce concentrations ir SA Water Quality Gu , 1995). nce concentrations ir as per WIO Region of riat and CSIR, 2009	Microbiology: Suffi 2012).	icient leve	els (DEA,		

6.12 DURBAN BAY RQOS FOR SHALLOW WATER AND INTERTIDAL AREAS

F	PES:	E	REC:		D	TEC:	D			
Compor REC/TE Prote Impr Rede Parti Prev	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 (MC	CM)			pMAR (MCM)				
	36.33				63.44					
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).									
Sedime	ent process	es:								
F	 The floc The sus sedimenestuary Change Change deviates middle a 	od regime maintains spended sediment co nt load-discharge rel do not differ significa is in tidal amplitude o s in sediment grain s by less than a facto and upper reaches d	the sediment distribu- oncentration from riv ationship (to be dete- antly from present (± of less than 20% fror size distribution patte- or of two from presen lo not change by mo	ution er inf rmin 0.5 n pre erns nt lev re tha	patterns and ac low does not de ed). The sedim m) (to be detern esent (to be deter similar to prese els (to be deter an 20% from Pr	quatic habitat (instrea eviate by more than 2 entation and erosion nined). ermined). nt. The median bed mined). The sand/m esent State over a fiv	im physical habitat). 20% of the present patterns in the sediment diameter ud distributions in ve year average.			
Hydrod	ynamics:									
E	Mouth oper	n conditions should b	e maintained within	the c	current range: 1	00%				
Water q	uality: Sali	nity								
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 q	uality: Othe	er								

F	PES:	E	REC:	D	TEC:	D		
	Ecosyster	m health:			Recreational use:	: Yes		
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) 							
Macrop	hytes (plar	nts)						
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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>Capitella capitata</i> should not occur in abundance and should not dominate the benthos. Penaeid prawns should occur. Sandprawn <i>C. kraussi</i> 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 <i>S. serrata</i>, <i>Macrophthalmus sp., Portunus sanguinolentus</i>, Sesarmidae and <i>Uca</i> sp. Molluscan assemblage should include bivalves (including tellinids, <i>S. cylindraceus</i>, <i>E. paupercula</i>, <i>Dosinia hepatica</i>) and gastropods (including <i>N. kraussianus</i>, <i>Natica</i> spp. and <i>Polinices</i> sp.). 							
Fish								
F↑	As sample 30 spec Estuari <i>Liza du</i> <i>Leiogn</i> samplin Pelagic No alie Fish sh No fish	d by seine and gill ne cies should occur to i ine resident species s <i>imerilli, Acathopagurs</i> <i>athus equula</i> and <i>P.</i> or piscivores should oc in fish species should hould be free of lesion kills should occur.	t in open waters: nclude estuarine res hould comprise a mi s vagus, R. holubi, S commersonni should ccur (including Carar l occur. ns and other anomali	ident and estuarine d inimum of three speci <i>illago sihama, Gerres</i> I be sampled with 100 nx and <i>Sphyraena</i> spp les related to water qu	ependant marine fis es. <i>filamentosus, Amb</i> 1% frequency of occ o.). uality.	shes. ass <i>i</i> s spp <i>.,</i> currence (ie, every		

6.13 uMNGENI (MGENI) RQOs

	PES:	D/E	REC:	D	TEC:	D		
Сс	omponents that re	quire interventions to	o achieve the REC/T	EC:				
•	Restore baseflor	ws to estuary to impr	ove mouth state and	d salinity profile and I	mplement flow alloc	ation in an estuary		
	friendly manner.							
•	A significant imp	provement in water q	uality needed.					
•	Restoration of m	acrophytes: remova	I of alien plant specie	es, replanting/ reintro	duction with indigen	ous species (some		
	of which is alrea	dy occurring).						
•	Wetland engine	ering (creation of new	w wetland habitats in	close proximity to th	ne uMngeni River ba	nks.		
•	Review the curre	ent breaching policy	that only requires br	eaching after 2 to 3 v	weeks, this poses a i	risk to plant		
	communities and	d birds.						
•	Develop an Estu	ary Management Pla	an.					
•	Prevent low oxygen events that results in fish kills.							
FI	Flow:							

	PES:	D/E	REC:	D	TEC:	D				
PES		nMAR (MC	pMAR (MCM)							
	671.30 208.46 Present flows poses a risk to the REC/TEC. Flows should not exceed natural and seasonal distribution									
D↑	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).									
Sedime	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 oper	n conditions should b	be maintained within t	he current range: 95	% (+5%).					
Water o	quality: Sali	nity								
F∱	The system reaches du confirmed).	n needs variability in ring the low flow sea	salinity regime, with a son. Mid-waters in th	a measurable increas ne lower reaches sho	se in salinity in the lo buld be between 5 ar	wer and middle nd 10 (to be				
Water of	quality: Oth	er			1					
	Ecosysten	n 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 Constraint and CSIP. 2000) 					sient levels (DEA,				
Macrop	ohytes (plan	its)								
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, <i>Azolla filiculoides</i>) 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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum</i>. 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 <i>S. serrata</i>, <i>V. litterata</i>, <i>Macrophthalmus</i> sp., Sesarmidae and <i>Uca</i> sp. Molluscan assemblage should include bivalves and gastropods (including <i>N. kraussianus</i>, <i>Natica</i> spp.). Invasive alien species do not dominate macrobenthos in lower reaches. 									
Fish										

PES:	D/E	REC:	D	TEC:	D
As sample 12 spece Estuari <i>G. calli</i> trip).	d by seine and gill ne cies should occur to i ne resident species s <i>dus, M. capensis</i> and	et in open waters: nclude freshwater, e should comprise a mi d <i>R. holubi</i> should oc	stuarine resident and inimum of three spec cur with 100% freque	d estuarine dependa cies. ency of occurrence (nt marine fishes. every sampling

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**

1

F	DES.	р	REC	В	TEC	В				
Ensure Rest Asig Parti Prev	that the exis tore baseflov gnificant imp ial restoratio vent low oxys	ting pumping schem ws to estuary to impl provement in water q on of estuarine habita gen events that resu	ne comes into operati rove mouth state and juality needed. at. at.	on so that the TEC of salinity profile.	can be achieved thro	ough the following:				
Flow:										
PES	nMAR (MCM) pMAR (MCM)									
	13.34 22.33									
D∱	Present flo be compror regime. The timing and	ws poses a risk to mised. Current base e distribution pattern variability) from that	the REC. Flows sho flows should be uphe s of the flood compor of the Present (2015)	uld not exceed nature and into estuary to mathematic nents differ by no mothematic).	ral and seasonal dis aintain present mout ore than 10% (in teri	tribution should not h state and salinity ms of magnitude,				
Sedime	ent process	es:								
D	 The floc The sus sedimenestuary Change Change deviates middle a 	od regime maintains spended sediment c nt load-discharge re do not differ signific es in tidal amplitude o s in sediment grain s by less than a fact and upper reaches c	the sediment distribut oncentration from rive elationship (to be del antly from present (± of less than 20% from size distribution patte tor of two from prese to not change by mor	tion patterns and ac er inflow does not d termined). The sec 0.5 m) (to be detern n present (to be deter erns similar to prese ent levels (to be deter re than 20% from Pre	uatic habitat (instre eviate by more thar limentation and erc nined). rmined). ent. The median be ermined). The sand esent State over a fi	am physical habitat). 1 20% of the present 1 sion patterns in the d sediment diameter 1/mud distributions in ve year average.				
Mouth s	state:		0,1							
D♠	Mouth ope	n conditions should	be maintained within	the current range: 4	8% (± 10%).					
Water o	uality: Sali	nity								
E↑	The system reaches du confirmed).	n needs variability in ring the low flow sea	salinity regime, with a son. Mid-waters in the	a measurable increa he lower reaches sh	se in salinity in the ould be between 5 a	ower and middle and 10 (to be				
Water o	quality: Othe	er								
	Ecosystem	n 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). 									
Macrop	hytes (plan	ts)								
С	 Maintair macrop particula 	n the distribution of c hyte habitats which ar the swamp forest	current macrophyte haccounts for natural c habitat is important.	abitats (< 20% chan changes due to the c	ge in the area cover lynamic nature of es	ed by different stuaries). In				

F	PES:	D	REC:	В	TEC:	В			
	 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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum and</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i> and <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods. 								
Fish									
E∱	As sampled 18 spec Estuarir Estuarir <i>G. callid</i> trip). <i>P. comi</i> Pelagic No alier	d by seine and gill ne sies should occur to ne resident species a ne resident and estu dus, <i>M. capensis</i> and <i>mersonni</i> should be piscivores should o n fish species should	et in open waters: include freshwater, e should comprise a m arine dependant mai d <i>R. holubi</i> should oc sampled with 80% fr ccur (including <i>Cara</i>) d occur.	estuarine resident and inimum of five specie rine fishes should do cur with 100% freque equency of occurrence nx spp.).	d estuarine dependa es. minate catches by a ency of occurrence (ce.	int marine fishes. bundance. every sampling			

- Fish should be free of lesions and other anomalies related to water quality. -
- No fish kills should occur.

6.15 uMDLOTI RQOs

I	PES:	D	REC:		С	TEC:	D*			
Compor Res A sig Part Prev	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.									
PES	PES nMAR (MCM) pMAR (MCM)									
		100.19				85.03				
D	Present flo be compror regime. Th timing and	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).								
Sedime	ent process	es:								
с	 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 oper	n conditions should b	e maintained within	the curre	nt range: 4	0% (± 5%).				
Water o	quality: Sali	nity								

				•						
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 q	Water quality: Other									
	Ecosysten	n 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: 										
Macrop	hytes (plan	nts)								
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 									
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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum and</i> insect taxa. Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. Carid prawns should occur. Sandprawn <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i> and <i>V. litterata</i>. 									
Fish										
D↑	As sampled Six spe Estuarir G. callid trip). P. com/ Pelagic No alier Fish sho No fish	d by seine and gill ne cies should occur to ne resident species s dus, <i>M. capensis</i> and <i>mersonni</i> should be piscivores should oc n fish species should ould be free of lesior kills should occur.	et in open waters: include freshwater, i should comprise a m d <i>R. holubi</i> should oc sampled with 30% fr ccur. l occur. is and other anomali	estuarine resident and inimum of three speci cur with 100% freque equency of occurrenc es related to water qu	d estuarine dependa ies. ncy of occurrence (e e. uality.	ant marine fishes. every sampling				

6.16 uTHONGATHI RQOs

	PES: D REC: C TEC: D*									
Key cor	ey components that require protection to maintain the TEC: Baseflows to estuary to maintain mouth state and salinity profile.									
 Bas Mai 	 Maintain water quality. 									
 Mai 	Maintain of estuarine riparian habitat.									
Compo	Components that require interventions to achieve the REC include:									
 A si 	ignificant imp	provement in water q	uality needed.	r sainity prome.						
 Part Ren 	Partial restoration of estuarine habitat. Remove weir/causeway in upper reaches.									
 Prev 	Prevent low oxygen events that results in fish kills.									
Flow:	:									
PES		nMAR (MC	CM)		pMAR (MCM)					
		70.79			79.21					
с	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 flo	ows poses a risk to	the REC.							
Sedime	ent process	es:								
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 a five year and a success. 									
Mouth	state:									
В	Mouth oper	n conditions should b	be maintained within	the current range: 84	% (± 10%).					
Water	quality: Sali	nity								
с	The system reaches du confirmed).	n needs variability in ring the low flow sea	salinity regime, with son. Mid-waters in t	a measurable increas he lower reaches sho	se in salinity in the lo buld be between 5 a	ower and middle nd 10 (to be				
Water	quality: Oth	er								
	Ecosystem	n health:			Recreational use:	N/A				
F	Water quali DIN: From DIP: From DO: Low Turbidit Toxic substar as per S (DWAF Substar targets Secreta	ity poses risk to REC eshwater inflow, 50% eshwater inflow, 50% wer estuary, average y: Estuary, clear (< 1 cances: nce concentrations in SA Water Quality Gu , 1995). nce concentrations in as per WIO Region of riat and CSIR, 2009	C/TEC, sufficiently rec 6ile < 0.5 mg/l (high risk) = 2 mg/l (high risk). 5 = 4 mg/l (high risk). 5 NTU) accept durin 15 NTU) accept durin 15 nturine waters no idelines for coastal m $15 nturine sedimentguidelines (UNEP/Na).$	duced if: risk). h risk). g high inflow events. of to exceed targets narine waters not to exceed not to exceed	Not identified as recreational area in stakeholder meeting.					
Macrop	phytes (plan	ts)								
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. 									

F	PES:	D	REC:	С	TEC:	D*	
	 Maintai in non-f 	n present salinity reg lood year).	ime to maintain reed	l and sedge habitats	s (< 50% loss of reed	and sedge habitats	
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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum.</i> 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 <i>C. kraussi</i> 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 <i>S. serrata</i>, <i>V. litterata, Macrophthalmus</i> sp., Sesarmidae and <i>Uca</i> sp. Invasive alien species do not dominate macrobenthos in lower reaches. 						
Fish							
Е	As sampled 10 spec Estuarii <i>G. callid</i> trip). <i>P. com</i> Pelagic No alien Fish sh No fish	d by seine and gill ne sies should occur to i ne resident species s dus, <i>M. capensis</i> and <i>mersonni</i> should be s piscivores should oc n fish species should ould be free of lesion kills should occur.	t in open waters: nclude freshwater, e hould comprise a mi l <i>R. holubi</i> should oc sampled with 30% fre ccur (including <i>Carar</i> occur. is and other anomali	stuarine resident an inimum of three spec cur with 100% frequ equency of occurren ix spp.). es related to water o	d estuarine dependa cies. ency of occurrence (ce. quality.	ant marine fishes. (every sampling	

* 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

l	PES:	C/D	B/C	TEC:	D						
Compor	imponents that require interventions to achieve the TEC: Ensure that water quality is maintained so that fish kills do not occur.										
Flow:	Flow:										
TEC		nMAR (MO	CM)		pMAR (MCM)						
		56.26			54.03						
В	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).										
Sedime	Present base flows poses a risk to the REC.										
Seume	The flor	es.	the sediment distribu	tion patterns and ac	watic habitat (instrea	am physical babitat)					
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% 										
Mouth	state:										
В	Mouth oper m Mean Se	n conditions should ea Level.	be maintained within	the current range: 4	48% (± 5%). Breach	ning levels are < 3.0					
Water o	quality: Sali	nity									
В	The system reaches du confirmed). Salinity val No 10 – 15	n needs variability in ring the low flow sea ues > 20 PSU in mid PSU zone detected	salinity regime, with a ason. Mid-waters in the Idle reaches during the in the estuary for two	a measurable increa he lower reaches sh ne low flow season o consecutive sampl	ase in salinity in the lo ould be between 5 a ing event in a row.su	ower and middle ind 10 (to be irveys.					
Water o	quality: Oth	er			<u> </u>						
	Ecosysten	n health:			Recreational use:	Yes					
Е	Water qual River: 7.5 < pl DO < 6 Turbidit NOx-N NH ₃ -N: PO ₄ -P: Estuary: Average Average Average Average Average Xerage Substant as per S (DWAF Substant as per S (DWAF	ity poses risk to REC mg/l. y > 15 NTU (low flow > 200 µg/l over two n > 20 µg/l over two m > 20 µg/l over two m > 10 µg/l in a sa e turbidity > 10 µg/l in stances: nce concentrations ir as per WIO Region g ariat and CSIR, 2009	C/TEC, sufficiently rec over two months. vs), naturally turbid un months. onths. onths. sampling survey. (low flows), naturally n a sampling survey. a sampling survey. a sampling survey. a sampling survey. n estuarine waters no idelines for coastal m n estuarine sediment guidelines (UNEP/Na).	duced if: nder high flows. turbid under high t to exceed targets narine waters not to exceed irobi Convention	Microbiology: Suffi 2012).	cient levels (DEA,					
	PES:	C/D	REC:	B/C	TEC:	D					
--------	---	------	------	-----	------	---	--	--	--	--	
Macrop	ohytes (plan	its)									
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. <i>G. callidus, M. capensis</i> and <i>R. holubi</i> should occur with 100% frequency of occurrence (every sampling trip). <i>P. commersonni</i> 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. 										

7.2 BOBS STREAM RQOs

F	PES:	B/C	REC:	B/	С	TEC:		B/C		
Key con Base Mair Mair	 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 (MC	CM)			pMAR (MCM)				
	0.53					0.53				
Α	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).									
Sedime	nt process	es:								
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 determined is present levels (to be determined). 									
Mouth s	state:									
Α	Mouth oper	n conditions should b	e maintained within	the current	range: 20)% (± 5%).				
Water q	uality: Sali	nity								
Α	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 q	uality: Othe	er								
	Ecosystem	n health:				Recreational use:		N/A		
D	Water quali DIN: Fre DIP: Fre	ity poses risk to REC eshwater inflow, 50% eshwater inflow, 50%	C/TEC, sufficiently red bile < 0.2 mg/l (high r bile < 0.015 mg/l (hig	duced if: isk). h risk).		No identified as reastakeholder meetir	creation	nal area at		

I	PES:	B/C	REC:	B/C	TEC:	B/C	
	 DO: Er Turbidi Toxic subs Substa as per (DWAF Substa targets Secreta 	ntire estuary, average ty: Estuary, clear (< 1 stances: SA Water Quality Gu ⁷ , 1995). Ince concentrations ir as per WIO Region (ariat and CSIR, 2009	≥_6 mg/l (high risk). IO NTU) accept durin n estuarine waters no idelines for coastal n n estuarine sediment guidelines (UNEP/Na).	g high inflow events. It to exceed targets narine waters not to exceed irobi Convention			
Macrop	ohytes (pla	nts)					
С	 Mainta macrop Mainta Preven No inva Contro Spanis 	in the distribution of c ohyte habitats which a in the integrity of the it further disturbance asive floating aquatic I the spread of invasi th reed, black wattle,	current macrophyte h accounts for natural or riparian zone. No ba and development of species present in th ve plants in the ripari Brazilian pepper tree	abitats (< 20% chang changes due to the dy ire patches or unvege the floodplain habitat he estuary e.g. water an zone. Invasive pla) cover < 5% of total	e in the area cover ynamic nature of es etated, cleared area hyacinth. ants (e.g. syringa b macrophyte area.	red by different stuaries). as along the banks. erry, Casuarina,	
Inverts							
В	 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 <i>A. natalensis</i> and <i>P. hessei</i>. Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab <i>H. projectum</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) are dominated by <i>V. litterata</i>. Molluscan assemblage should include bivalves and gastropods (including <i>Melanoides tuberculata</i>). 						
Fish	-						
в	As sample 15 spe Estuari <i>G. call</i> trip). <i>P. com</i> Pelagio No alie Fish sh No fish	d by seine and gill ne cies should occur to i ine resident species s ine resident and estu- <i>idus, M. capensis</i> and <i>mersonni</i> should be so piscivores should oc en fish species should hould be free of lesion hills should occur.	et in open waters: include freshwater, es should comprise a mi arine dependant mar d <i>R. holubi</i> should occ sampled with 30% fre ccur. l occur. hs and other anomalie	stuarine resident and nimum of four specie ine fishes should don cur with 100% freque equency of occurrenc es related to water qu	estuarine dependa s. hinate catches by a ncy of occurrence e. ality.	ant marine fishes. abundance. (every sampling	

7.3 SETENI RQOs

P	PES:	B/C	REC:		B/C	TEC:	B/C			
Key com Base Main Main	 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 (MC	CM)		pMAR (MCM)					
		1.42			1.42					
Α	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 									

1	PES: B/C REC: B/C TEC: B/C							
	sedimer estuary Change Change deviates middle a	nt load-discharge rel do not differ significa es in tidal amplitude o es in sediment grain s s by less than a facto and upper reaches d	ationship (to be dete antly from present (± of less than 20% fror size distribution patte or of two from preser o not change by mo	rmined). The sedime 0.5 m) (to be determ n present (to be dete erns similar to presen nt levels (to be detern re than 20% from Pre	entation and erosion nined). rmined). it. The median bed s nined). The sand/m esent State over a fiv	patterns in the sediment diameter ud distributions in /e year average.		
Mouth	state:							
Α	Mouth oper	n conditions should b	e maintained within	the current range: 35	5% (± 5%).			
Water o	quality: Sali	nity						
Α	The system reaches du	n needs variability in ring the low flow sea	salinity regime, with son. Mid-waters in t	a measurable increa the lower reaches sho	se in salinity in the lo ould exceed 5 (to be	ower and middle confirmed).		
Water quality: Other								
	Ecosystem	n health:			Recreational use:	N/A		
D	Water quali DIN: Fre DIP: Fre DO: Ent Turbidit Toxic substar as per S (DWAF, Substar targets a Secreta	ity poses risk to REC eshwater inflow, 50% eshwater inflow, 50% tire estuary, average y: Estuary, clear (< 1 tances: nce concentrations ir SA Water Quality Gu , 1995). nce concentrations ir as per WIO Region g riat and CSIR, 2009	duced if: risk). h risk). ng high inflow events. ot to exceed targets narine waters not to exceed airobi Convention	No identified as red stakeholder meetir	creational area at ig.			
Macrop	ohytes (plan	ts)						
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, 							
Inverts								
В	As sampled Populat more th Zooplar groups : Macrob- isopods Chirono Penaeid Sandpra Large b Mollusc	d by plankton net, gra ion abundances of p an 30%. hkton should be dom such as mysids. Mer enthos should be ab t, tanaids and the cra omid larvae and oligo d and carid (Caridina awn <i>C. kraussi</i> shoul rachyuran crabs (ma an assemblage shoul e alien species shoul	ab and dip nets/traps lankton and benthic inated by estuarine of oplankton are abund undant and dominat ab <i>H. projectum and</i> ichaetes should not and Macrobrachium Id occur in sandy are acrocrustacea) shoul uld include bivalves a d not occur in abund	s (as appropriate): assemblages (baseli copepods <i>A. natalens</i> dant. ed by amphipods and insect taxa. occur in abundance a n) prawns should occ eas in the systems low d include <i>S. serrata</i> a and gastropods. lance.	nes to be set) should sis and <i>P. hessei</i> , bu d polycheates, but sh and should not domin ur. wer reaches (to be c and <i>V. litterata.</i>	d not deviate by It include other hould include hate the benthos. onfirmed).		
Fish								
в	As sampled 18 spec Estuarir <i>G. callid</i> trip). <i>P. comr</i> Pelagic No alier Fish sho No fish	d by seine and gill ne sies should occur to i ne resident species s dus, <i>M. capensis</i> and <i>mersonni</i> should be piscivores should oc n fish species should ould be free of lesion kills should occur.	et in open waters: nclude freshwater, e should comprise a m arine dependant man I <i>R. holubi</i> should oc sampled with 80% fre ccur (including <i>Caran</i> occur. as and other anomali	stuarine resident and inimum of five specie rine fishes should dor cur with 100% freque equency of occurrenc nx spp.). es related to water qu	d estuarine dependa es. minate catches by al ency of occurrence (ce. uality.	nt marine fishes. oundance. every sampling		

7.4 MVOTI RQOs

PES:		D	REC:	С	TEC:	C/D			
Components that Protect basefi A significant in Partial restora Prevent low o	require i lows to e mprovem ation of e xygen ev	nterventions to stuary to impro- lent in water q stuarine habita rents that resu	o achieve the TEC: ove mouth state and uality needed. at. ilts in invertabrate/fis	salinity profile.					
Component/ Indicator	TEC			RQO					
Hydrology	C/D	Maintain the birds, fish, ma River inflor recomme Monthly ri Monthly ri Monthly ri	target EC (> 57%). acrophytes, microalgow distribution patter nded flow scenario f iver inflow > 1.0 m ³ /s iver inflow > 2.0 m ³ /s iver inflow > 2.0 m ³ /s	Protect the flow regir gae and water quality ns differ by more tha or the Mvoti Estuary s. s persists for longer t s for more than 50%	me to create the requ r: nn 5% from that of So). han three months in of the time.	uired habitat for cenario A (i.e. the a row.			
Hydrodynamics	Α	Maintain the ecosystems a quality: • Mouth clo • Mouth clo • Mouth clo	target EC (> 93%). and the associated h osure occurs less that osure occurs for less osure does not occur	Maintain a mouth co labitat for birds, fish, in two - three weeks than two years out c s between Novembe	nditions to protect es macrophytes, micro in a year. of ten. er and June.	stuarine algae and water			
Water quality	C/D	Maintain the achieving the pH: 7.0 - 4 DO > 4 m Turbidity Turbidity Dissolved Trace me Pesticides ROQs for wa and ROQs in Salinity: S time?? Turbidity PH: Avera Dissolved Dissolved any samp Total met Guideline	target EC (> 57%). E EC and ROQs indi 8.5. g/L. (low flow): < 15 NTU (low flow): Naturally I nutrients: NO _x -N < tals (to be determined s/herbicides (to be d ater quality in estuar ndicated for the vario Salinity > 20 PSU on (low flow): Average - (high flow): Naturally age 7.0 - 8.5 in any s I oxygen: Average > I nutrients: Average bling survey. al concentrations in s for coastal marine al concentration in s s (UNEP/Nairobi Con	RQOs for river inflow cated for the various turbid. 400 µg/L; NH ₃ -N < 3 ed). etermined). y to protect estuarine us biotic component e km from the mouth < 10 NTU in any samp / turbid. sampling survey. 4 mg/L in any sampl NO _x -N < 400 µg/L, N water not to exceed waters (DWAF, 1999 ediment not to exceed nyention Secretariat	v to protect estuarine biotic components: 0 μg/L; PO₄-P < 25 μ e ecosystem, that is s: c; Salinity < 1 PSU fo npling survey. Ha3-N < 30 μg/L and target values as per 5). ed target values as per and CSIR, 2009).	ecosystem, that is Jg/L. achieving the EC r > 50% of the PO ₄ -P < 25 μ g/L in SA Water Quality er WIO Region			
Sediment dynamics	B/C	Maintain the distribution pa River inflo of magnit Suspende sediment (Present 3 Findings 1 indicate n occurred Changes (2013) Changes in s benthic invert The medi determine	 guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009). Vaintain 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 th 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 b determined as part of baseline studies (Present State 2013). 						
Microalgae	в	Present S Maintain the diatom specie Medium p	State (2013). target EC (> 78%). es at a frequency > 3 shytoplankton: > 3µg	Maintain current mic 3% of the total popula /L for more than 50%	roalgae assemblage ation in lower saline 6 of the stations	s, specifically > five reaches:			

PES:		D	REC:	С	TEC:	C/D				
		 MPB: > 2 Observation 	0 mg m ² for more th ble bloom in the estu	an 50% of the statior ary.	ns in the saline portion	on of the estuary.				
Macrophytes	D	 Maintain particular estuary setuary setua	 Waintain the target EO (> 45%). Maintain the distribution of macrophyte habitats, particularly the freshwater mangrove, <i>Barringtonia racemosa</i> 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	Е	N/A								
Fish	D	Maintain the A nursery which use Habitat for their life of Habitat for A migration This will r Any one of Any two of estuary. Any one of Any one of A	 Naintain 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 <i>Mugil cephalus</i>, <i>M. capensis</i> from Zones A, B and C. Any two of the following species <i>Barbus</i> spp, <i>O. mossambicus</i> from Zones A, B and C. Any one of the following species <i>Barbus</i> spp, <i>O. mossambicus</i> from Zones A, B and C. 							
Birds	Е	Maintain the community, c representativ cormorants) including mig and roosting Presence Fish Eagl Numbers Number c	target EC (> 23%). boccurring at high den es of all the major g and large wading pis pratory Palaearctic sa terns and gulls. This of successful breed es. of bird species do n of roosting terns reco	The estuary should c isities (relative to ava roups, i.e. aerial (e.g scivores (e.g. herons) andpipers, herbivoro s means that the follo ling by Collared Prati ot drops below 30 for orded in mid-summer	contain a rich avifaur ilable shorelength) t . kingfishers), swimn), small invertebrate- us waterfowl (e.g. du owing will be observe ncoles and the resid r three consecutive of no fewer than 2000	hal waterbird hat includes ning (e.g. feeding waders, icks and geese) ed: lent pair of African. counts.				

7.5 MDLOTANE RQOs

F	PES:	В	REC:	A/B		TEC:	A/B			
Interven Impr Parti 	tions require ove water q ial restoratio	ed to achieve the RE uality. on of estuarine habita	C: at.							
Flow:	Flow:									
PES		nMAR (MO	CM)			pMAR (MCM)				
		6.04				5.85				
А	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).									
Sedime	nt process	es:								
В	 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 s	state:									

	PES:	В	REC:	A/B	TEC:	A/B			
В	Mouth oper	n conditions should b	pe maintained within	the current range: 14	•% (± 5%).				
Water	quality: Sali	nity							
В	The system reaches du	n needs variability in ring the low flow sea	salinity regime, with ason. Mid-waters in t	a measurable increas he lower reaches sho	se in salinity in the loud of the second second second second second second second second second second second s	ower and middle e confirmed).			
Water	quality: Oth	er							
	Ecosystem	n health:			Recreational use:	Yes			
D∱	Water quali DIN: Fre DIP: Fre DO: Ent Turbidit Toxic substar as per S (DWAF Substar targets Secreta	ity poses risk to REC eshwater inflow, 50% eshwater inflow, 50% tire estuary, average y: Estuary, clear (< 7 tances: nce concentrations in SA Water Quality Gu , 1995). nce concentrations in as per WIO Region iriat and CSIR, 2009	duced if: risk). gh risk). ng high inflow events. ot to exceed targets marine waters t not to exceed airobi Convention	s. Microbiology: Sufficient levels (DEA, 2012).					
Macro	phytes (plan	its)							
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) 								
Invert	S								
¢∱	As sampled Populat more th Zooplar Macrob polycha Chirono Penaeid Sandpra Large b Mollusc <i>Melano</i>	d by plankton net, gr ion abundances of p an 25%. nkton should be dom enthos should be ab tetes, the crab <i>H. pro</i> omid larvae and oligo d and carid (Caridina awn <i>C. kraussi</i> shou trachyuran crabs (ma can assemblage shou ides tuberculata). e alien species shou	ab and dip nets/trappolankton and benthic blankton and benthic bundant and dominat bjectum and insect ta bochaetes should not a and Macrobrachiun Id occur in sandy are acrocrustacea) are d uld include bivalves Id not occur.	s (as appropriate): assemblages (baselin copepods <i>A. natalens</i> red by amphipods, but axa. occur in abundance a n) prawns should occu eas in the systems low ominated by <i>V. littera</i> (including <i>Hiatula lunu</i>	nes to be set) should sis and <i>P. hessei.</i> t should include isop and should not domin ur. ver reaches (to be c <i>ta.</i> <i>Jata</i>) and gastropoc	d not deviate by bods, tanaids, nate the benthos. onfirmed). Is (including			
Fish									
СĄ	As sampled 18 spec Estuarir Estuarir <i>G. callid</i> trip). <i>P. comi</i> Pelagic No alier Fish sho No fish	d by seine and gill ne cies should occur to the resident species s the resident and estu <i>dus, M. capensis</i> and <i>mersonni</i> should be piscivores should or n fish species should ould be free of lesion kills should occur.	et in open waters: include freshwater, e should comprise a m arine dependant ma d <i>R. holubi</i> should oc sampled with 70% fr ccur (including <i>Cara</i> d occur. hs and other anomal	estuarine resident and inimum of four specie rine fishes should dor ccur with 100% freque equency of occurrenc nx spp.). ies related to water qu	l estuarine dependa es. ninate catches by al ency of occurrence (e. uality.	nt marine fishes. oundance. every sampling			

7.6 NONOTI RQOs

PES:	С	REC:	С	TEC:	С			
Key components that require protection to maintain the TEC:								
 Baseflows to est 	tuary to maintain mo	uth state and salinity	profile.					

	PES:	С	REC:	C TEC: C						
 Ma 	intain water o	quality.								
■ Ma	intain of estu	arine riparian habitat								
PES		mMAD (M	284)							
PES			JVI)							
	Elows shou	34.74	and concorral distr	ibutio	n chould not ha	34.74	ront h	acoflowe		
В	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).									
Sedim	ent process	es:								
 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:									
В	Mouth oper	n conditions should b	be maintained within	the c	urrent range: 18	3% (± 5%).				
Water	quality: Sali	nity								
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: Oth	er								
	Ecosysten	n health:				Recreational uses		Yes		
D	Water qual DIN: Fri DIP: Fri DO: En Turbidit Toxic substa as per s (DWAF Substar targets Secreta	ity poses risk to REC eshwater inflow, 50% eshwater inflow, 50% tire estuary, average cy: Estuary, clear (< 1 tances: nce concentrations ir SA Water Quality Gu (, 1995). nce concentrations ir as per WIO Region (ariat and CSIR, 2009	C/TEC, sufficiently re 6ile < 0.3 mg/l (high 6ile < 0.025 mg/l (high $2 \ge 4$ mg/l (high risk). 10 NTU) accept during the estuarine waters no 10 idelines for coastal re- 10 estuarine sediment 10 guidelines (UNEP/Na 10).	duced risk). In risk ng hig ot to e marine t not t airobi	d if: h inflow events exceed targets e waters o exceed Convention	Microbiology: Suffi 2012)	cient	levels (DEA,		
Macro	phytes (plan	nts)								
 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. 										
Invert	6									
С	Inverts 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 <i>A. natalensis</i> and <i>P. hessei</i> . Macrobenthos should be abundant and dominated by amphipods, but should include isopods, tanaids, polychaetes, the crab <i>H. projectum</i> 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 <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed).									

	PES:	С	REC:	С	TEC:	С					
	MolluscInvasive	an assemblage shoue alien species do no	uld include bivalves a ot dominate macrobe	and gastropods. enthos.							
Fish											
ш	As sampled 10 spec Estuarir <i>Estuarir</i> <i>G. callid</i> trip). <i>P. comr</i> Pelagic No alier Fish sho No fish	I by seine and gill ne ites should occur to it ne resident species s dus, <i>M. capensis</i> and <i>mersonni</i> should be piscivores should on thish species should ould be free of lesior kills should occur.	 Invasive alien species do not dominate macrobenthos. sh 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. <i>G. callidus, M. capensis</i> and <i>R. holubi</i> should occur with 100% frequency of occurrence (every sampling trip). <i>P. commersonni</i> 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: **REC:** B/C A/B TEC: В 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) 14.49 14.04 Flows should not exceed natural and seasonal distribution should not be compromised. Current baseflows Α 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: 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). С 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: Mouth open conditions should be maintained within the current range: $28\% (\pm 5\%)$. Α Water quality: Salinity The system needs variability in salinity regime. Mid-waters in the lower reaches should be between 20 to 15, R while the middle reaches should vary between 10 to 15 and the upper reaches between 5 to 10. Water quality: Other 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 \geq 6 mg/l (high risk). Turbidity: Estuary, clear (< 10 NTU) accept during high inflow events. C**↑** Microbiology: Sufficient levels (DEA, Toxic substances: 2012). 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)

macrophytes (plai

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 <i>A. natalensis</i> and <i>P. hessei</i>, 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 <i>H. projectum and</i> insect taxa. Chironomid larvae and oligochaetes should not occur in abundance and should not dominate the benthos. Penaeid and carid (<i>Caridina</i> and <i>Macrobrachium</i>) prawns should occur. Sandprawn <i>C. kraussi</i> should occur in sandy areas in the systems lower reaches (to be confirmed). Large brachyuran crabs (macrocrustacea) should include <i>S. serrata</i> and <i>V. litterata</i>. 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. <i>Oligolepis keiensis, Oligolepis acutipennis, Gilchristella aestuaria, G. callidus, M. capensis</i> and <i>R. holubi</i> should occur with 100% frequency of occurrence (every sampling trip). <i>P. commersonni</i> should be sampled with 80% frequency of occurrence. Pelagic piscivores should occur (including <i>Caranx</i> and <i>Sphyraena</i> 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: <u>http://bgis.sanbi.org/nba/project.asp</u>.

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 9.1Area 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					
Imaphefo 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 (eTh (Item reference comments on	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 <i>et al.</i>). 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 <u>"the pressures for urban development in the</u> <u>uThongathi catchment requires wastewater</u> <u>management and disposal facilities in the short</u> term. To bridge this planning gap it is therefore proposed that treatment and discharge to the <u>uThongathi take place over the short term which</u> may reduce the Ecological Category (EC) of the <u>estuary to an E.</u> " 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.