

uMKHOMAZI ESTUARY MANAGEMENT PLAN FINAL REPORT

May 2026



Prepared by



For

Verdant Environmental



and

Department of Economic Development, Tourism and Environmental Affairs, Province of
Kwazulu-Natal



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GLOSSARY

Abiotic	Non-living characteristics of a habitat or ecosystem that affect organisms' life processes.
Algae	Chlorophyll containing non-vascular organisms, plant or plant-like.
Alien	A species that occurs outside of its natural range and dispersal potential.
Biotic	Referring to living things
Benthic	Describing the substrate or bottom of a water body.
Benthos	Bottom-dwelling plants and animals from bacteria to the highly visible macrobenthos such as mussels, crabs and worms.
Catchment area	The area from which rainfall flows/drains into the estuary.
Estuary	A semi-enclosed body of water at the coast where land derived freshwater drainage at times meets the sea and within which seawater is measurably diluted by fresh water derived from land drainage.
Eutrophication	Process by which additions of nutrients (phosphates and/or nitrates) causes imbalances in algal and/or emergent plant growth.
Floodplain	Broad and relatively flat area on either side of a stream, river or estuary inundated by water during floods.
Head (of estuary)	The upstream part of the system where freshwater enters.
Indigenous	Species within the limits of their native range (Synonyms: native).

Invasive alien species	Species whose natural range occurs outside the area being considered which were transported to their current location by artificial means allowing them to reproduce, spread and typically cause negative ecological impact.
Impact	A change to the existing environment, either adverse or beneficial, that is directly or indirectly due to the development of the project and its associated activities.
Invertebrate	An animal that does not have a backbone (<i>e.g.</i> a prawn, crab, or worm).
Legislation	Laws, legal requirements or the process of making or enacting laws.
Macrophytes	Aquatic plants large enough to be seen by the naked eye.
Microalgae	Microscopic algae, typically found in freshwater and marine systems, living in both the water column and sediment. They are unicellular species which exist individually, or in chains or groups.

LIST OF ABBREVIATIONS

CMP	Coastal Management Programme
DEDTEA	Department of Economic Development, Tourism and Environmental Affairs KZN
EC	Ecological Category
EFZ	Estuarine Functional Zone
EA	Environmental Authorisation
EIA	Environmental Impact Assessment
EMP	Estuarine Management Plan
DWA	Department of Water Affairs (Changed after 2008)
DWS	Department of Water Affairs and Sanitation (Changed after May 2014)
ICMA	National Environmental Management: Integrated Coastal Management Act (Act No. 24 of 2008), as amended by National Environmental Management: Integrated Coastal Management Amendment Act (Act No. 36 of 2014)
IDP	Integrated Development Plan
KZN	KwaZulu-Natal
MAR	Mean Annual Runoff
MER	Marine and Estuarine Research
MLRA	Marine Living Resources Act (Act No. 18 of 1998, amended 2000)
MPA	Marine Protected Area
NBA	National Biodiversity Assessment
NEMA	National Environmental Management Act (Act No. 107 of 1998)
PES	Present Ecological State
Protocol	National Estuarine Management Protocol
REC	Recommended Ecological Category
SAR	Situation Assessment Report

uMkhomazi Estuary Management Plan



1 INTRODUCTION

1.1 Background

Estuaries along the South African coast are complex environments because they are subjected to dynamic processes arising from adjoining marine, riverine and terrestrial ecosystems. They form a connection between marine and freshwater systems and are part of regional, national, and global ecosystems linked either directly via water flows or indirectly through the movement of fauna. Along the sub-tropical KwaZulu-Natal coastline these systems are important assets supporting and providing important goods and services to the area and acting as attractive nodes for tourism and development.

1.2 Context of the Estuary Management Plan

A Situation Assessment Report (SAR) typically precedes an Estuarine Management Plan (EMP) which in combination form a sound platform to provide action plans and guidance on the best management practices. The development of an EMP is required in terms of Chapter 4, Section 34 of the National Environmental Management: Integrated Coastal Management Act, 2008 (Act 24 of 2008) ("Act") and the National Estuarine Management Protocol of 2013 ("the Protocol"). These serve as the guiding documents for the development and implementation of EMPs. In addition, the EMP must be consistent with the National, Provincial and Municipal Coastal Management Programmes (CMP) requiring that these be taken into account as part of the process. In addition, the Department of Environmental Affairs has developed holistic and inclusive "*Guidelines for the development and implementation of Estuarine Management Plans*" to supplement the

Protocol in providing clear procedures and guidance to the responsible management authority who develop and coordinate the implementation of EMPs (DEA 2015). Under the Provincial CMP, it is a requirement that strategies be developed for the effective and co-operative management of the coastal zone. It is taken as a given in this management plan that it is implicit that management refers to control of human activities in order to allow and maintain the natural functioning of coastal ecosystems, specifically including estuaries. At this point the prime anthropogenic activities impacting on or degrading estuarine function are well-known.

An estuarine management framework, based on the minimum requirements stipulated in the Protocol, is required to be structured in terms of the three main phases, namely the Scoping phase, Objective setting phase and the Implementation phase.

The **Scoping** phase comprises a situation assessment to reflect on the current status of estuarine management in a specific estuary, conducted in collaboration with other relevant lead authorities and interested and affected parties, including estuarine scientists. This phase has been completed and is available (MER 2025).

The **Objective** setting phase leads into the preparation of the Estuarine Management Plan, in accordance with the minimum requirements of the Protocol. The Objectives and vision for the estuary were developed in consultation with the I&APs during the meeting to present the Situation Assessment Report and is reported in the Public Participation Stakeholder Report by Verdant Environmental.

The **Implementation** phase comprises the execution and monitoring of the estuarine management plan. During the implementation phase responsible departments (or sectors) are required to develop project plans for management priorities identified in the estuarine management plan, and to execute and monitor progress in accordance with monitoring plans. In the implementation on management plan an adaptive management approach (*i.e.* learning-by doing) should be followed where new learning (*e.g.* gained through monitoring) is continuously used to improve implementation strategies and execution of projects, and ultimately to improve the estuarine management plan. A detailed review of the estuarine management plan needs to be conducted at least every five (5) years in accordance with the Protocol.

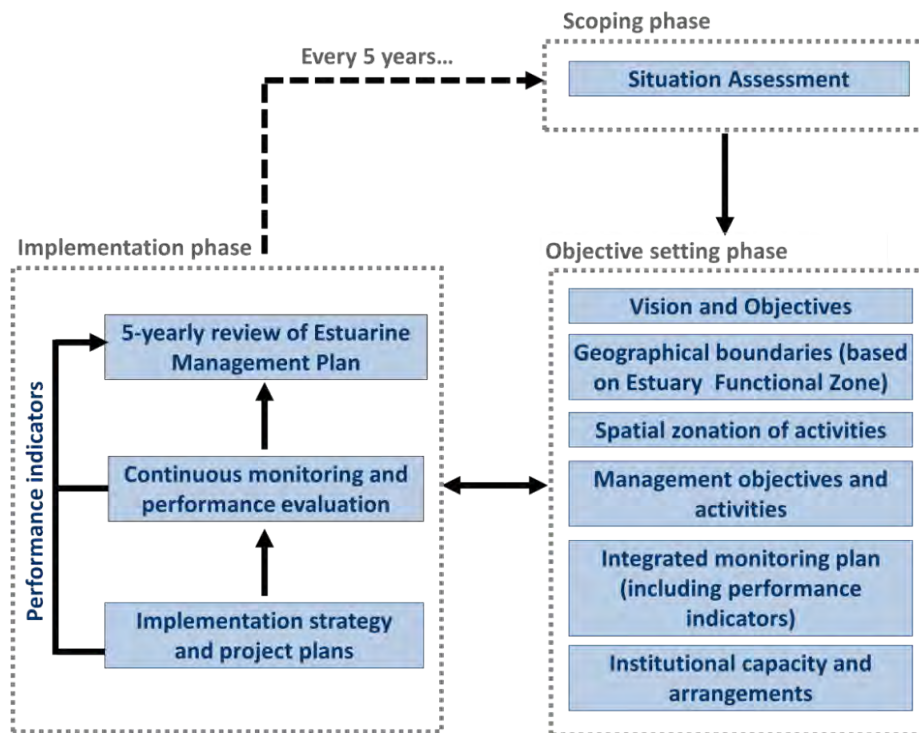


Figure 1-1 Framework for integrated Estuary Management in South Africa (DEA 2015)

2 SUMMARY OF THE SITUATION ASSESSMENT REPORT

The summary extracts relevant sections of the SAR (MER 2025) where these reflect the position, role and importance of the uMkhomazi Estuary on the KZN coast, followed by

anthropogenic impacts and changes, and particularly where these changes have the potential for adverse impact and thereby require management, mitigation, or possible reversal.

2.1 Position, Major Features and Classification of the Estuary

The uMkhomazi Estuary is situated approximately 50 km south of Durban within the eThekweni Municipality, at coordinates 30°48'13.9"S and 30°12'9.3"E (Figure 1-1). It forms from the terminus of the uMkhomazi River, a major KwaZulu-Natal system roughly 300 km long, draining a catchment of about 4 300 km²—second only to the Thukela within the province. The system has a Mean Annual Runoff (MAR) of around $1\,072 \times 10^6 \text{ m}^3$, and while abstraction and off-channel storage occur, the river remained unregulated by a major dam (2025). Current developments toward main-stem impoundment mark a significant hydrological shift that must be considered in future estuarine management and reserve determinations.

Of significant regional importance is the Aliwal Shoal Marine Protected Area (MPA), which lies adjacent to the uMkhomazi estuary. Proclaimed in 2019 as part of the national expansion of MPAs that raised South Africa's coastal protection from 0.4 % to 5 %, the 678 km² Aliwal Shoal MPA includes both restricted and controlled zones. The National Biodiversity Assessment (NBA 2018) downgraded its level of protection due to degraded water quality and fishing pressure from feeder environments, notably the uMkhomazi Estuary. Consequently, improving the estuary's condition would directly enhance the ecological integrity and protection status of this important MPA.

The uMkhomazi is currently classified as a Permanently Open Estuarine System (van Niekerk *et al.* 2019b), although its strong fluvial influence, episodic flooding, and extended freshwater dominance have led some to argue for a "River Mouth" categorisation. The estuary's Estuarine Functional Zone (EFZ) extends approximately 130 ha, from the mouth upstream to the SAPPI-intake weir near the steel bridge, about 6 km inland. The estuary's freshwater requirements were first assessed in 1998 (Quinn & Whitfield 1998) in studies related to the proposed uMkhomazi-uMngeni Transfer Scheme. That work initiated one of South Africa's longest-running estuarine monitoring programmes (1998–2022) by MER, providing a rare multi-decadal record of hydrodynamics, water quality, and biotic responses that underpins contemporary understanding of this dynamic, high-energy system.

2.2 Catchment characteristics

The uMkhomazi catchment reflects a complex interaction between its geology, geomorphology, and coastal setting. The region's environmental character is strongly influenced by its underlying geology and coastal processes, which together shape the dynamic nature of the estuary. The eThekweni coastline has been significantly modified by human infrastructure such as harbour walls, sea walls, marinas, pipelines, and reclamation schemes, all of which disrupt natural coastal processes. Because of these interventions, feedback effects such as erosion, sediment deposition, and shoreline instability have become common. The KwaZulu-Natal coast, characterised by its straight alignment and narrow continental shelf, is particularly exposed to marine forces, making it highly responsive to both acute storm events and slow, long-term geomorphological change.

The southern portion of the municipal coast, where the uMkhomazi enters the sea, is dominated by rocky headlands interspersed with sandy beaches that often cross the mouths of estuaries. The catchment geology ranges from ancient granites to rocks of the Stormberg Series, with deep sediment deposits—more than 80 m thick in places—recorded beneath the N2 bridge. The catchment rises steeply from the Drakensberg escarpment, where numerous tributaries descend rapidly toward the coast, creating one of the steepest river gradients globally. This steep topography promotes high-energy runoff, erosion, and sediment transport even under relatively modest rainfall conditions.

The region experiences a subtropical climate with warm, humid summers and cooler, drier winters. Mean annual rainfall along the coast is about 1 000 mm, resulting in highly seasonal river flow. Summer inflows average around 0.2 m³/s, decreasing to 0.03 m³/s in winter, though historically baseflows seldom dropped below 1.0 m³/s under natural conditions. The natural Mean Annual Runoff (MAR) was estimated at $1\,077 \times 10^6$ m³, now reduced by about 12% due to abstraction and land-use changes. Low-flow reductions, together with diminished flood peaks, have altered estuarine mouth dynamics—reducing salinity intrusion and increasing the likelihood of mouth closure. Despite the absence of major impoundments, these hydrological changes have cumulative effects on the estuary's geomorphology and ecological functioning.

Land use across the 4 300 km² catchment is diverse, reflecting the strong environmental gradients from the Drakensberg to the coast. Roughly half of the catchment remains

natural grassland, with 25% thicket and bushveld, 13% forest plantations, 7% cultivated land (including 1% sugarcane), and smaller areas of degraded grassland. The estuarine surroundings are dominated by KwaZulu-Natal Coastal Belt Grassland and Northern Coastal Forest, with Subtropical Seashore Vegetation along the littoral zone. Historical aerial imagery from the 1930s onward shows progressive transformation of the lower catchment through agriculture, forestry, and settlement, underscoring the cumulative pressures on the estuary and its sensitive coastal interface.

2.3 Present State of the Estuary

Early comparative assessments of South African estuaries by Harrison, Cooper & Ramm (2000) rated the uMkhomazi Estuary as *good* for both fish community and water quality, and *moderate* for aesthetics. Subsequent local studies within the eThekweni municipal area (Forbes & Demetriades 2010) downgraded the condition to *fair* based on physico-chemical and biological indicators. More recently, the Estuarine Health Index (EHI) has been adopted nationally to integrate abiotic and biotic measures into a single functional assessment. Using this framework, estuaries are classified from A (natural) to F (critically modified), reflecting their degree of modification and ability to sustain natural processes.

The most recent evaluation undertaken for the National Biodiversity Assessment (NBA 2018) and associated Ecological Water Requirement (EWR) study (van Niekerk et al. 2019) assigned the uMkhomazi Estuary an overall Present Ecological State (PES) of Category C—a *moderately modified* condition equivalent to about 69 % of its natural state. Key abiotic and biotic components scored variably: hydrodynamics (A), physical habitat (B), hydrology and water quality (C), invertebrates (C), microalgae (B), macrophytes (E), fish (D), and birds (D). The principal pressures lowering condition include the weir restricting longitudinal connectivity, sandmining that has destroyed intertidal and backwater areas, recreational disturbance of birds, over-exploitation of living resources, and habitat loss within the Estuarine Functional Zone. Future monitoring, evaluation and adaptive management actions undertaken as part of the implementation of this EMP should, where applicable, be aligned with and benchmarked against the gazetted Resource Quality Objectives (RQOs), Recommended Ecological Category (REC) and associated ecological reserve requirements established in terms of the National Water Act. Monitoring programmes should therefore be structured, where feasible, to assess trends

in relation to these ecological objectives and to support adaptive management responses where deterioration from target conditions is detected.

Despite these pressures, the uMkhomazi remains an ecologically important estuary of high functional value. It provides nursery habitat for commercially and recreationally exploited fish, contributes significantly to fish egg production in the adjacent coastal zone, and forms an essential migration corridor for eels (a CITES-listed group). Its ecological linkage with the Aliwal Shoal Marine Protected Area further elevates its conservation significance. Accordingly, the system is listed as a priority estuary at national, provincial, and municipal levels, warranting protection and rehabilitation attention.

Table 2-1 *Ecological categories associated with individual components of the estuary health index for the uMkhomazi Estuary on a desktop basis.*

NBA 2018 Condition			
ABIOTIC		BIOTIC	
Hydrology	C	Microalgae	B
Hydrodynamics	A	Macrophytes	E
Water Quality	C	Invertebrates	C
Physical habitat	B	Fish	D
		Birds	D
Overall Health Score			
C			

The Recommended Ecological Category (REC) for the uMkhomazi has been gazetted as Category B, with a Targeted Estuary Category (TEC) of B/C, implying that the estuary's condition should be improved from its present C status. Achieving this will require targeted interventions such as halting sandmining, restoring riparian vegetation—especially along the southern bank—reducing unsustainable fishing and boating pressures, and maintaining environmental flows. The Resource Quality Objectives (RQOs) established under the National Water Resource Strategy define the flow, water-quality, habitat, and biotic requirements necessary to reach and sustain these target conditions, ensuring that the uMkhomazi Estuary retains its vital ecological and functional role within the KwaZulu-Natal coastal system.

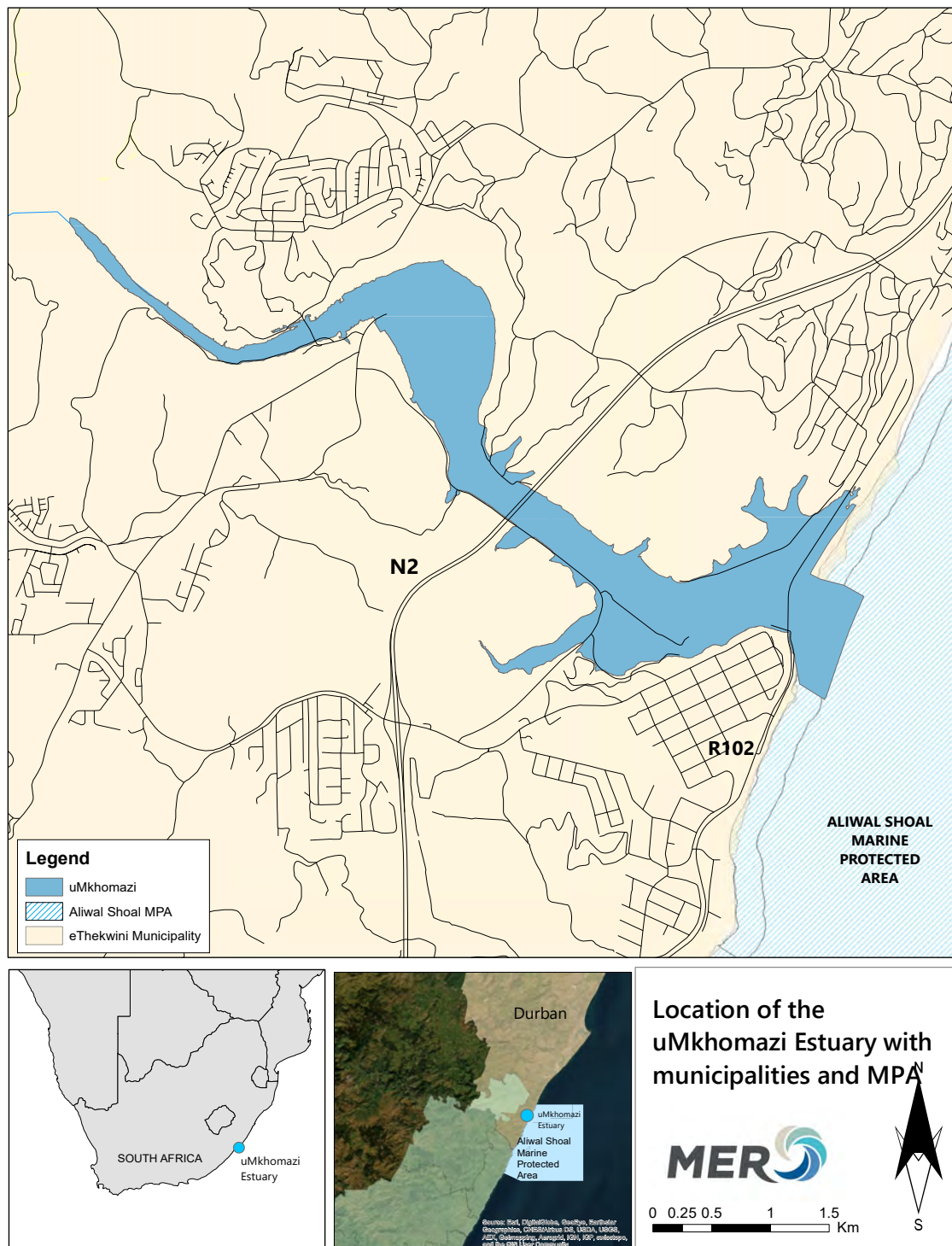


Figure 2-1 *Position of the uMkhomazi Estuary on the KwaZulu-Natal coast relative to Durban. The Estuary lies within the boundaries of the eThekweni Municipality, and the Marine Protected Area are indicated.*

2.4 Services provided by the uMkhomazi Estuary

Ecosystem services are the benefits people derive from functioning ecosystems, encompassing provisioning, regulating, cultural, and supporting services. They represent the “natural capital” that underpins human well-being and economic activity. Estuaries, positioned at the interface between land and sea, provide a particularly diverse range of such services. In South Africa, their value has been recognised in national biodiversity and water resource strategies, as many systems are degraded and deliver only a fraction of their potential services. KwaZulu-Natal’s estuaries are among the most impacted, making those still functioning—such as the uMkhomazi—especially important to regional ecological resilience and human livelihoods.

The uMkhomazi Estuary provides a suite of provisioning and regulating services. Limited harvesting of reeds occurs, while fishing—both recreational and subsistence—supports local livelihoods but is increasingly unsustainable due to gillnetting and sandmining activities. The estuary also plays a key role in carbon sequestration, as its sediments store organic carbon at rates exceeding many terrestrial systems, contributing to climate regulation and shoreline stability. In addition, the estuary performs critical waste-treatment and filtration functions, receiving runoff that may contain herbicides, nutrients, or sediments and processing these before discharge to the marine environment. Maintaining these services depends on safeguarding the estuary from further contamination and hydrological alteration.

From an ecological perspective, the uMkhomazi serves as an essential refuge and nursery for fish and invertebrates, supporting biodiversity within the estuary and replenishing adjacent coastal waters, including the Aliwal Shoal Marine Protected Area. It also plays a pivotal nutrient and sediment export role, delivering material that sustains nearshore habitats and stabilises beaches along the KwaZulu-Natal coastline. The river is one of only five major systems (uMfolozi, uMvoti, uMngeni, uMkhomazi, and uMzimkulu) that provide such large-scale sediment and nutrient inputs—making it functionally irreplaceable for coastal ecosystem health and fisheries productivity.

Culturally and economically, the estuary supports tourism and recreation, linked both to its scenic value and its association with the world-renowned Aliwal Shoal diving destination. Activities such as boating, angling, and birdwatching generate revenue for local communities. However, the continuation of these benefits depends on addressing

cumulative pressures including sandmining, habitat disturbance, reduced freshwater connectivity, and over-exploitation of resources. Protecting the uMkhomazi's ecological integrity will ensure that this high-value estuary continues to deliver multiple ecosystem services that sustain biodiversity, local economies, and coastal resilience well into the future.

2.5 Threats, Impacts and Management Issues

The uMkhomazi Estuary has been shaped and constrained by a range of engineering structures, including several road and rail bridges, causeways, and a series of weirs associated with water abstraction for industrial use. These crossings alter the hydrodynamics and sediment balance of the system, restricting natural mouth movement, interrupting floodplain connectivity, and causing localised scouring around bridge pylons. Historical construction often pre-dated environmental legislation, and many structures were not rehabilitated after flood damage. The reinforced weir maintained by Sappi Saiccor continues to modify flows and sediment transport, representing a key constraint on upstream–downstream ecological connectivity.

Sedimentation processes are a defining feature of the uMkhomazi, governed by the interaction between river flow, wave action, and longshore drift. Historical records reveal that the estuary was once deep enough to support coastal shipping in the 1800s, with vessels entering and off-loading cargo until sedimentation and navigation hazards led to abandonment of this use. Today, the estuary is shallow and dynamic, with sediment accumulation during low-flow periods and scouring during floods. Over geological timescales, sea-level changes and sediment deposition have shaped a system where bed levels fluctuate by several metres, reinforcing the need for careful management of sediment inputs and mouth processes.

Sand mining has long been one of the most damaging and persistent pressures. Continuous extraction since the late 1990s has altered sediment dynamics and channel morphology and destroyed benthic, intertidal and riparian habitats, including shallow backwater and depositional areas important for estuarine biota such as fish, crustaceans and bait organisms. Mining infrastructure such as haul roads and access tracks has fragmented riparian zones and reduced natural buffers along the estuary. Although access control on the south bank has recently improved, the activity remains a major threat to the ecological integrity and recovery potential of the system.

Water quality within the estuary is generally good and within guideline values for most parameters, although elevated bacterial levels are intermittently recorded near the Mpisini stream outlet, likely due to effluent from the small wastewater treatment works. Road runoff from the N2 and R102 bridges introduces heavy metals, oils, and nutrients, and agricultural return flows from sugarcane lands may further degrade water quality. Alteration of the floodplain—including stabilisation of banks, lawn maintenance, slipways, and industrial development—has reduced natural habitat and flood storage capacity, particularly around the SAPPI factory and along the south bank.

Invasive alien species are currently limited to terrestrial weeds along disturbed margins rather than aquatic plants, likely due to salinity and flow conditions. However, coastal access and human activity in the lower estuary, especially dive-boat launching and recreational fishing, cause recurrent disturbance to birds and intertidal habitats. Collectively, these cumulative pressures—structural modification, sand extraction, contamination, habitat alteration, and disturbance—have eroded the resilience of the uMkhomazi Estuary and will require integrated management actions focused on connectivity restoration, sediment control, and stricter regulation of extractive and recreational uses.

2.6 Coastal Access

Public access to the uMkhomazi Estuary and adjacent shoreline is primarily from the north bank, via a short access road branching off the R102 coastal road near the town of Umkomaas. This route provides direct entry to the estuary mouth and adjoining beach area, which are used intensively for recreational fishing, beach access, and commercial dive-boat launching linked to the Aliwal Shoal Marine Protected Area. The formal boat launch site is situated on the beach at the mouth, but in practice, some operators continue to use the estuary channel for launching and recovery, causing localised bank erosion and disturbance to birds and intertidal habitats. Pedestrian access is also high, with anglers regularly using informal paths and reedbed areas upstream of the iMpisini stream. While this access supports the social and economic value of the area, it also poses ongoing management challenges related to habitat disturbance, littering, vehicle encroachment, and safety. Improved demarcation of access points, control of off-beach vehicle movement, and clear signage within the Estuarine Functional Zone (EFZ) would

help balance public use with the conservation objectives of this important estuary–coastal interface. This is dealt with in section 5.

2.7 Opportunities and Constraints

Reflecting from the detail in the Situation Assessment report it is apparent that a number of opportunities exist to improve estuary health and manage impacting activities. However, several significant constraints have also been identified, particularly around infrastructure and socio-economic developments in the catchment and these will present challenges to ensure they prevent impact on estuary function and health.

The uMkhomazi Estuary remains one of KwaZulu-Natal's few large, relatively unmodified systems, combining high ecological integrity with strong hydrological and biodiversity value. Its natural flow regime, intact riparian margins, and contribution to the Aliwal Shoal Marine Protected Area make it a site of exceptional ecological and functional importance. The estuary benefits from low industrial pressure, high aesthetic and tourism potential, and a unique long-term dataset spanning more than two decades. These strengths provide a firm foundation for evidence-based management and restoration planning. Institutional commitment from local and provincial authorities, coupled with its recognition as a national, provincial, and municipal conservation priority, further strengthens prospects for effective future stewardship.

Despite these advantages, several weaknesses and constraints limit the estuary's resilience. Permanent infrastructure such as bridges, causeways, and the SAPPI weir have irreversibly altered habitat and hydrodynamics, while non-point source pollution, poor wastewater management, and limited inter-agency coordination continue to erode ecosystem health. Governance fragmentation and insufficient enforcement of existing legislation—particularly around sand mining, land-use control, and discharge management—remain persistent challenges. These structural and institutional weaknesses underscore the need for a formalised estuary management structure with clear roles, mandates, and accountability.

At the same time, there are notable opportunities for innovation and recovery. The establishment of a dedicated uMkhomazi Estuary Management Committee or Forum could improve coordination, build capacity, and drive implementation of the Estuary Management Plan. Programmes to improve water quality, promote long-term ecological

monitoring, and link education, research, and community participation could strengthen stewardship and awareness. The estuary also offers scope for eco-tourism, carbon sequestration initiatives, and integration into land stewardship and biodiversity offset programmes, particularly given its adjacency to the Aliwal Shoal MPA and the eThekweni Biodiversity Network.

However, the system faces growing threats from upstream water resource developments such as the uMkhomazi Water Project, large dam construction, urban expansion, sand mining, and pollution from both catchment and marine sources. Broader-scale pressures including sea-level rise, climate change, and loss of political or financial support could further compromise the estuary's health. Without proactive management interventions, the estuary's moderate ecological status (Category C) could deteriorate. Yet, with targeted restoration, improved governance, and stakeholder engagement, the uMkhomazi Estuary has the potential to achieve its Target Ecological Category (B/C) and continue delivering vital ecosystem services to both people and nature.

2.8 Key Information Gaps

A frequent gap during the development of estuarine management plans is the absence of recent data. The uMkhomazi Estuary is exceptional in South Africa for its comprehensive 24-year dataset (1998–2022) of physico-chemical and biological monitoring, originally initiated to assess the impacts of SAPPI's water abstraction activities from the weir at the *de facto* head of the estuary. With the recent acceptance that a fish ladder will be incorporated into the weir construction, monitoring will be essential to evaluate connectivity and flow-related impacts.

Key pressures include forestry, abstraction, and the new inter-basin transfer scheme, all of which may further reduce freshwater inflows. Sustained monitoring of water quality, flow use, sediment toxicity, and biotic communities is therefore critical to safeguard estuarine health and to guide adaptive management under changing catchment and climate conditions. The forty-year dataset of daily mouth state provided by SAPPI SAICCOR is an exceptionally valuable resource and continuation and maintenance of this dataset is essential. This could be easily lifted to an automated process with the installation of a water level recorder near the mouth.

3 GEOGRAPHICAL BOUNDARIES OF THE ESTUARY

In order to ensure the present and future health of estuaries, it is necessary to define the 'space' within which estuaries function over longer time scales – these areas are referred to as the EFZ. The NBA (Van Niekerk *et al.* 2019 a,b,c,d) defines the EFZ as *"the area that not only encapsulates the estuary waterbody, but also the supporting physical and biological processes and habitats necessary for estuarine function and health. It includes all dynamic areas influenced by long-term estuarine sedimentary processes, i.e. sediment stored or eroded during floods, changes in channel configuration, aeolian transport processes, and changes due to coastal storms. It also encompasses all the multiple ecotones of floodplain and estuarine vegetation that contribute detritus (food source) and provide refuge from strong currents during high flow events"*

The upstream boundary of the estuaries was determined as the limits of tidal variation or salinity penetration, whichever penetrates furthest. The estuary mouth was taken as the downstream boundary of an estuary. The highly dynamic nature of this area presents a significant challenge to accessing change in biodiversity and even managing estuaries. To account for this, and to allow for a seamless integration with the Marine and Coastal Realm, the concept of 'Estuarine Shore' was introduced to reflect the dynamic nature of the interface between estuaries and the coast. The term 'estuarine shores' refers to sand berms or bars that form in front of estuaries. They vary substantially in size and shape over decadal scales and can be completely absent during a flood or a near permanent feature during periods of low flow. Estuarine Shore was defined as the area from the base of the foredune, or where this line would be if dunes were present, to the back of the surf zone. The full extent of the Estuarine Shore is encapsulated in the EFZs and not be considered separate from the functional unit. The surfzone was included to reflect a continuum in estuarine-marine connectivity through estuarine inputs to the surfzone, either as direct flow through an open mouth or in seepage through the berm in a closed system.

The geographical extent of the uMkhomazi Estuary has been progressively refined through successive studies and National Biodiversity Assessments (NBAs). The NBA 2011, the 5 m above mean sea level (amsl) contour was used as a first-order desktop delineation, guided primarily by topography and vegetation patterns. However, subsequent analysis identified that this approach underestimated the spatial extent of

dynamic estuarine processes, particularly in larger systems such as the uMkhomazi. The NBA 2018 therefore adopted a more inclusive, process-based method that integrated 5 m and 10 m topographic contours, supported by LiDAR elevation data, to better capture the natural variability of estuarine form and function. For higher-flow systems where these contours lie in close proximity, as is the case at uMkhomazi, the 10 m contour or a combination of the 5 m and 10 m contours was selected as the default boundary to account for mapping uncertainty, floodplain processes, and long-term morphological change.

This refined delineation defines the Estuarine Functional Zone (EFZ)—the spatial envelope within which the estuary and its supporting processes operate. As defined by Van Niekerk et al. (2019), the EFZ encompasses not only the estuarine waterbody but also all adjacent areas influenced by sedimentary, hydrodynamic, and ecological processes. It includes floodplains, backwater channels, aeolian dunes, and vegetated transition zones that provide detrital input, habitat connectivity, and refuge during high-flow events. In the case of the uMkhomazi, this zone extends from the SAPPI weir (approximately 6 km from the mouth) to the shoreline and nearshore marine interface, representing an estimated area of about 130 ha.

Importantly, the EFZ is recognised in South African legislation as a sensitive environmental area. Under the NEMA Environmental Impact Assessment Regulations (2010), any development or land-use change within this zone requires formal environmental authorisation. The EFZ also has direct relevance to the Integrated Coastal Management Act and the National Water Act, both of which must consider the implications of floodplain connectivity, back-flooding potential, and the maintenance of ecological processes that sustain the estuary's long-term health. Accurate delineation and protection of the EFZ are therefore fundamental prerequisites for effective estuarine management and for ensuring the resilience of the uMkhomazi system in the face of catchment modification and climate variability.

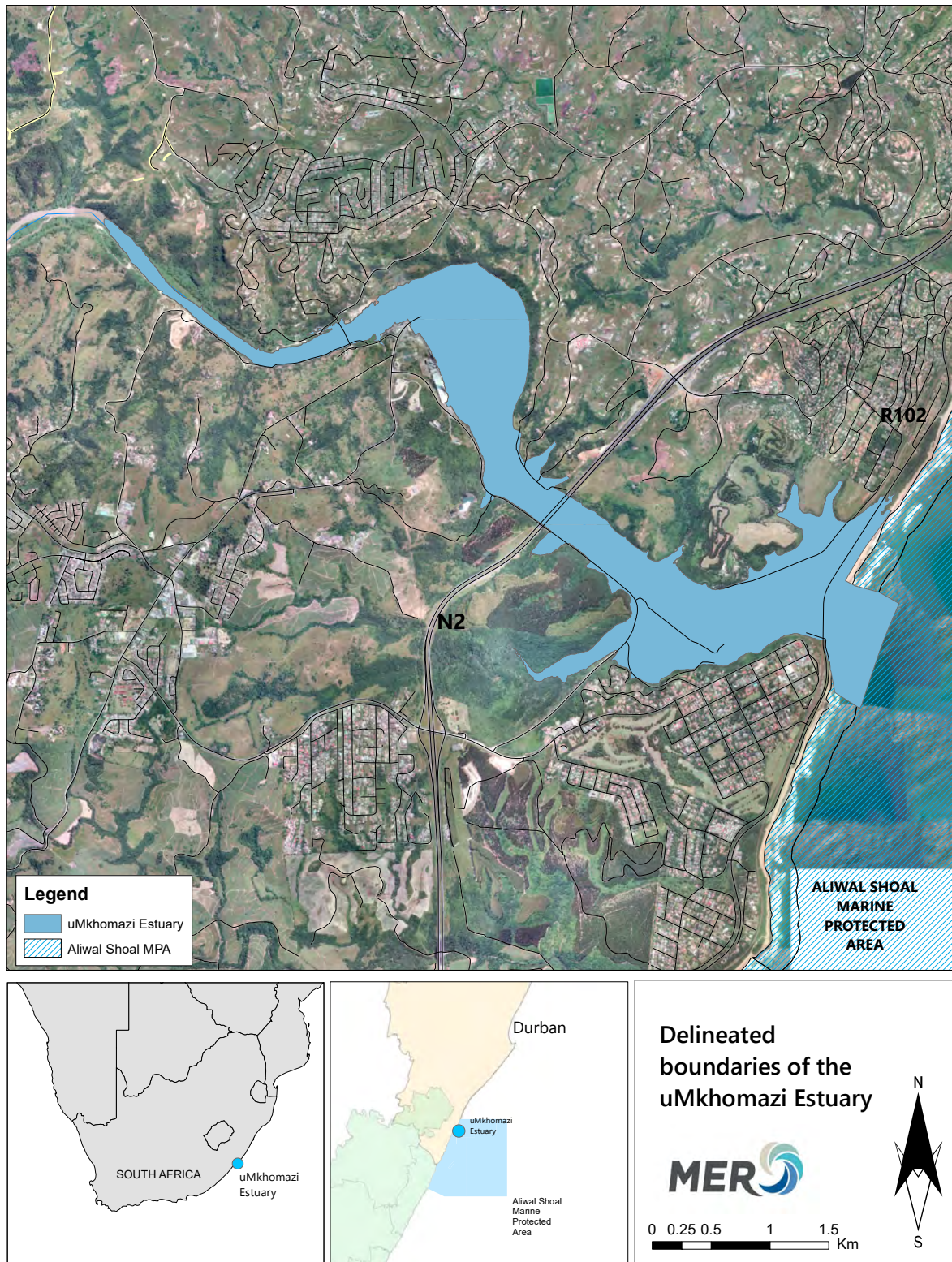


Figure 3-1 The EFZ (130ha) of the uMkhomazi Estuary with the road network and other key features and areas discussed in the text

4 VISION AND KEY STRATEGIC OBJECTIVES

4.1 Vision Statement

South Africa's National Estuarine Management Protocol (DEA 2013: Government Gazette 36432. No 341 of 10 May 2013) provides a national vision for estuary management within the country as a whole i.e. *"The estuaries of South Africa are managed in a sustainable way that benefits the current and future generations."* Implicit again in this statement, as previously emphasised, is the fact that management must refer to the control and mitigation of human impacts on estuarine function while appreciating that diversity within the natural drivers of catchment effects and marine influences have historically been the determinants of the nature of individual systems.

The following vision statement for the uMkhomazi Estuary was developed and presented at a workshop to present the Situation Assessment Report (MER 2025) held on the 26th with authorities and the 28th August 2025 with all stakeholders:

The uMkhomazi Estuary is envisioned as a healthy, resilient, and well-functioning system that sustains its unique ecological role within the eThekweni coastal landscape and strengthens its connection to the Aliwal Shoal Marine Protected Area.

As one of the few estuaries that remains predominantly open year-round, it supports ecological connectivity, delivers freshwater, sediment, and nutrients to the inshore marine environment, and maintains essential estuarine and marine biodiversity. This functionality underpins fisheries productivity, coastal stability, and critical ecosystem services for local communities.

Through collaborative stewardship, sound science, and adaptive management, the uMkhomazi Estuary will be safeguarded and progressively elevated to greater formal protection, ensuring it endures as a cornerstone of ecological diversity, cultural value, and sustainable coastal development within the eThekweni Municipality.

4.2 Key Strategic Objectives

The specific objectives which underpin this vision statement include, not necessarily in priority order, are as follows:

- ❖ **Improve institutional arrangements and cooperation** through the formation of an Estuary Management Forum (**EMF**) composed of relevant authorities and stakeholders who will undertake to implement the uMkhomazi EMP.
- ❖ **Develop partnerships** for the integrated management to assist this uMkhomazi EMF to achieve the targets of the EMP
- ❖ **Protect and restore key habitats within the Estuarine Functional Zone (EFZ)** Rehabilitate degraded riparian, intertidal, and floodplain habitats and prevent further habitat loss through sustainable land-use practices and enforcement of environmental regulations within the EFZ.
- ❖ **Enhance knowledge, monitoring, and adaptive management** Continue and expand long-term monitoring of physical, chemical, and biological indicators; build on the unique 1998–2022 dataset; and apply findings through adaptive management and transparent reporting. Update and implement the monitoring programmes to cover the entire EFZ and the seasonality of flow and states.
- ❖ Improve the present-day estuarine health raising it from its present **C** category to the recommended **B** status. This requires a multipronged approach to deal with different estuary abiotic and biotic components as well as impacting activities and inappropriate infrastructure.
- ❖ To ensure that the uMkhomazi's Estuary's resilience is improved and that this ecological resilience remains in place as the area surrounding it continues to be developed and transformed.
- ❖ Educate and raise awareness to creation of a greater appreciation of the environmental, social, and economic value of the estuary amongst all neighbours and users of the system.
- ❖ Consideration of the protection of the estuary through its incorporation into a formal conservation area (part of the MPA?) or as an area incorporated into a biodiversity stewardship project under the National, Provincial or Municipal Biodiversity Stewardship initiatives.

5 MANAGEMENT OBJECTIVES AND REQUIRED ACTIONS

5.1 Management Objectives

The management objectives for the uMkhomazi Estuary have been developed from the opportunities and threats identified during the Situation Assessment as well as from the local vision and key objectives for the estuary. The aim of this section is to list the overarching objectives which deal with the activities impacting the health of the uMkhomazi Estuary and which will need to be addressed to achieve the vision and allow implementation of the required actions. The management objectives and activities were identified during the presentation of the scoping phase by estuary specialists and through consultation with authorities and stakeholders.

In order to achieve the vision for the estuary, the following key management objectives have been identified:

Key management objectives are to:

- ❖ **Establish an uMkhomazi Estuary Management Forum (EMF)** to coordinate planning, implementation, and compliance monitoring across authorities and stakeholders.
- ❖ **Continue and enhance long-term ecological monitoring**, integrating historical datasets (1998–2022) with ongoing surveys.
- ❖ **Maintain and improve water quality**, addressing both diffuse and point-source pollution.
- ❖ **Conserve, restore and protect** remaining estuarine habitats within the delineated Estuarine Functional Zone (EFZ) and its buffers.
- ❖ Rehabilitate degraded riparian and floodplain habitats and control invasive vegetation.
- ❖ **Safeguard ecological connectivity** from the catchment to the Aliwal Shoal Marine Protected Area through coordinated land-sea management.
- ❖ **Secure and manage environmental flows** to maintain hydrological and salinity regimes essential for estuarine health.

- ❖ **Prevent and control** sandmining and other destructive impacting activities within and adjacent to the EFZ.
- ❖ **Promote sustainable livelihoods and eco-tourism** opportunities compatible with conservation objectives.
- ❖ **Foster education, awareness, and community stewardship** to build a culture of protection and responsible use.
- ❖ **Work towards formal protection status** for the uMkhomazi Estuary in alignment with the Aliwal Shoal MPA and the eThekweni Biodiversity Stewardship Programme.

5.2 Management actions

The objectives in Section 5.1 have been assigned actions and where applicable, a description of the ecological impact or socio-economic consequence, the responsible implementing agent as well as the expected duration in which the action should be implemented has been provided. Where objectives are achieved through similar action items these have been combined to produce an easy-to-follow guide to the actions in the tables below.

5.2.1 *Establish an estuary management forum (EMF) and develop partnerships for the integrated management of the estuary and Monitor and facilitate responsible commercial and infrastructural development within and immediately adjacent to the EFZ*

Specific action	Ecological consequence	Responsible Agency	Duration
Establishment of an uMkhomazi EMF with a clear terms of reference and wider representation from government and stakeholders	Co-ordinated and co-operative management of the estuary guided by the EMP	KZN EDTEA/ eTM / Stakeholders /IAPs	Immediate
Landowners not already participating in this EMP within and adjacent to the EFZ should be drawn into the planning and implementation.	Co-operative management improved of the estuary improved and better control of impacting activities.	uMkhomazi EMF with strong support from EPCPD (eTM) and KZN EDTEA	Urgent for immediate action.
Develop partnerships with developers of Renishaw and other authorised developments to ensure the most appropriate outcomes and best practice implementation during construction and through the life of the development	Protection of the estuary through actions and buffers from disturbance (influencing sensitive biota), poor water quality and quantity runoff (whole estuary benefits), and pressure impacts.	uMkhomazi EMF with strong support from EPCPD (eTM) and KZN EDTEA	Urgent for immediate action.
Explore possible eco-tourism and other appropriate activities which will enhance the value of the estuary and surrounding areas through additional services and benefits.	The estuary will be surrounded by an additional protective layer through activities that are low impact or have no impact or enhance estuary services. This will provide some assurance of sustainability of estuary process and function into the future.	uMkhomazi EMF with a specialist economist or specialist in integrated conservation and rural development	First three years

Specific action	Ecological consequence	Responsible Agency	Duration
		programmes that improve social and economic well-being while considering environmental processes.	

5.2.2 Conserve and protect the remaining habitats within the delineated estuary boundary. This should include the establishment of appropriate buffers where topography and proposed development and other activities are proposed and Encourage natural ecological functioning and processes and improve the overall health of the estuary by restoration/remediation of habitats or mitigation of impacting activities.

Specific action	Ecological consequence	Responsible Agency	Duration
Establish boundaries of EFZ on the ground and determine appropriate buffers particularly in light of any development plans authorised or in process	Protection of estuary space providing room for natural processes and forming a first line of defence from impacting activities along estuary boundary	uMkhomazi EMF with strong support from EPCPD (eTM) and KZN EDTEA	Immediate and urgent action item and on-going
Enact some form of protected status for the estuary. Consideration of the protection of the estuary through its incorporation into a formal conservation area or as an area incorporated into a biodiversity stewardship project under the National,	The estuary interfaces with the Aliwal Shoal MPA and as such there is a strong motivation for estuary to be incorporated with protected status as part of this important biodiversity mosaic. It is also a good candidate area for a biodiversity stewardship	EMF in collaboration with - it is recommended that the eThekweni Municipality's Biodiversity Stewardship Programme ¹ is	Ongoing

¹ Establishment of the EM's Biodiversity Stewardship Programme prompted the formation of the Biodiversity Stewardship Task Team (BSTT), comprised of staff that either (a) have biodiversity stewardship as a deliverable on their individual performance plans or, (b) are voluntary members with keen interest in biodiversity conservation. The task team currently consists of members from several branches of the Environment Planning and Climate Protection Department (EPCPD), which deal with biodiversity planning, development impact assessment, project implementation, and environmental management. Since the establishment of the BSTT, the team has had the Ethekeeni Biodiversity Stewardship Policy developed and formally approved by Council in May 2017. The team

Specific action	Ecological consequence	Responsible Agency	Duration
Provincial or Municipal Biodiversity Stewardship initiatives.	project through a municipal, provincial or national programme.	contacted initially for advice on how to proceed.	
Establish appropriate management lines in addition to the EFZ to reduce risks and enhance Climate Crisis adaptation measures	Management lines determined and enforced. This ensures estuary function and sustainability on a longer time scale.	KZN EDTEA (DEFF) EM uMkhomazi EMF EMF	Urgent and ongoing
Establish the water quantity and quality inputs to the estuary and put steps in place to manage these into the future.	A health hydrological profile and quality of water to the estuary are the main drivers of ecosystem health.		As soon as possible and ongoing
Rehabilitate riparian vegetation where necessary within the EFZ and in collaboration with neighbouring landowners.	Removal of alien invasive species (terrestrial and aquatic) to improve overall EHI through a change to the vegetation score and even possibly the invertebrate, fish and bird biotic scores.	DEA, DWS, EPCPD, EPWP & uMkhomazi EMF	As soon as possible and ongoing
Management and control of alien invasive floating aquatic plant species. It is important that this response is not treated but the causes which result in the proliferation of these species i.e. excessive nutrient input (see specific actions under water quality)	The removal of these floating macrophytes will increase light penetration to the benthos and improve flow and water quality. Approved, and suitable methods of removal must be undertaken e.g., water hyacinth is a class one invasive species which requires a permit prior to its removal.	DEA, DWS, EPCPD, EPWP & uMkhomazi EMF	As soon as possible and ongoing

5.2.3 Update estuary health status and implement monitoring programmes to confirm present ecological status in more detail than the current programme and allow temporal changes to be tracked.

Specific action	Ecological consequences	Responsible Agency	Duration
Implement the Recommended Integrated Monitoring Plan	Confirmation PES is critical to establish a realistic baseline against which to track progress of the uMkhomazi EMP	uMkhomazi EMF with strong support from DWS, DEFF,	Immediate and urgent action item and on-going

has also had the BS eco-file produced (in both isiZulu and English) to raise awareness about the eThekweni Biodiversity Stewardship programme.

	A deeper understanding of the state of the estuary, will allow better and more focussed responses to the specific action items needed to improve the outcomes of the EMP	EPCPD (eTM) and KZN EDTEA	
Forensic audit of impacting activities including diffuse and point source pollution inputs, irregular infrastructure	Understand the issue and focus interventions starting with the most impacting activities and working down.	uMkhomazi EMF with strong support from DWS, DEFF, EPCPD (eTM) and KZN EDTEA	Immediate and urgent action item and on-going

5.2.4 Promote education and awareness and facilitate research opportunities within the estuary.

Specific action	Ecological consequence	Responsible Agency	Duration
Increase awareness of estuary importance, health, impacting activities and ecosystem services	Develop and implement public awareness programme	uMkhomazi EMF KZN EDTEA/	Ongoing and life of EMP
Maximise education opportunities	Encourage active involvement of schools, particularly local schools within the catchment, through environmental education programmes. An education centre is a possibility to be considered here.	uMkhomazi EMF with strong support from EPCPD (eTM) and KZN EDTEA	Ongoing and life of EMP
Involvement of stakeholders, scholars and neighbours in monitoring of the estuary	Prepare annual report card on estuarine health with benefits of increasing awareness.	uMkhomazi EMF with strong support from EPCPD (eTM) and KZN EDTEA	Ongoing and life of EMP
Ensure that any economic development in the EFZ and the immediately adjacent areas occurs in a manner that does not negatively impact the health of the system and is in full compliance with all relevant environmental legislation.	The estuary will be surrounded by an additional protective layer through activities that are low impact or have no impact or enhance estuary services. This will provide some assurance of sustainability of estuary process and function into the future.	EMF with a specialist economist or specialist in integrated conservation and rural development programmes that improve social and economic well-being while	First three years

Specific action	Ecological consequence	Responsible Agency	Duration
		considering environmental processes.	

5.2.5 Strengthen compliance monitoring and enforcement of activities within and immediately adjacent to the EFZ.

Specific action	Ecological consequence	Responsible Agency	Duration
Identify pollution sources driving degradation of water and habitat quality	A clear database of all illegal and legal discharges. Legal discharges should be checked for compliance with conditions	uMkhomazi EMF with strong support from DWS, EPCPD (eTM) and KZN EDTEA	Immediate and urgent action item and on-going
Improve ecological integrity of degraded estuary habitats through compliance with the legislated requirements for specifically identified interventions.	Removal of alien invasive vegetation Removal or improvement of all causeways or unnatural flow obstructions	DEA, DWS, eTM (incl) EPCPD, EPWP & uMkhomazi EMF	Prioritise / Ongoing
Audit sand mining operations impacting on the estuary and ensure compliance	Disturbance of habitats, destruction of riparian vegetation, facilitation of alien vegetation colonisation and sediment budget disturbances to estuary and coast.	uMkhomazi EMF, DMR, KZN EDTEA, eTM	Prioritise / Ongoing
Compliance with development authorisations and conditions.	Best practice and principles applied to ensure impacts to estuary are minimised.	uMkhomazi EMF	Prioritise / Ongoing
Encourage public participation and reporting of suspected illegal activities within the EFZ through awareness programmes, clear reporting pathways, and improved communication between authorities, stakeholders and local communities.	Improved detection and reporting of illegal activities including unlawful sand mining, pollution incidents and habitat destruction, supporting more effective compliance and enforcement actions.	uMkhomazi EMF with support from KZN EDTEA, DFFE, eThekweni Municipality and relevant enforcement authorities.	Immediate and ongoing.

6 PROPOSED ZONATION OF ACTIVITIES

DEA (2015) states that the planning and zonation of activities in coastal environments are increasingly becoming a necessity rather than an option. This need has been acknowledged by stipulating the zonation of activities as one of the minimum requirements in estuarine management planning. They define the process of zonation (or spatial planning) in the context of estuarine planning as “a process of analysing and allocating the spatial and temporal distribution of human activities and conservation areas in an estuary to achieve the vision and objectives (*i.e.*, the envisaged outcomes).”

A zonation plan therefore provides a means of spatially depicting the envisaged desired state for a particular estuary and would typically allow for:

- ❖ Partitioning of activities within the estuary and its catchments thus permitting their existence without one activity precluding or conflicting with another.
- ❖ Identifying sensitive habitat fragments for protection and restoration.
- ❖ Focussing management activities in specific areas.
- ❖ Guiding future land/water uses and development activities in the area.

The uMkhomazi Estuary is a large, permanently open, and hydrologically active estuary approximately six kilometres long, with an Estuarine Functional Zone (EFZ) of approximately 130 ha. Its size, diversity of habitats, and range of user activities — including boat launching to access the Aliwal Shoal Marine Protected Area, recreational angling, and shoreline access — make some spatial planning practical and necessary. Zonation will assist in balancing ecological protection with sustainable public and commercial use.

The authorised boat launch site associated with the Umkomaas/uMkhomazi Ski Boat Club is recognised as an important existing recreational and commercial access point to the adjacent Aliwal Shoal Marine Protected Area. The EMP does not propose relocation of this launch site. Should enhanced protection status for the estuary be pursued in future, this would need to be considered through the relevant statutory process and should explicitly consider existing lawful access arrangements, safety requirements, launch-site authorisations, and the socio-economic importance of the launch site. Protected status would not necessarily preclude continued boat launching, but may require appropriate

zonation, operating conditions, speed/no-wake controls, launch monitoring, signage and compliance measures to ensure that access remains compatible with estuarine ecological functioning and user safety. This is supported by the public launch-site regulations: protected-area management plans can identify public launch sites within protected areas, and public launch sites are managed through operational plans/conditions rather than automatically prohibited. The Aliwal Shoal MPA itself already includes controlled zones around Umkomaas beach areas, so the existence of an MPA framework is not inherently incompatible with managed vessel access.

Zonation recognises varying sensitivity from the mouth and nearshore interface through the mid-estuary reaches to the upper estuarine and freshwater transition, ensuring that activities are spatially managed to reduce conflict, maintain ecological processes, and enhance user safety.

It is therefore proposed that the uMkhomazi Estuary be divided into functional management zones (Figure 6.1), each with specific guidelines:

- ❖ **Mouth and near-shore interface**– maintained primarily for sediment dynamics and safe boat access to the Aliwal Shoal MPA; beach launches to occur only from the authorised site on the north bank.
- ❖ **Lower estuary** (mouth to old public jetty) – low-impact recreation area; slow-speed boating permitted below the public slipway only; no jet-ski operation or high-speed craft.
- ❖ **Middle estuary** (old slipway to steel bridge)– core conservation area; no motorised boating or bait-netting; protection of wader and fish nursery habitats.
- ❖ **Upper estuary** (N2 bridge to SAPPI weir) – restricted management area; access for monitoring and maintenance only; protection of riparian rehabilitation and fish-ladder operations.
- ❖ **Floodplain and riparian buffer** – maintained as a development-free zone to support flood attenuation, habitat connectivity, and climate-resilience.

General management provisions applicable throughout the estuary should include:

- ❖ No cast-netting or bait collection within the estuary due to the narrow mouth, juvenile fish vulnerability, and potential impacts on benthic fauna.
- ❖ No sand-mining, dredging, or infilling within the EFZ.
- ❖ Speed limit of 5 knots and *no-wake* operation for all authorised craft.
- ❖ Pedestrian access confined to designated trails; vehicles prohibited within the EFZ except for emergency or authorised management purposes.
- ❖ Ongoing enforcement and compliance monitoring coordinated through the proposed uMkhomazi Estuary Management Forum (EMF).

The zonation framework will form the spatial foundation for this Estuary Management Plan and must be refined in consultation with stakeholders, SAPPI, municipal authorities, and the Aliwal Shoal MPA management team to ensure integration of the land–sea interface and long-term protection of this ecologically and economically significant estuary.

7 RECOMMENDED MANAGEMENT PRIORITIES

This chapter prioritises the listed management actions (as linked to Section 5.2: Management Actions) and does not repeat the detailed descriptions. It simply provides a concise list of the priority actions and the order in which they should be undertaken under each management category to support coordinated implementation of the uMkhomazi Estuary Management Plan.

1. Establishment of a uMkhomazi Estuary Management Forum (EMF)

Formation of a representative EMF is the first and most critical step in ensuring cooperative governance of this complex system. The Forum should include local and provincial authorities, SAPPI, conservation agencies, local landowners, the Umkomaas community, and user representatives such as divers and anglers. Urgent sub-actions include formalising partnerships with SAPPI (regarding the weir and fish ladder monitoring), developers of adjacent areas, and the Aliwal Shoal MPA management team to align land-sea management goals.

2. Implementation of an Integrated Monitoring Programme and Confirmation of Present Ecological Status (PES)

Building on the exceptional long-term dataset (1998-2022), a renewed, coordinated monitoring effort must confirm the current baseline ecological health of the estuary. This includes regular water quality and flow monitoring, sediment sampling, and biological surveys (fish, invertebrates, and birds) to validate and update the desktop Ecological Health Index. The programme should also assess the effectiveness of the new fish ladder and track flow impacts associated with abstraction and the uMkhomazi Water Transfer Scheme.

3. Confirmation and Ground-Truthing of the Estuarine Functional Zone (EFZ)

The delineation of the EFZ and associated buffer zones must be verified on the ground using current topographic, LIDAR, and vegetation data. This process should ensure that the EFZ incorporates all dynamic floodplain and backwater areas up to the 10 m amsl contour and includes provisions for climate resilience and future flood attenuation. Clear signage and mapping of the EFZ boundaries should follow, accompanied by awareness campaigns for landowners and developers.

4. Identification and Management of Pollution Sources

A forensic audit is required to identify point and non-point pollution sources, including effluent from the Mpisini wastewater works, stormwater from bridges and roads, agricultural runoff, and any industrial discharges. This database should form the foundation for compliance monitoring and enforcement under the EMF, ensuring progressive improvement of water quality and sediment health.

5. Control and Rehabilitation of Riparian and Floodplain Habitats

Restoration of degraded riparian zones along the south bank and upper estuary should begin immediately, with removal of alien vegetation and re-establishment of indigenous vegetation. Collaboration with landowners, SAPPI, and municipal programmes (e.g., EPWP, Land Stewardship) is essential to restore ecological connectivity and buffer function.

6. Implementation of Activity Zonation and Regulation Framework

Adopt and enforce the proposed zonation of activities (Section 6) through clear communication, signage, and compliance patrols. Priorities include regulating boat and jet-ski access, prohibiting cast-netting and bait collection, and enforcing speed limits and no-go zones for conservation areas. Coordination with Aliwal Shoal MPA authorities will be essential for safety and ecosystem integrity across the land-sea interface.

7. Climate Change Resilience, Thresholds and Adaptive Management

The uMkhomazi Estuary is a highly dynamic system whose functioning is strongly influenced by interactions between freshwater inflow, marine processes, sediment dynamics, flood events and coastal geomorphology. Future climate change pressures, including sea-level rise, altered rainfall patterns, increased hydrological variability, changing flood frequency and prolonged low-flow conditions, have the potential to significantly influence estuarine processes, ecological functioning and the spatial extent of the Estuarine Functional Zone (EFZ).

Although precise future trajectories remain uncertain, the estuary management approach should incorporate adaptive management principles that recognise the likelihood of progressive environmental change over time. Long-term monitoring

programmes should therefore include indicators capable of detecting climate-related trends and changes in estuarine condition. These may include, where feasible, monitoring of:

- ❖ changes in estuarine mouth state frequency, duration and behaviour;
- ❖ salinity intrusion and hydrodynamic patterns;
- ❖ shoreline movement, erosion and sediment deposition trends;
- ❖ changes in floodplain connectivity and inundation extent;
- ❖ shifts in the spatial extent or functional behaviour of the EFZ relative to existing delineation contours;
- ❖ changes in freshwater inflow patterns and low-flow persistence; and
- ❖ habitat response within intertidal, riparian and floodplain areas.

Where significant long-term trends or deviations from expected estuarine functioning are identified, the EMP and associated management responses should be reviewed and updated through an adaptive management process. This may include reassessment of monitoring priorities, management interventions, setback or buffer considerations, rehabilitation priorities, infrastructure vulnerability, and future land-use planning within and adjacent to the EFZ.

Given the strategic importance of the uMkhomazi Estuary within the regional coastal system and its ecological linkage to the Aliwal Shoal Marine Protected Area, maintaining ecological resilience in the face of climate-related change should remain a central long-term management objective.

8. Promote Environmental Education, Awareness and Eco-tourism Opportunities

Develop and promote educational programmes highlighting the ecological importance of the uMkhomazi Estuary and its link to the MPA. Support low-impact recreational and tourism activities such as birdwatching, guided estuary walks, and educational diving or estuary-reef interpretation to build local stewardship and economic value.

8 INTEGRATED MONITORING PLAN

Estuaries are dynamic systems and conditions are continually changing as a result of natural processes and human activities. Consequently, an effective management plan for an estuary must retain certain flexibility so that modifications can be made in relation to environmental change and changes in human activities. The EMP therefore needs to be considered as a rolling programme of liaison and action, rather than a one-off, all embracing management plan. The management actions outlined in this EMP are not exhaustive and should be added to as the plan progresses and goals are achieved. Also when new issues are highlighted and as issues currently highlighted are resolved, the necessary adjustments to the EMP will be made. This EMP is regarded as the first of a series of rolling five year plans, with the EMP being subject to on-going review to ensure continuing validity and relevance.

A significant constraint to change detection in estuaries is the lack of long-term measured data on South African estuaries. One of the challenges that has led to this situation is the existence of a range of mandated Departments involved in estuary management and therefore monitoring. However, some progress has been made since the NBA 2011. Given the dynamic nature of the uMkhomazi Estuary and the potential influence of climate change, sea-level rise and altered freshwater inflows on estuarine functioning, long-term monitoring programmes should, where feasible, include indicators capable of detecting climate-related change. These may include changes in estuarine mouth state frequency and duration, salinity distribution, shoreline and sediment dynamics, floodplain connectivity, and shifts in the spatial extent of the Estuarine Functional Zone (EFZ) relative to existing delineation contours. Significant long-term deviations or trends identified through monitoring should trigger review of management responses, zonation considerations and future revisions of the EMP under an adaptive management approach.

The Department of Water and Sanitation established the National Estuarine Monitoring Programme, NEsMP, in 2008. However, currently, the National Estuary Monitoring Programme implemented by DWS is under resourced (Cilliers and Adams 2016). This multi-tier, multi-parameter (include biotic and abiotic components) programme is based on current best practice and with sufficient funding, and support from other organs of state, could go a long way in addressing data deficiencies in future estuary assessments. The purpose of NEsMP is the monitoring of water quality, physico-chemical and

biological aspects for determining long-term trends and changes in the condition of South African estuaries. The NEsMP coordinates national monitoring efforts and provides support in the form of sampling equipment, training, data management and information dissemination, while collaborating institutions collect physico-chemical data and water samples. The absence of explicit listing suggests that uMkhomazi may not currently be included in the formal NEsMP network (or at least it was not in public datasets I could access). However, the DEA 2015 estuary management guideline stipulates that an integrated monitoring plan should be developed for each estuary and must cover three categories, namely:

- ❖ Resource monitoring, which is directed at specific ecological indicators (to monitoring the state or health of the natural resource – in this case the uMkhomazi estuary as defined by the EFZ)
- ❖ Compliance monitoring, which aims to monitor the effectiveness of the implementation of the EMP by assessing the intensity and nature of the activities occurring within the uMkhomazi Estuary. It would also serve to identify activities that are not compliant with the relevant legislation, policies and guidelines as described in the EMP, as well as timeously identify potential threats to estuary health.
- ❖ Performance monitoring, which is aimed at gauging progress in terms of achieving the management objectives, and ultimately, the vision (and associated outcomes) for the uMkhomazi estuary, relative to its management plan.

To address these categories the integrated monitoring plan has been provided that indicates the activity/output, the indicator, the temporal scale, the target, and the responsible authority. The uMkhomazi Estuary is a large, permanently open estuary (~6 km long, 130 ha EFZ) with high discharge, a major industrial abstraction (SAPPI), and connectivity to the Aliwal Shoal MPA. It experiences sandmining, pollution risks (iMpisini wastewater, stormwater, upstream forestry), and is a priority system under the National Biodiversity Assessment. It already has a good foundational 24-year monitoring record (1998–2022) — a unique legacy dataset to integrate and extend. Taking all this into account the suggested framework is included in the table below.

Future monitoring, evaluation and adaptive management actions undertaken as part of the implementation of this EMP should, where applicable, be aligned with and benchmarked against the gazetted Resource Quality Objectives (RQOs), Recommended Ecological Category (REC) and associated ecological reserve requirements established in terms of the National Water Act. Monitoring programmes should therefore be structured, where feasible, to assess trends in relation to these ecological objectives and to support adaptive management responses where deterioration from target conditions is detected.

Table 8-1 Monitoring recommendations for the uMkhomazi Estuary

Ecological Component	Action	Spatial Scale	Temporal Scale	Responsible Authority
BATHYMETRY & MORPHOLOGY				
Depth profiles of the estuary	Measure depth profiles across sectional transects and longitudinal profile at 200 m intervals; include flood-tide delta and mouth channel mapping.	Every 200 m - Entire estuary from mouth to SAPPI weir	Baseline and, then every 3–5 years or post-flood	uMkhomazi EMF / DWS contracting specialist
	Map bank erosion, sediment deposition and channel shifts using drone or LiDAR surveys.	EFZ and mouth	Annual visual survey	
WATER QUANTITY / HYDROLOGY				
Hydrology	Measure freshwater inflows just above the estuary.	Install a flow meter or recorder at or above the head of the estuary	Continuous	DWS
	Install and maintain water level recorder in the estuary relative to mean sea level.	As close to the estuary mouth as possible (R102 likely position).	Continuous	DWS
	Record scale, frequency and duration of episodic events.	The estuarine area whenever events occur e.g. flood, fish kill, pollutant contamination	Episodic	uMkhomazi EMF
Hydrodynamics	Visual record of mouth.	Fixed point photography of mouth	Weekly	uMkhomazi EMF
Mouth dynamics	Ensure daily mouth record is maintained.	Mouth	Daily	SAPPI already does this
Sediment fluxes	Collect grab samples across and along the estuary for analysis of particle size distribution.	Whole estuary at sampling sites	Baseline and thereafter every 2 years	uMkhomazi EMF
WATER QUALITY				
Physical and chemical variables	Measure temperature, salinity pH, dissolved oxygen, turbidity and toxins	Longitudinal axis of estuary over one spring and one neap tide (at least 5 stations)	Quarterly (seasonal)	DEFF/DWS
	Measure nutrients (nitrate, nitrite, ammonia and phosphate) and suspended solids.	Longitudinal axis of estuary over one spring and one neap tide (at least 5 stations)	Monthly	DEFF/DWS

Ecological Component	Action	Spatial Scale	Temporal Scale	Responsible Authority
	Analyse water samples for pathogens such as bacteria, Staphylococci and Enterococci species such as Escherichia coli	Longitudinal axis of estuary over one spring and one neap tide (at least 5 stations)	Monthly Weekly for one month if a sewage spill has occurred	DEFF/DWS
	If contaminated water reaches the estuary measure dissolved oxygen concentration in the water.	Longitudinal axis of estuary (at least 5 stations)	Daily for one month before sunrise	DEFF/DWS
	Record and report episodic events (floods, fish kills, pollution incidents).	Entire estuary	Event basis	DWS and uMkhomazi EMF
SEDIMENT DYNAMICS				
	Collect grab samples for particle size, organic content, and contaminants (metals, hydrocarbons, pesticides).	Representative upper, middle, lower estuary sites	Baseline then every 2 years	uMkhomazi EMF / DWS / DEFF
BIOTA				
Microalgae	Water chlorophyll-a measurements taken at the surface and 1 m depths, under typically high and low flow conditions. Intertidal and subtidal benthic chlorophyll-a measurements using a recognised technique or SANAS accredited laboratory.	Longitudinal axis of estuary (at least 5 stations)	Quarterly (seasonal)	DEFF/ DWS/ EMF
	Record relative abundance of dominant phytoplankton groups, i.e. flagellates, dinoflagellates, diatoms, chlorophytes and blue-green algae (cyanobacteria).	Longitudinal axis of estuary (at least 5 stations)	Quarterly (seasonal)	DEFF/ DWS/ EMF
Macrophytes	Map macrophyte communities in EFZ using hi-res aerial photography. This must be groundtruthed by field surveys. Red-data, protected and invasive species must be noted.	Whole EFZ	Once a year in summer	DEFF/ DWS/ EMF
Invertebrates	Surveys of the zooplankton, benthic invertebrate and larger crustaceans must be conducted. This should include burrowing species such as <i>Kraussilichirus kraussi</i>	Longitudinal axis of estuary (at least 5 stations)	Quarterly (seasonal)	DEFF/ DWS/ EM

Ecological Component	Action	Spatial Scale	Temporal Scale	Responsible Authority
	Collect sediment samples using the grab for particle size analysis and organic content (at same sites as zooplankton) (preferably link with sediment dynamics)	Longitudinal axis of estuary (at least 5 stations)	Quarterly (seasonal)	
Fish	Record species and abundance of fish, based on seine net sampling. Gill nets should not be deployed in such a small estuary as they will result in fish deaths	Longitudinal axis of estuary (at least 3-5 stations)	Quarterly (seasonal)	DEFF/ DWS/ uMkhomazi EMF
	Assess fish passage at SAPPI weir (evaluate fish ladder effectiveness).	Weir site	Annual	SAPPI/DEFF/ DWS/ uMkhomazi EMF
Birds	Undertake counts of all water-associated birds. All birds should be identified to species level and total number of each counted, covering as much of the estuarine area as possible, from a boat and on foot.	Whole EFZ	Seasonal (winter and summer counts must be conducted annually)	uMkhomazi EMF
LINKED COASTAL & MPA INTERFACE				
	Monitor sediment, nutrient, and turbidity fluxes between estuary and Aliwal Shoal nearshore zone.	Mouth plume & nearshore transect	Annual (summer)	DEFF Oceans & Coasts / MPA Team / EMF
	Collaborate on fish larvae and plankton exchange studies with MPA.	Estuary mouth and reef margin	Annual or project-based	uMkhomazi EMF / DEFF / MPA Team
CLIMATE & WEATHER DATA				
	Record rainfall, air temperature, and storm events at catchment and mouth.	Catchment & coast	Continuous	SAWS / DWS / EMF
PUBLIC & PARTICIPATORY MONITORING				
	Establish citizen-science group under EMF for mouth photography, bird counts, and litter surveys.	Mouth, banks, riparian zone	Continuous	EMF / Local NGOs / Schools

Notes:

- ❖ Data collected through this framework should align with the National Estuarine Monitoring Programme (NEsMP) Tier 1–3 guidelines and be submitted to DWS/RQIS.
- ❖ The long-term dataset (1998–2022) provides the baseline; new monitoring will serve for trend validation and adaptive management.
- ❖ Emphasis should be placed on integration with the Aliwal Shoal MPA, ensuring compatible methodologies for sediment, nutrient, and fish-community monitoring.

9 IMPLEMENTATION AND INSTITUTIONAL ARRANGEMENTS

Effective institutional arrangements guided by legislative frameworks are critical to achieving the goals of the uMkhomazi Estuary Management Plan (EMP). Implementation of the management actions listed in this document requires commitment from government, private sector partners, and civil society. The EMP is governed by the Integrated Coastal Management Act (ICMA, Act 24 of 2008) and the National Estuarine Management Protocol, published in terms of section 33(2) of the ICMA (Government Notice 341, Gazette 36432 of 10 May 2013).

The Protocol does not introduce new institutional structures but confirms that provincial and municipal coastal committees serve as the formal coordinating bodies for estuary management. Section 5 of the Protocol designates the KwaZulu-Natal Department of Economic Development, Tourism and Environmental Affairs (EDTEA) as the lead agency responsible for the development and implementation of estuary management plans, working collaboratively with municipalities and relevant authorities. The uMkhomazi Estuary EMP has therefore been prepared in consultation with the eThekweni Municipality, Department of Water and Sanitation (DWS), Ezemvelo KZN Wildlife, SAPPI Saiccor, and community stakeholders.

Section 34(1)(a) and (ii) of the ICMA requires that an EMP must:

- ❖ Be consistent with the National Coastal Management Programme (NCMP) and all applicable provincial and municipal coastal management programmes; and
- ❖ Be developed through the public participation process prescribed in Part 5 of Chapter 6 of the ICMA.

The NCMP recognises estuarine management as a national coastal priority. In response, EDTEA has commissioned the uMkhomazi EMP in terms of section 5.6 of the Protocol to ensure that this important, high-value system is managed in a sustainable, coordinated, and legally compliant manner. This EMP meets the requirements of the ICMA, the Protocol, and the DEA (2015) Estuarine Management Planning Guidelines.

9.1 Institutional Framework

Given the ecological, industrial, and social complexity of the uMkhomazi Estuary, implementation of this EMP requires integrated governance between multiple authorities and stakeholders. The recommended institutional arrangement is as follows:

- ❖ Lead Implementing Authority:
KwaZulu-Natal EDTEA (Coastal and Biodiversity Management), responsible for overall coordination, compliance with national policy, and reporting to the Minister.
- ❖ Supporting Implementing Authorities:
 - Department of Water and Sanitation (DWS): hydrology, flow regulation, and water-quality monitoring under the National Estuarine Monitoring Programme (NEsMP) framework.
 - eThekweni Municipality land-use control, wastewater management, and catchment interface.
 - Ezemvelo KZN Wildlife: biodiversity conservation, enforcement within the EFZ, and integration with coastal protected areas.
 - SAPPI Saiccor: industrial abstraction, compliance with water-use licence, and monitoring of fish-ladder functionality.
 - Aliwal Shoal MPA Management Team: integration of estuary–marine connectivity, monitoring of sediment and nutrient fluxes, and co-management of shared biodiversity objectives.
 - Civil Society and Research Partners: BirdLife eThekweni KZN, ORI, MER, WESSA, local NGOs, schools, and citizen-science initiatives for awareness and monitoring support.

9.2 Regulatory Authorisations and Compliance

A range of activities occurring within or adjacent to the Estuarine Functional Zone (EFZ) may require environmental authorisation, permits, licences or approvals in terms of applicable legislation and associated regulations. In particular, activities such as sand mining, infrastructure development, vegetation clearing, water abstraction, wastewater

discharge, dredging, alteration of riverbanks or estuarine habitat, and certain recreational or commercial activities may trigger requirements under legislation including the National Environmental Management Act (NEMA), National Water Act (NWA), Integrated Coastal Management Act (ICMA), Marine Living Resources Act (MLRA) and Mineral and Petroleum Resources Development Act (MPRDA). It remains the responsibility of applicants, landowners, developers, operators and relevant authorities to ensure that all necessary approvals and compliance requirements are identified and obtained prior to commencement of activities within or adjacent to the EFZ.

Table 9-1 Monitoring recommendations for the uMkhomazi Estuary

This table is indicative only and does not replace the need for proponents to confirm legal requirements with the competent authority.

Activity	Likely Regulatory Requirement	Primary Authority
Sand mining within/adjacent EFZ	EA, Mining Right/Permit, Water Use Authorisation	DMR, DWS, EDTEA
Development within EFZ/coastal buffer	NEMA EA, Coastal authorisation where applicable	EDTEA/eThekwini
Water abstraction/use	Water Use Licence/General Authorisation	DWS
Water abstraction/use	Water Use Licence/General Authorisation	DWS
Fishing activities	MLRA permits/rights	DFFE
Sand mining within/adjacent EFZ	EA, Mining Right/Permit, Water Use Authorisation	DMR, DWS, EDTEA
Development within EFZ/coastal buffer	NEMA EA, Coastal authorisation where applicable	EDTEA/eThekwini
Water abstraction/use	Water Use Licence/General Authorisation	DWS
Boat launching	Launch site permits/operational controls	DFFE/municipality

9.3 uMkhomazi Estuary Management Forum (EMF)

A uMkhomazi EMF should be formally established within six months of EMP gazettement. The Forum will function as the advisory and coordinating platforms for all stakeholders, promoting transparency, collaboration, and accountability. The uMkhomazi Estuary Management Forum (EMF) is intended to function as a cooperative governance, coordination, advisory and stakeholder engagement structure to facilitate implementation of the EMP, improve communication between authorities and stakeholders, support monitoring and reporting, and promote integrated estuary management.

The EMF itself does not hold independent statutory enforcement or permitting powers. Compliance monitoring, regulatory enforcement, directive issuance and permitting responsibilities remain vested in the relevant competent authorities in terms of their respective legislative mandates, including but not limited to KZN EDTEA, DWS, DFFE, eThekweni Municipality and DMRE.

Key responsibilities include:

- ❖ Facilitating implementation of management actions and monitoring programmes;
- ❖ Overseeing alignment with NEsMP and ICMA frameworks;
- ❖ Coordinating with the Aliwal Shoal MPA Forum on shared objectives;
- ❖ Reviewing data and preparing annual Estuary Health Report Cards; and
- ❖ Advising EDTEA and municipalities on policy, compliance, and funding priorities.

The Forum should elect a Chairperson and Secretariat, meet at least quarterly, and maintain a transparent record of decisions, progress, and data.

9.4 Monitoring, Reporting and Evaluation

All lead agencies must develop project implementation plans linked to the EMP's management actions and their statutory mandates. The EMF will consolidate progress through synthesis of all actions, the annual monitoring and evaluation reports, detailing:

- ❖ Implementation progress;

- ❖ Estuary health trends (PES and REC status); and
- ❖ Emerging risks or data needs.

EDTEA will compile and submit an annual provincial estuarine management report to the National Coastal Committee, which will then be tabled in Parliament as required by the ICMA.

Citizen science refers to structured participation by members of the public, stakeholders, schools or NGOs in environmental observation or data collection activities following recognised protocols or guidance. Data generated through citizen science initiatives should, where possible, be quality controlled, verified and integrated with formal scientific monitoring programmes before use in regulatory or management decision-making.

9.5 Resourcing and Funding Mechanisms

Adequate financial and human resources are fundamental to successful implementation. The EMP proposes that EDTEA, eThekweni Municipality, and DWS jointly prepare a five-year implementation budget within six months of gazetting. Funding options to be explored include:

- ❖ Government allocations (EDTEA, DWS, DEA Oceans & Coasts, SANBI);
- ❖ Private sector partnerships (e.g. SAPPI Saiccor environmental offset, corporate social investment);
- ❖ NGO and donor support (WWF, WESSA, UNDP GEF Small Grants Programme); and
- ❖ In-kind contributions through research institutions and community projects.

Implementation of the EMP will require sustained financial and institutional support from a range of stakeholders and authorities. Opportunities should therefore be explored for collaborative funding partnerships, stewardship support, grant funding, research partnerships and voluntary contributions from stakeholders whose activities, operations or interests are linked to the estuary and its catchment. Such support may assist with implementation of monitoring programmes, rehabilitation initiatives, environmental education, awareness campaigns, research and other priority management actions identified through the EMP.

9.6 Sustainability and Long-Term Governance

To secure the future of the uMkhomazi Estuary, governance should aim for:

- ❖ Integration of estuary management objectives into municipal Spatial Development Frameworks (SDFs) and Coastal Management Programme;
- ❖ Continued alignment with the Aliwal Shoal MPA management objectives to ensure coherent land–sea conservation; and
- ❖ Periodic review of this EMP every five years, or sooner if triggered by significant hydrological or ecological changes (e.g. uMkhomazi Water Project or major floods).

9.7 Integration with Municipal Planning Frameworks

Implementation of the uMkhomazi EMP will require alignment and integration with broader municipal and provincial planning instruments to ensure that estuarine management objectives are considered within future land-use, infrastructure and development decision-making processes. In particular, the EMP should be considered within the eThekweni Municipality Integrated Development Plan (IDP), Spatial Development Framework (SDF), Coastal Management Programme (CMP), environmental planning frameworks and relevant land-use management processes.

This integration is important to ensure that development planning within and adjacent to the Estuarine Functional Zone (EFZ) appropriately considers ecological functioning, floodplain dynamics, coastal processes, biodiversity priorities, climate resilience and the maintenance of ecosystem services associated with the estuary. The proposed uMkhomazi Estuary Management Forum (EMF) should therefore seek ongoing engagement with relevant municipal and provincial planning authorities to support cooperative governance and alignment between estuarine management objectives and spatial planning processes.

9.8 In summary

Implementation of this EMP will depend on active collaboration, clear institutional accountability, and the mobilisation of sustainable funding. With a strong governance framework, integrated monitoring, and engagement of all stakeholders — from SAPPI to local communities — the uMkhomazi Estuary can serve as a national model for cooperative estuarine management linking river, estuary, and marine protected areas.

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11 APPENDIX A

uMkhomazi Estuary Resource Quality Objectives (DWS 2015)

PES:	C	REC:	B (Remove Weir)	TEC:	B/C (Leave weir)
Key components that require interventions to achieve the TEC: - Remove sandmining from the upper reaches below the Sappi Weir. - Restoration of vegetation in the upper reaches and along the northern bank in the middle and lower reaches. - Curb recreational activities in lower reaches. - Reduce/remove cast netting in the mouth area. To achieve the REC: - Restore estuarine habitat through the relocation/removal of Sappi Weir. - Restore baseflows to estuary. (Only possible by building of a dam).					
Component/ Indicator	TEC	RQO			
Hydrology	C/D	Maintain the target EC (> 57%). Protection of estuarine ecosystem to achieve ECs and ROQs indicated for hydrodynamics, water quality, sediment dynamics and the various biotic components: River inflow distribution patterns differ by less than 5% from that of Scenario B (i.e. approved flow scenario for the uMkhomazi). Monthly river inflow > 1.0 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.			
		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 m³/s): < 15 NTU. - Turbidity (low flow > 5 m³/s): Naturally turbid. - Dissolved nutrients (low flow < 5 m³/s): NO_x-N < 150 µg/L; NH₃-N < 20 µg/L; PO₄-P < 10 µg/L. - Dissolved nutrients (high flow > 5 m³/s): NO_x-N < 200 µg/L; NH₃-N < 20 µg/L; PO₄-P < 20 µg/L. - Trace metals (to be determined). - Pesticides/herbicides (to be determined).			
Water quality	C	Minimum requirement for recreational use (DEA, 2012): <i>Enterococci</i>: Ninety percentile (90thile) over a 12 month running period ≤ 185 counts per 100 ml. <i>E. coli</i>: Ninety percentile (90thile) over a 12 month running period ≤ 500 counts per 100 ml.			
		ROQs for water quality in estuary to protect estuarine ecosystems, that is achieving the EC and ROQs indicated for the various biotic components: - Salinity: 0 in the upper reaches; > 20 middle reaches during the low flow season; freshwater dominated for 70% of the time. - Turbidity (low flow < 5 m³/s): Average < 10 NTU in any sampling survey. - Turbidity (high flow > 5 m³/s): Naturally turbid. - pH: Average 7.0 - 8.5 in any sampling survey. - Dissolved oxygen: Average > 6 mg/L in any sampling survey. - Dissolved nutrients (low flow < 5 m³/s): Average NO_x-N < 150 µg/L, NH₃-N < 20 µg/L and PO₄-P < 10 µg/L in any sampling survey. - Dissolved nutrients (high flow > 5 m³/s): Average NO_x-N < 300 µg/L, NH₃-N < 20 µg/L and PO₄-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).			
		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).			

Component/ Indicator	TEC	RQO
Sediment dynamics	B	Flood regime to protect estuarine ecosystem's sediment distribution patterns and aquatic habitat (instream physical habitat): - River inflow distribution patterns (flood components) differ by less than 20% (in terms of magnitude, timing and variability) from that of the Present State (2013). - Suspended sediment concentration from river inflow deviates by less than 20% of the sediment load-discharge relationship to be determined as part of baseline studies (Present State 2013). - Findings from the bathymetric surveys undertaken as part of a monitoring programme indicate that no changes in the sedimentation and erosion patterns in the estuary have occurred (± 0.5 m). - Intertidal and subtidal habitat in upper reaches below the weir are available for estuarine species (increase by > 20% from present). Changes in sediment grain size distribution patterns to maintain benthic invertebrates. - The median bed sediment diameter deviates by less than a factor of two from levels to be determined as part of baseline studies (Present State 2013). - Sand/mud distribution in middle and upper reaches change by less than 20% from Present State (2013). - Changes in tidal amplitude at the tidal gauge of less than 20% from Present State (2013).
Microalgae	B	- Maintain the target EC (> 78%). Maintain current microalgae assemblages, specifically > 5 diatom species at a frequency > 3% of the total population in saline reaches (i.e. Zone A in low flow). - Medium phytoplankton: > 5µg/L for more than 50% of the stations. - Microphytobenthos (MPB): > 30 mg m² for more than 50% of the stations in the saline portion of the estuary.
Macrophytes	D	- Observable bloom in the estuary. - Maintain the target EC (> 43%). Maintain the 2015 distribution of macrophyte habitats: - Maintain the integrity of the riparian zone particular where the sandmining no longer occurs. - No invasive floating aquatic species present in the estuary e.g. water hyacinth. - No sugarcane in the EFZ. - No greater than 10% change in the area covered by different macrophyte habitats. - No canalisation of lower reaches. - No invasive plants (e.g. syringa berry, Spanish reed, black wattle, Brazilian pepper tree) largely absent from the riparian zone. - No die-back of reeds and sedges in the lower reaches. - No unvegetated, cleared areas along the banks. - No floating invasive aquatics observed in the upper estuary reaches. - No Sugarcane is present in the EFZ.
Invertebrates	B	Maintain the target EC (> 78%). Maintain current levels of zoobenthic abundance (including seasonal variation). Retain an invertebrate community assemblage in the estuary based on species diversity and abundance that includes a variety of indigenous species. This include the following: - Species diversity (between 15 species in summer - 40 species in winter). - Polychaetes, amphipods and tanaeids should numerically dominate during all seasons. However, abundance of all taxon groups should be higher during summer high flow periods and lower during winter low flow period. - DOs should > 4 ppt in > 75% of the estuary. - Less than 20% change in the intertidal and subtidal habitats. - No occurrence of invertebrate alien species (e.g. Tarebia granifera). - No decrease in abundance of zooplankton (> 20%) in terms of numbers per m² over entire estuarine area (three sample sites) over three years. - No decrease in abundance of benthic macroinvertebrates. - No occurrence of <i>Paratyloplax blephariskios</i> in annual sample.

Component/ Indicator	TEC	RQO
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</i>, <i>Acanthopagrus vagus</i>, <i>Pomadasys comerssonii</i>, <i>R. holubi</i>). • A good trophic basis exists for predatory estuarine dependant marine species (e.g. <i>Agyrosomus japonicus</i>, <i>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>G. spp.</i>, <i>Oligolepis</i> spp. <i>Ambassis</i> spp. and <i>Gilchristella 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	C	Maintain the target EC (> 63%). The estuary should contain a rich avifaunal waterbird community, occurring at high densities (relative to available shorelength) that includes representatives of all the major groups, i.e. aerial (e.g. kingfishers), swimming (e.g. cormorants) and large wading piscivores (e.g. herons), small invertebrate-feeding waders, including migratory Palaearctic sandpipers, herbivorous waterfowl (e.g. ducks and geese) and roosting terns and gulls. • The presence of a resident pair of African Fish Eagle that breed successfully. • Pied Kingfishers, White-breasted Cormorants or Reed Cormorants are recorded on more than three consecutive counts spanning a period of 18 months or more. • Numbers of waterbird species do drop below 10 for two consecutive counts.