DRAFT TYOLOMNQA ESTUARY MANAGEMENT PLAN

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Declaration of Independence

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ABBREVIATIONS AND ACRONYMS

BCMM	Buffalo City Metropolitan Municipality
CMA	Catchment Management Agency
DEA	Department of Environmental Affairs
DEDEAT	Department of Economic Development, Environmental Affairs and Tourism
DMRE	Department of Mineral Resources and Energy
DWS	Department of Water and Sanitation (previously Department of Water Affairs)
EAF	Estuary Advisory Forum
EBSA	Ecologically or Biologically Significant Marine Area
EC	Eastern Cape
ECSECC	Eastern Cape Socio-Economic Consultative Council
ECPTA	East Cape Parks and Tourism Agency
EFZ	Estuarine Functional Zone
EIA	Environmental Impact Assessment
EMP	Estuary Management Plan
ERC	Ecological Reserve Category
EHI	Estuary Health Index
EWR	Ecological Water Requirement
ICMA	Integrated Coastal Management Act (Act No. 24 of 2008 as amended in 2014)
IDP	Integrated Development Plan
MAR	Mean Annual Runoff
MCC	Municipal Coastal Committee
MEC	Member of Provincial Executive Council
MLRA	Marine Living Resources Act (Act No. 18 of 1998 as amended in 2014)
Mm^3	Million cubic metres
MPA	Marine Protected Area
MSL	Mean Sea Level
NBA	National Biodiversity Assessment
NEMA	National Environmental Management Act (Act 107 of 1998 as amended)
NEMP	National Estuarine Management Protocol (as amended in 2021):
NWA	National Water Act (Act No. 36 of 1998)

PCC	Provincial Coastal Committee
PES	Present Ecological Status
PSDF	Provincial Spatial Development Framework
SAEON	South African Environmental Observation Network
SAHRIS	South African Heritage Resources Information System
SAIAB	South African Institute of Aquatic Biodiversity
SANBI	South African National Biodiversity Institute
SAR	Situation Assessment Report
SDF	Spatial Development Framework
WMA	Water Management Area

1. Introduction

1.1 Background

The Tyolomnqa River (once known as "Chalumna") and its associated estuary are located in the Eastern Cape of South Africa about 45 km south of East London. The catchment is 441 km^2 and the river is 78 km in length, making it one of the smallest river systems in the Eastern Cape. The river is formed by the confluence of two smaller rivers – the Qugwala River in the west and the Mtyolo River in the east. The main tributaries in the Tyolomnqa River catchment are the Nyatyora, Nxwashu, Rode, Twecu, Quru, Tsaba and Mpintso Rivers (Gaulana & Weni, 2009). The estuary falls entirely within the Buffalo City Metropolitan Municipality (BCMM), but the Tyolomnqa river catchment lies partly within the BCMM and partly within the Ngqushwa Local Municipality (Figure 1).

Biogeographically the estuary is in the warm temperate region, is approximately 107 Ha in extent and has been classified variously as a temporary open closed system (Colloty et al. 2000; Van Niekerk et al. 2019), as a near permanently open system (Harrison et al. 2000) and as a permanently open system (Whitfield 1992; James & Harrison 2011). The estuary is narrow, and channel like in its upper reaches ($\pm$32 m wide) but widens to form a flood tidal delta (200 - 300 m wide) which provides extensive intertidal sand flats near the mouth (Harrison et al. 2000; Papadopoulos 2006; James & Harrison 2011). The estuary is considered to be in a near natural condition, but fishing pressure has recently escalated to a point where it may soon impact on ecological function. Water depth in the estuary ranges between 1.3 m and 3.6 m. Water abstraction from the Tyolomnqa River is minimal and apart from a number of small stock dams in catchment communities, the river flow is blocked only by a small weir about 14 km from the mouth of the estuary. The weir forms the upper limit of the estuary.

The Eastern Cape Department of Economic Development, Environment Affairs and Tourism (DEDEAT) is the authority responsible for management of the terrestrial and coastal environment of the Eastern Cape except in formally declared protected areas, where the Eastern Cape Parks and Tourism Agency (ECPTA) and the South African National Parks share the responsibility of managing protected areas. The amended National Estuarine Management Protocol (NEMP 2021) identifies the provincial authority responsible for management of the coastal environment as the authority responsible for management of estuaries that fall entirely within a local municipality – in this case the Tyolomnqa Estuary in the BCMM. The estuary is in the middle of the Algoa to Amathole Ecologically or Biologically Significant Marine Area (EBSA) which extends from Sardinia Bay in Gqeberha to the Kei River and from the dune base to the continental shelf break. The EBSA encompasses possibly the biggest single collection of significant and special marine features in all of South Africa that also jointly support key ecological processes, including important land-sea connections (MARISMA Project 2020).

Middle to high income communities own much of the land on the east side of the lower estuary (Chalumna, Kingfisher and the Coelacanth Estates). There are several permanent residents in each Estate. The Phozi, Tsaba, and Sandile, communities occupy land on the western side of the estuary and the Mpintsho community is located on the eastern side, immediately north-west of the TR 14504 road bridge. Subsistence farming and livestock grazing are the main land use form and livelihood associated activities on the western

side. An abandoned eco-estate development is located on the western bank about halfway up the length of the estuary. Land use inland of the residential estates comprises agricultural activities associated mainly with dairy farming.

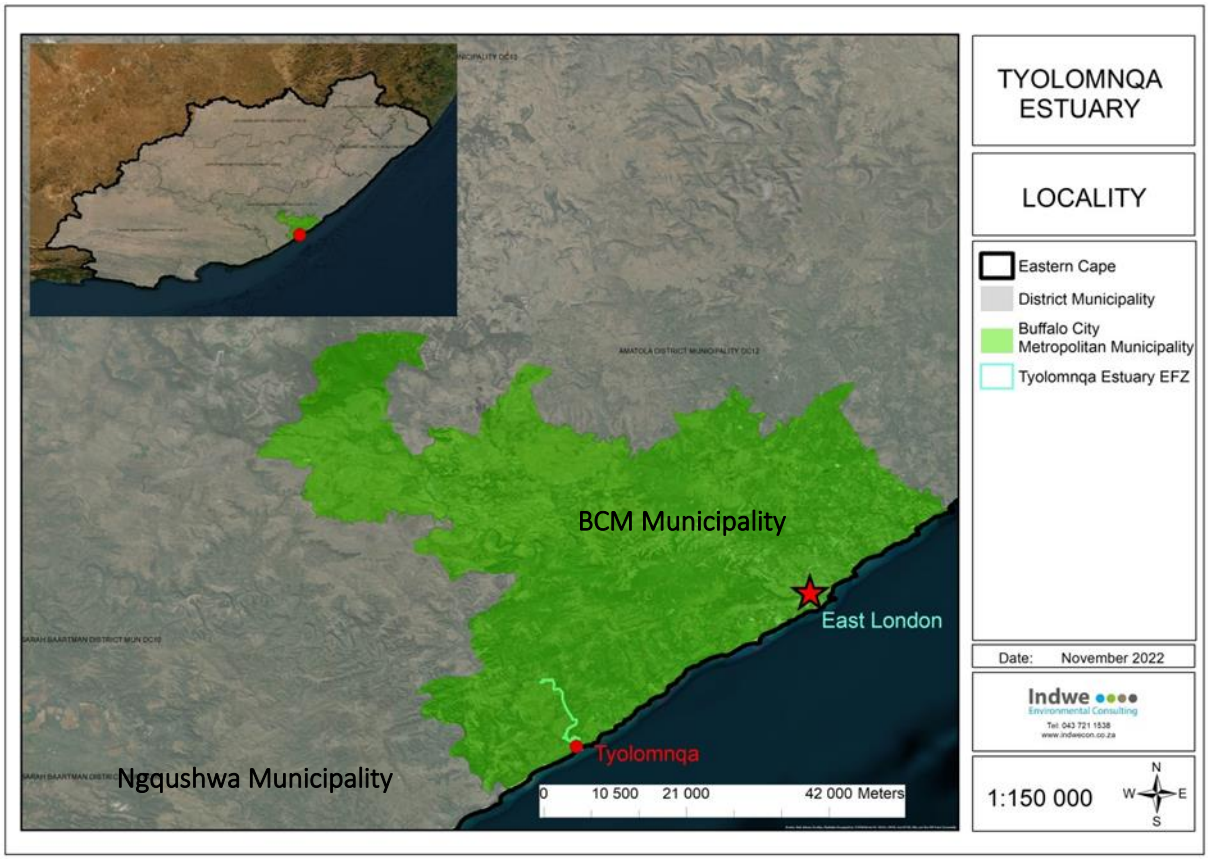

Figure 1: Location of the Tyolomnqa Estuary in the Buffalo City Metropolitan Municipality.

1.2 Purpose and Scope of the Tyolomnqa Estuary Management Plan

The requirement for Estuarine Management Planning is outlined in the National Environmental Management: Integrated Coastal Management Act (Act No. 24 of 2008 as amended by NEM: Integrated Coastal Management Act No. 36 of 2014). Chapter 4, Section 33 of the ICM Act outlines the requirement for an Estuarine Management Plan (EMP) to be developed in accordance with a National Estuarine Management Protocol (NEMP 2021). The NEMP provides a list of key management standards applicable to the management of any estuary. The structure and purpose of the EMP is outlined in the Guidelines for the Development and Implementation of Estuary Management Plans (DEA 2015). The NEMP sets out to promote the effective cooperative governance of estuaries by means of a legal and institutional framework that will provide broad alignment on a regional scale. The focus is on statutory provisions for cooperative governance, taking into account current principles, policy, legislation, regulations and practice. The NEMP and the Guidelines for the Development and Implementation of Estuary Management Plans provide guidance on the process, requirements, and structure of EMPs. Key steps in the process are:

- Develop a Situation Assessment of the estuary which incorporates all available information relating to the estuary and highlights key information that would inform management decisions for the estuary.

- Develop a geographical description and a map of the estuary defining the Estuarine Functional Zone (EFZ) and clearly identifying the boundaries of the system.
- Define a local vision and a series of management objectives for the estuary that would contribute to achieving the strategic vision and objectives for South African estuaries as outlined in the NEMP.
- Develop a set of management actions that will achieve the management objectives of the estuary and will maintain or improve the conditions of the estuary. Management actions should be associated with targets, time frames and performance indicators for gauging the progress towards achieving the objectives of the plan.
- Outline a proposed spatial zonation of the estuary that defines activities that may or may not take place in different sections of the estuary.
- Outline practical and implementable baseline measurement and long-term monitoring programmes.
- Outline the institutional capacity and arrangements required for managing different elements of the EMP.
- Obtain formal approval of the EMP from the relevant approval authority (MEC).
- Adoption of the EMP by the responsible management authority.
- Incorporation of the EMP into the Provincial Coastal Management Programme and the BCMM IDP.

The EMP for the Tyolomnqa Estuary is an adaptive document that will evolve over time according to the changing requirements of the estuary and its users. A monitoring programme and a review of the management plan every five years will guide such changes. The Department of Economic Development, Environmental Affairs and Tourism (DEDEAT, Eastern Cape) is the management authority. To help implement the management plan, an advisory management institution or Estuary Advisory Forum (EAF) comprising representatives of all stakeholder groups should be formed. The Eastern Cape Provincial Coastal Committee (PCC) and the BCMM Municipal Coastal Committee (MCC) should monitor the implementation of the management plan, helping to coordinate management efforts and ensuring that the government departments and individuals responsible for various management functions related to the estuary undertake their responsibilities.

1.3 Structure of the Report

The EMP conforms to the structure outlined in the Guidelines for the Development and Implementation of Estuary Management Plans (DEA 2015). The sections of the report are outlined below.

1. A summary of the Situation Assessment Report (SAR) for the estuary. The SAR is designed to provide a sound understanding of the estuary, documenting existing bio-physical conditions and describing processes, drivers and responses of the estuarine system and highlighting key information relevant to management. The SAR is thus the principal reference document for the estuary, and it is therefore important for the contextual information contained in it to be summarised at the start of the management planning process.

2. A geographic description and map of the estuary based on the Estuarine Functional Zone (EFZ) and defining the jurisdictional and physical space within which the EMP must be applied.

3. A local Vision and Management Objectives for the Estuary. A management objective is a priority area of action for the estuary and addresses one or more of the values defined by the Vision.

4. A series of management strategies required in the next five years in order to achieve the Objectives and concomitantly the overall vision.

5. A set of management actions that must be performed to implement the management strategies. Management actions must be undertaken within certain time frames and should result in a deliverable or deliverables that measure the success of the implementation.

The EMP contains seven Strategic Management Objectives listed under seven Key Result Areas. Under the seven Strategic Management Objectives are 17 Strategies identified as necessary to achieve the Objectives. A range of Management Actions have been identified to implement the Strategies. The implementation of these management actions may start slowly because DEDEAT, BCMM, the PCC and MCC as well as all the other stakeholders comprising the EAF will need to coordinate their responsibilities relating to the management of the estuary. There may be some conflict between local stakeholders, and this may take some time to resolve. An initial lack of funding may also limit management activities.

It is important to recognize that this document is designed to focus management attention at a strategic level and does not provide guidance on the day-to-day management actions required for management of the estuary. Ideally an Annual Operational Plan (AOP) should be developed by DEDEAT and the EAF. The AOP should be guided by this EMP in that major effort should be directed towards priority activities that support the strategic objectives of the EMP.

2. Summary of the Situation Assessment

2.1 Biophysical details

The Tyolomnqa River and its associated estuary are located in the Eastern Cape of South Africa about 45 km south of East London. The catchment is 441 km^2 and the river is 78 km in length, making it one of the smallest river systems in the Eastern Cape. The Tyolomnqa river is formed by the confluence of two smaller rivers – the Qugwala River in the west and the Mtyolo River in the east. There are seven main tributaries in the Tyolomnqa River catchment and the estuary falls entirely within the BCMM.

Biogeographically the estuary is in the warm temperate region, is approximately 107 Ha in extent and is considered as a permanently open estuary although there have been reports that classify it as a temporary open closed system or as a near permanently open system. The estuary is narrow in its upper reaches ($\pm$32 m wide) but widens to form a flood tidal delta (200 - 300 m wide) at the mouth. The flood tide delta forms extensive intertidal sand flats near the mouth. The estuary is considered to be in a near natural condition, but fishing pressure has recently escalated to a point where it may soon impact on ecological function. Water

depth in the estuary ranges between 1.3 m and 3.6 m. Water abstraction from the Tyolomnqa River is minimal and apart from a number of small stock dams in catchment communities, the river flow is blocked only by a small weir about 14 km from the mouth of the estuary. The weir forms the upper limit of the estuary.

Geologically, the majority of the Tyolomnqa River catchment lies within the Beaufort group and Tarkastad subgroup. The latter is typified by well consolidated calcareous sandstone and sandy limestones. The lower reaches of the estuary are characterized by rocky outcrops, and sandstone bedrock outcrops appear in the intertidal zone. The upper beach and coastal fringe consist of both free and fixed sand dunes. South of the estuary the shoreline is mainly sandy and north of the estuary rocky wave-cut platforms predominate. Multiple small temporary open-closed estuaries occur to the north and south of the estuary, underlining the ecological importance of the permanently open Tyolomnqa Estuary. Soils in the catchment and around the estuary are mainly freely drained structureless soils which have poor fertility and are highly erodible.

The climate along the coast where the estuary is located is mild and generally warm and temperate. Rainfall occurs throughout the year with maximum precipitation in October-November and March. Average rainfall in the Tyolomnqa catchment is about 665 mm a year. The Tyolomnqa catchment lies within the Eastern Coastal Belt ecoregion and forms part of the Mzimvubu to Tsitsikamma Water Management Area. The quaternary catchments for the upper and lower parts of the river are the R40B and R40C respectively. The total catchment for the river is 441 km^2 making it one of the smallest catchments on the east coast. Current Natural Mean Annual Run-off (MAR) is 35.6 x 10^6 $m^3.y^{-1}$. Estimated reduction in MAR is probably only about 4%, probably because of changes in the climate regime rather than from freshwater abstraction. The health of the ecological reserve for the system is rated A indicating a system that has been minimally impacted by obstructions like dams, weirs and water abstraction.

There are limited data relating to flow and flood history in the Tyolomnqa River. Because of the summer rainfall the main freshwater inflow to the estuary is in summer months. However, salinities in the Tyolomnqa Estuary appear to be high throughout the system, indicating a tidally dominated system and very limited freshwater inflow. A weir ($\pm$1.5 m high) under the TR 14504 road bridge effectively blocks all surface freshwater flow into the estuary until the weir is over-topped. The weir appears to be the only blockage to river flow on the Tyolomnqa River and freshwater input into the system is not seriously compromised. A few stock dams are located on some of the ephemeral watercourses draining into the river.

The mouth of the Tyolomnqa river opens to the sea in a north-easterly direction with the main channel outflow running parallel to the shore for several hundred metres before turning directly seawards, creating a rip that extends through the surf line. The mouth of the estuary is protected from sand deposition by longshore currents and wave action by rocky headlands on either side of the estuary mouth. Strong tidal currents and scour probably also help to keep the mouth open. Because of the nature and orientation of the rocky point at the mouth of the estuary it is likely that the location of the mouth remains fairly consistent. Other factors that help to keep the mouth of the river open are the lack of dams on the river and the relatively well vegetated nature of much of the catchment which limits silt runoff into the river. Sediments in the estuary are sandy at the mouth changing to mud about 800 m upstream of the mouth. Sand prawns (60 -

80 sand prawns.m^{-2}).and mud prawns ($\pm$222.m^{-2}) occur in their respective habitats in the lower part of the estuary. Bank erosion from boating is not a problem in the estuary and where there is evidence of bank collapse it is likely to be a result of natural wind induced wave action. However, throughout the length of the estuary there are occasional erosion channels on the banks that appear to have originated from the passage of cattle to and from the river and possibly from community members undertaking traditional activities or rituals.

2.2 Water Quality

There are few water quality data for the Tyolomnqa River and Estuary. Some evidence of limited faecal bacterial contamination was found in the 1990s but most information sources indicate that the water quality is good with no thermoclines, uniform salinities (31 – 33 ppt) both longitudinally and vertically in the water column, and high oxygen saturation levels (9.2 - 11.4 $mg.l^{-1}$) throughout. Turbidity is low, there are no signs of eutrophication or macrophyte and invertebrate die-off and the avian diversity using the estuary is high.

2.3 Vegetation

A range of vegetation types occur in the Tyolomnqa catchment and along the banks of the estuary. Cape Seashore Vegetation comprising grasses, sedges, herbaceous and dwarf shrubby or succulent vegetation occurs on the beaches, dunes, dune slacks and coastal cliffs of the seashore north and south of the estuary mouth. Southern Coastal Forest is present on the frontal dune cordon to the north and south of the estuary mouth. Bhisho Thornveld occupies much of the central inland Tyolomnqa catchment. Hamburg Dune Thicket occupies most of the Tyolomnqa lower catchment extending inland and South Eastern Coastal Thornveld is present in a narrow band along western bank of the middle and lower parts of the Tyolomnqa Estuary. The critically endangered *Acmadenia kiwanensis* that only occurs between the Keiskamma and Tyolomnqa Rivers was recently found on the east bank of the estuary and an endemic range restricted (20 km^2) dwarf species of bulb (*Drimia chalumnenses*), was collected near the Tyolomnqa Estuary in 2001. Alien vegetation cover in the catchment is relatively low but along the saltmarsh and banks of the estuary prickly pear (*Opuntia monacantha*) is relatively common. Syringa, Lantana, Inkberry, Rooikrans and Black wattle occur in degraded areas on the west bank.

Two stands of mangroves (*Avicenia marina*) were planted about 15 years ago in the salt marsh habitat of the middle estuary. The current size of the mangrove habitat is 0.5 Ha and the original trees are all mature. Saplings and seedlings have also rooted on both banks of the estuary upstream and downstream of the adult mangrove stands and are becoming quite dense upstream. More than 17 Ha of intertidal saltmarsh and 10.5 Ha of supratidal saltmarsh are present in the lower and middle reaches of the Tyolomnqa Estuary and extensive beds of the seagrass *Zostera capensis* are present in the middle part of the estuary, particularly around the edges of the saltmarsh. Both these habitat types are important food sources, sediment stabilisers and carbon sequesters. Reeds and sedges appear in isolated patches in the upper estuary and in the river above the weir. Phytoplankton production is probably quite low but there is no information on this primary producer.

2.4 Fauna

The vegetation, mud and sand banks of the estuary provides a habitat for many invertebrate species including mud and sand prawns, mangrove snails and several species of crab. There are no data on smaller crustacean species and the annelids and molluscs in the estuary but similar estuaries not far from the Tyolomnqa Estuary host >118 species of invertebrates on the tidal flood plain and adjacent beach. A large and diverse invertebrate population is a key indicator of the health of an ecosystem because invertebrates are sensitive to toxins and pollution as they generally cannot disperse as efficiently as vertebrates

Sampling has recorded a high diversity of fish species (34 species of fish) in the estuary relative to the size of the estuary. Many of these species are estuary dependent for some stage of their life cycle. In total 57 fish species have been identified in the estuary through sampling and by residents. Overall, both estuarine-resident and estuarine-dependent marine species dominate the fish fauna of the Tyolomnqa Estuary, which highlights the importance of the system as a nursery area for these fishes. Juvenile white steenbras (*Lithognathus lithognathus*; an Endangered species) are common .

The Chalumna Estates birding community has recorded 191 bird species around the estuary. The diverse habitat that makes up the Tyolomnqa Estuary offers resident and migratory birds feeding and breeding grounds all year-round. The vertical banks of the estuary below the R72 road bridge are utilised by several species of kingfisher and other burrow nesting species. A number of small mammal species have been recorded near the estuary including monkeys, otters, blue duiker, mongoose, lynx, bushbuck and jackal. However, hunting by local community members discourages the establishment of stable mammal populations.

2.5 Present Ecological State

The Present Ecological State (PES) of the Tyolomnqa Estuary is a B which indicates an estuary that is largely unmodified and is in a natural or near natural condition. The Recommended Ecological Condition (the state that management of the estuary should seek achieve) is also a B. The estuary is rated as important from a biodiversity perspective. Fishing (illegal gill netting) has been identified as a major threat to the health of the estuary. Degradation in the catchment has a negative impact on water quality. Other pressures on the health of the estuary are development/cultivation within the Estuarine Functional Zone and roads, bridges, causeways and culverts which affect river flow. Hydrodynamic health of the estuary (status of the mouth) is considered very good. As a fish nursery area, the estuary has a medium conservation priority rating.

Botanically the estuary is of limited importance because its narrow channel-like nature and small flood plain restrict the development of extensive areas of estuarine plants. Only saltmarsh and seagrass species and a small mangrove community occur on the flood plain and minor reed beds are present further up the estuary. The estuary falls within the Algoa to Amathole Ecologically or Biologically Significant Area (EBSA) which includes much of the Eastern Cape shoreline (Sardinia Bay to the Kei River) and extends from the dune base to the continental shelf break. Important ecological processes in the EBSA to which the Tyolomnqa system contributes are land-sea connections and as a nursey area for commercially important fish species.

The Eastern Cape Biodiversity Conservation Plan (ECBCP 2019) locates the Tyolomnqa Estuary in a terrestrial Critical Biodiversity Area and the estuary constitutes an aquatic Critical Biodiversity Area. Critical Biodiversity Areas have high irreplaceability and must be maintained in a natural state to secure retention of biodiversity patterns and ecological processes.

2.6 Ecosystem Services

Contribution to livelihoods

The Tyolomnqa Estuary contributes to local and regional livelihoods by providing a range of resources. Fish in the Tyolomnqa Estuary provide the greatest contribution to livelihoods. There are no catch data for the estuary, but it is estimated that 40 tonnes of fish a year are removed from the estuary, by subsistence and small-scale fishers operating illegal gillnets. Mud crabs are also caught in significant numbers in the estuary. Crabs are bagged and sold on the R72 road bridge over the estuary. There are no data on mud crab catches and prices, but the fishery is very active and therefore presumably quite lucrative. Most subsistence line fishers use mud and sand prawns from the estuary to catch line fish for food. There are no catch data to quantify subsistence linefish catches, but subsistence fishers are present, collecting bait and fishing every day, so clearly the estuary is an important food source for surrounding communities. Subsistence use of the estuary is valued at between R50 000 and R100 000 per year.

There are no data for recreational catches in the Tyolomnqa Estuary but based on catch rates for anglers in East coast estuaries and an estuarine area of 107 Ha, 6.3 tonnes of fish might be caught each year by estuarine recreational anglers. Fish in East coast estuaries are valued at R414/kg (this includes value added by subsidiary industries such as tackle supplies and engine maintenance, other equipment including vehicle costs and travel to fishing sites) so the Tyolomnqa Estuary recreational angling probably generates about R2.6 million to the economy. However, residents note that currently there is very little recreational fishing in the estuary. Community cattle graze in the saltmarsh, and reeds and mangroves in the estuary probably provide construction materials for local buildings, but the extent of their use is unknown.

Contribution to marine fishery values through provision of nursery areas for the maintenance and productivity of marine fish populations

A high diversity of fish species is present in the Tyolomnqa Estuary, many of which are estuary dependent for the early stages of their growth. The Tyolomnqa Estuary has a range of habitat types (mangroves, *Zostera* beds, saltmarshes, reed beds, mud and sand banks) all of which provide refugia and/or rich food sources for juvenile fish and invertebrates. Many of these fish species that are dependent on or utilise the estuary are exploited by recreational and commercial fishers in the inshore marine environment. The estimated value to the inshore marine fish sector of estuary associated fish between the Swartkops and Kei Estuaries is in the region of R513 million. The Tyolomnqa Estuary probably has a lower nursery value for early life stage fish of the most sought after species like kob, grunter and Cape stumpnose, but as one of the larger permanently open estuaries it must make an important contribution to marine inshore fisheries. The estimated fish nursery value of the estuary is between R1 million and R5 million per year.

Outputs to the marine zone

Estuaries transport sediments and nutrients of terrestrial, riverine and estuarine origin into the marine zone, where they contribute to marine ecosystem productivity. This is a particularly important function for estuaries on the east coast of South Africa, where the marine environment is nutrient poor. There are no data on sediment or nutrient loads transported into the marine environment by the Tyolomnqa River but the catchment MAR (35.6 x 10^6 $m^3.y^{-1}$ - generally used as a proxy for sediment inputs) is indicative of an important contribution to inshore productivity. Across-shelf transport of sediments and nutrients are important in maintaining demersal communities and fisheries resources. Benthic pelagic coupling and terrestrial marine coupling are important features of the marine environment of the Amathole region. The presence of a shelf-intersecting submarine canyon offshore of the Tyolomnqa Estuary provides a pathway for sediments and nutrients to reach depths of at least -2000 m.

Contribution to recreation, tourism and property values as a result of ecosystem attributes that lend aesthetic beauty and are attractive for recreational activities.

Tourism is not a feature associated with the Tyolomnqa Estuary. Access to the estuary is very limited because most of the land on the east bank between the R72 road bridge and the sea is privately owned. The community land on west bank lacks infrastructure to support tourism. Recreational activities on the estuary include fishing, water skiing, photography and bird watching and are mainly conducted by Estate residents and their visitors. The estimated value of the Tyolomnqa Estuary's recreational use is between R1 million and R5 million per year.

Fishing clubs access the estuary from an illegal slipway upstream of the R72 and these anglers sometimes spend an entire weekend fishing from their skiboats. The value of the recreational fishing sector has been described above.

Property values on the eastern side of the river are fairly high partly because of the estuarine setting. The exclusive nature of the contiguous estates that occupy most of the eastern bank also plays a role in inflating property values and large houses are valued at ±R2.5 million. However, property values are capital values which are incompatible measures when compared with values expressed per unit time such as tourism expenditure or recreational fishing values.

Contribution to the amelioration of climate change damages through sequestration of carbon from the atmosphere

The relative carbon storage potential of estuarine habitats is now widely acknowledged. Vegetation types like mangroves, seagrass beds and salt marshes can lock carbon into the soil for several thousand years. However, the Tyolomnqa Estuary, probably plays a fairly limited role in terms of climate regulation because of the minor extent of its carbon absorbing vegetation types (0.5 Ha of mangroves; 28.3 Ha of supratidal and intertidal saltmarsh; 0.8 Ha of seagrass). Based on carbon sequestration values for tropical mangroves, the Tyolomnqa Estuary mangroves would bury about 835 kg of carbon a year. Nevertheless, it is important to guard against damage to and destruction of the vegetation types of the Tyolomnqa Estuary because all the vegetation in the

estuary and the EFZ produces oxygen as part of the photosynthetic process, and this is an important positive contribution to climate control.

Erosion control

The Tyolomnqa Estuary is not particularly turbid and erosion in the catchment is limited. However, after heavy rain sediment will enter the estuary with catchment runoff. The reed beds in the upper estuary and the mangroves and saltmarshes in the lower estuary play an important role in slowing water flow and removing sediment from the water. They will also take up nutrients and thus de-toxify pollutants present in any run-off.

Contribution to sense of wellbeing through the knowledge of the contribution to the continued existence of nature and biodiversity

It is extremely difficult to quantify in monetary terms a sense of wellbeing generated by the existence of a feature of the environment. Existence value of a feature is basically the value individuals accord that feature simply from the knowledge that it exists and can be enjoyed by future generations. This value is often closely associated with the aesthetic attractions of a place. The aesthetic attractions associated with the Tyolomnqa Estuary include its peace and quiet, low visitor levels, rich bird life, near natural condition, and the attractions of the surrounding thicket vegetation. Clearly, the existence value accorded the estuary will be much higher for homeowners along the bank than for urban residents in East London. Existence values for estuaries that were quantified using a Willingness to Pay evaluation scheme, with scenic beauty being the main factor contributing to the existence value of a particular estuary, ranged between R50 000 to R500 000 per estuary on the east coast of South Africa. The Tyolomnqa Estuary existence value is considered to be of moderate importance.

2.7 Socio-economic context

The Tyolomnqa sub-region forms part of the BCMM. Annual reviews of socio-economic data for the BCMM aggregate data for the Tyolomnqa area, which is essentially rural, with data for Mdantsane which is a densely populated urban environment, and it is not possible to dis-aggregate the information to focus on the Tyolomnqa area.

The BCMM has a total population of 848 000 people. Tyolomnqa and Mdantsane together have a population of 275 000 or about 32% of the BCMM population but almost all of this population resides in Mdantsane rather than in Tyolomnqa. The area has the second highest population growth rate in BCMM. The population density in the Tyolomnqa area is probably around 38 people.km^{-2} (the average population density for rural areas in the Eastern Cape). Within the Mdantsane – Tyolomnqa area, African households make up 86% of the population, White households make up 8% of the population, 5% are Coloured households and 1% are Asian households.

Land use surrounding the estuary includes privately owned residential development in the form of estates, small scale urban development in the form of the town of Tyolomnqa, informal settlements (the Phozi, Tsaba, Mpintsho, and Sandile communities), and subsistence and commercial farming on communal and privately owned land respectively. The landscape associated with the Tyolomnqa Estuary is largely natural thicket,

bushveld, and unimproved grassland, with some cultivated semi-commercial/subsistence drylands in the western part of the Tyolomnqa area. Land use impacts on the catchment are relatively minor and the catchment health status is considered good. However, stock grazing continues to degrade the terrestrial habitat of the catchment and the extent of community housing continues to expand. These factors will impact on the status of the catchment with time. A Mining Permit issued for open cast sand mining of mineral sands on Farm 1163 near the mouth of the Tylomnqa Estuary is a cause for concern for the management of the estuary because it will entail land clearing and infrastructure development. I&APs from both local communities and the East Bank Residents Association have expressed concern that the sourcing and disposal of processing water, and the onsite temporary storage of heavy metal concentrate could detrimentally impact estuary function.

Unemployment is key issue for people the BCMM population generally and particularly for the rural areas where the unemployment rate for potentially economically active people (15 – 65 years) is >30%. More than 60% of young people in the age group 15 – 34 years are unemployed. Poverty is another critical issue. Although there has been a general increase in the incomes of households in the municipality, almost 53% of people in the Mdantsane - Tyolomnqa sub-region live in poverty. In rural Tyolomnqa very few houses are likely to have water available inside the house and there is a high proportion of informal housing with no legal electrical connection and no water-borne sewage or ventilated improved pit latrines.

Members of the communities surrounding the Tyolomnqa Estuary engage in limited subsistence farming and most households own a few head of stock (cattle, and goats mainly) but government grants and pensions probably comprise the main source of income for the area. Subsistence line fishing is pursued by some members of all the communities, and the estuary is an important food source. Crab fishing and illegal gillnetting take place on a large scale and are reportedly sold on the roadside and to well organised syndicates with considerable financial backing. Income derived from crab sales would appear to be an important element in the economy of the Tyolomnqa area but income from gill netting appears to accrue to fishers from outside the Tyolomnqa area.

2.8 Tourism and recreational infrastructure

Apart from the facilities associated with individual residences of the Estates on the east bank of the estuary, there is very little in the way of tourism and recreation infrastructure in or near the Tyolomnqa EFZ, because access to both banks of the estuary is very restricted. Unpaved tracks approach the estuary at various points but there are no formal public roads to the estuary.

Most of the riverside houses on the east bank have wooden jetties and some have slipways which are used by residents for recreational purposes. Some of the jetties on the east bank are subject to Section 24G (*post facto authorisation)* processes because they were constructed without prior environmental authorisation. The owners are also required to make Sea Shore Lease applications. The estuary accommodates approximately 1875 visitors a year for various activities (swimming and canoe races, bird watching, fishing) but most visitors access the estuary by way of the private estate roads. One of the issues the management authority and estate residents will have to consider is improving access to the estuary. The ICM Act includes the waters of an

estuary in its definition of coastal public property and identifies the rights of the coastal public to be allowed reasonable access to coastal public property.

2.9 Cultural heritage

The Tyolomnqa Estuary is located in the coastal archaeological sensitivity zone, which is within 3 km of the coast. Dispersed scatters of Middle Stone Age artefacts as well as fragmented scatters of marine shellfish have been found nearby. Possible unmarked burial sites and remains of a historical/Late Iron Age settlement have been found, and Late Stone Age and Iron Age shell middens and scattered tools have also been recorded inland of the coastal dunes/dune forest, near Kidds Beach.

Maritime archaeological heritage on the Amathole coast is extensive and there are several documented shipwrecks on the coast between the Fish and Kei Rivers. The African Coelacanth Ecosystem Programme Imida Frontiers Project team discovered a wreck that warrants further investigation in the Amathole Offshore MPA adjacent to the Tyolomnqa Estuary. The first scientific record of a coelacanth was obtained in the Tyolomnqa area of the Amathole Offshore Marine Protected Area (MPA). The Palaeo-Sensitivity Map of the South African Heritage Resources Information System (SAHRIS) describes the Tyolomnqa area as having a very high palaeontological sensitivity.

2.10 Pressures and potential threats

The cumulative pressures on the Tyolomnqa Estuary (flow modification, pollution, habitat loss, fishing effort, artificial breaching, invasive alien plants and fish) are fairly low. Natural flow is almost normal, water quality is good, pollution is minimal, and the mouth is never artificially breached. Alien invasive plants occur in the EFZ, but their distribution and density are currently limited. Land degradation in the catchment is currently not a serious problem but this situation is likely to deteriorate as the communities surrounding the estuary grow. There is some erosion along the banks from the passage of cattle and from wind generated waves. The impact with the greatest potential to damage the ecological functioning of the estuary is the very high fishing effort (estimated 40 tonnes per year removed), particularly as unselective gillnetting is responsible for a very large proportion of the fish catch. Potential threats to the estuary are listed below:

Water quantity/quality

- Increased water extraction in the catchment area and/or construction of dams leading to reduced freshwater input into the estuary and possible mouth closure with a host of salinity and back flooding implications.
- Catchment erosion: Population growth in surrounding communities, increases in livestock numbers and subsistence farming efforts, and ongoing poverty will result in degradation of the catchment and a reduction in run-off water quality.
- Unmaintained cattle paths accessing the estuary cause gully erosion and sedimentation. Natural bank erosion may be exacerbated by boat wakes.
- Informal sand mining resulting in erosion, sedimentation, and channel modification/mouth closure.

- Commercial open cast sand mining for heavy metals near the mouth - Sourcing of operation water and disposal of wastewater and onsite storage of heavy metal concentrate may impact estuary ecological function.
- Pollution of water: Use of agricultural chemicals in the catchment, increases in the extent of informal housing and the attendant lack of waste disposal facilities, pathogens from conservancy/septic tank leakage or flooding.

Natural resource use

- Bait collection: Some bait collection practices damage the saltmarsh habitat and result in erosion and loss of water quality.
- Illegal gillnetting: High levels of unselective gillnetting alters estuarine ecological function, destroys the contribution of the estuary to sustainable marine fisheries and negatively impacts recreational catches.
- Crab fishing: very high levels of *Scylla serrata* fishing and non-compliance with MLRA regulations.
- Uncontrolled recreational fishing - no compliance or monitoring.
- No management related research or monitoring programmes.

Habitat degradation

- Gradually increasing impacts of alien invasive species on natural vegetation.
- Destruction of mudbanks and saltmarsh from inappropriate bait collecting techniques
- Damage to sensitive habitats like seagrass (*Zostera*) beds by boat propellors
- Cooking/camping fires in the EFZ leading to damaged vegetation and subsequent erosion
- Spread of mangroves upstream and downstream of original sites.

Recreational activities

- Noise disturbance by all night fishing activities, high horsepower boat engines and the use of jet-skis - impacts breeding and feeding of birds and other fauna, nuisance impact to residents and recreational users.
- Restricted access to the estuary limits tourism and recreation opportunities

Land use and management

- Lack of development planning for catchment: Uncontrolled housing developments in community areas
- Construction of jetties, slipways and buildings alters hydrology, channel morphology and water quality, potentially impacting ecological processes and fish nursery areas.

- Operation of commercial sand mining lease close to the estuary mouth may impact estuary function (see above).

Stakeholders

- Wide range of stakeholders with very different perspectives for the estuary
- Difficulties in engaging and communicating with all stakeholders
- High potential for conflict if there is effective enforcement

Climate change related threats

- Sea level rise and the loss of estuarine habitats like mangroves and salt marsh, impacts on residential and tourism infrastructure, impacts on avifauna breeding.
- Increased rainfall causing changes in freshwater input, hydrology, channel morphology, water temperature and water quality.
- Increased wave action/storm events impacting on estuary mouth dynamics

2.11 Opportunities and constraints

Effective management of the Tyolomnqa Estuary could provide some employment opportunities – compliance activities, alien vegetation clearing, developing and servicing access and tourism infrastructure, ecotourism opportunities related to fishing, hiking, river cruises, and birding. There are opportunities for research since the estuary is relatively pristine and provides good scientific reference conditions. The formal licensing of the illegal launch site above the R72 could generate employment opportunities in the form of car guarding and launch site management services to recreational anglers. Awareness raising and education activities would contribute towards effective management of the estuary. However, management of the estuary is likely to be constrained by lack of capacity in both DEDEAT and BCMM, by a lack of funding to implement the management plan and possibly by conflict over resource use issues.

2.12 Major information gaps

Currently there appears to be no formal monitoring of the Tyolomnqa Estuary. The management authority will require information on

- The extent of gillnetting operations and mud crab harvesting (communities and number of people involved, quantities of fish and crabs caught, sizes, frequency of operations, timing, species composition and value chain).
- The dynamics of the bait collection fishery in the estuary.
- The dynamics of the recreational fishery in the estuary (quantities of fish caught, species, angler profiles, timing and locations etc.) and other social use of the estuary.

- Water quality monitoring - at least some of the following at regular intervals and fixed sampling points: Salinity, or conductivity, Temperature, Nutrient levels – Ammonia, Nitrates, Nitrites, Silicates, Phosphates, *E. coli* bacteria and other pathogens, algal blooms.
- Numbers, timing and species of birds using the estuary.
- In the short to medium term the commercial sand mining operation near the mouth of the estuary should be closely monitored – sourcing and disposal of production water, disposal of tailings, rehabilitation of mined area, heavy metal contamination of estuary water.

3. Boundaries of the Tyolomnqa Estuary (EFZ)

In South Africa, the Estuarine Functional Zone (EFZ) is defined as the area that includes the estuary waterbody, as well as the area supporting physical and biological processes and habitats necessary for estuarine function and health. As such it includes all dynamic areas influenced by long-term estuarine sedimentary processes, changes in channel configuration, aeolian transport processes, and changes that might result from coastal storms. It also includes the floodplain, and estuarine vegetation that contributes detritus to the system and provides refuges from strong currents during high flow events, as well as all the multiple transition areas between different biological communities. The purpose of the EFZ is to identify the 'space' in which estuarine physical and biological functions take place over long timescales (>decades; van Niekerk et al. 2019). In order to standardise the spatial delineation of the EFZ, the EFZ is generally defined by the 5 m contour above mean sea level (MSL), unless there are habitats or ecological processes that clearly impact on an estuary and lie further afield. The National Biodiversity Assessment (NBA 2018) also extended the scope of EFZs to incorporate contiguous habitat that is principally surrounded by estuarine habitat or processes (Van Niekerk et al. 2019).

The upstream boundary of an estuary is considered to be the limit at which tidal action is evident at spring tides when the estuary is open to the sea, or the point at which salinity is measurably higher as a result of marine influence. This is in line with scientific studies and the administrative definition of a South African estuary (DWAF 2008; Van Niekerk et al. 2019). For the Tyolomnqa Estuary the upstream boundary is the weir at the TR 14504 road bridge 14 km upstream of the mouth. The water is clearly saline below the weir and fresh above the weir.

For practical purposes, the downstream boundary of an estuary is generally the estuary mouth. However, the mouth is a very dynamic area and thus presents problems from a legal and biodiversity management perspective. The NBA (2018) introduced the concept of an Estuarine Shore to reflect the dynamic nature of the interface between estuaries and the coast (Harris et al. 2019). Estuarine Shores refers to sand berms or bars that form in front of estuaries and which may be ephemeral, seasonal or near permanent features of the estuary. An 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 alongshore extent was taken as the width of shore

that includes the known variability in estuary mouth position based on all available historical imagery for each estuary (see van Niekerk et al 2019).

For the purposes of this estuarine management plan, the 5m topographical contour obtained from the NBA (2018) geo-spatial Information was used to define the lateral boundaries of the Tyolomnqa Estuary. The weir below the TR 14504 road bridge defines the upstream boundary, and the Estuarine Shore extends from the base of the foredune to the back of the surf zone for a distance of approximately 500 m on either side of the mouth (based on available historical imagery of the mouth position (Figure 2).

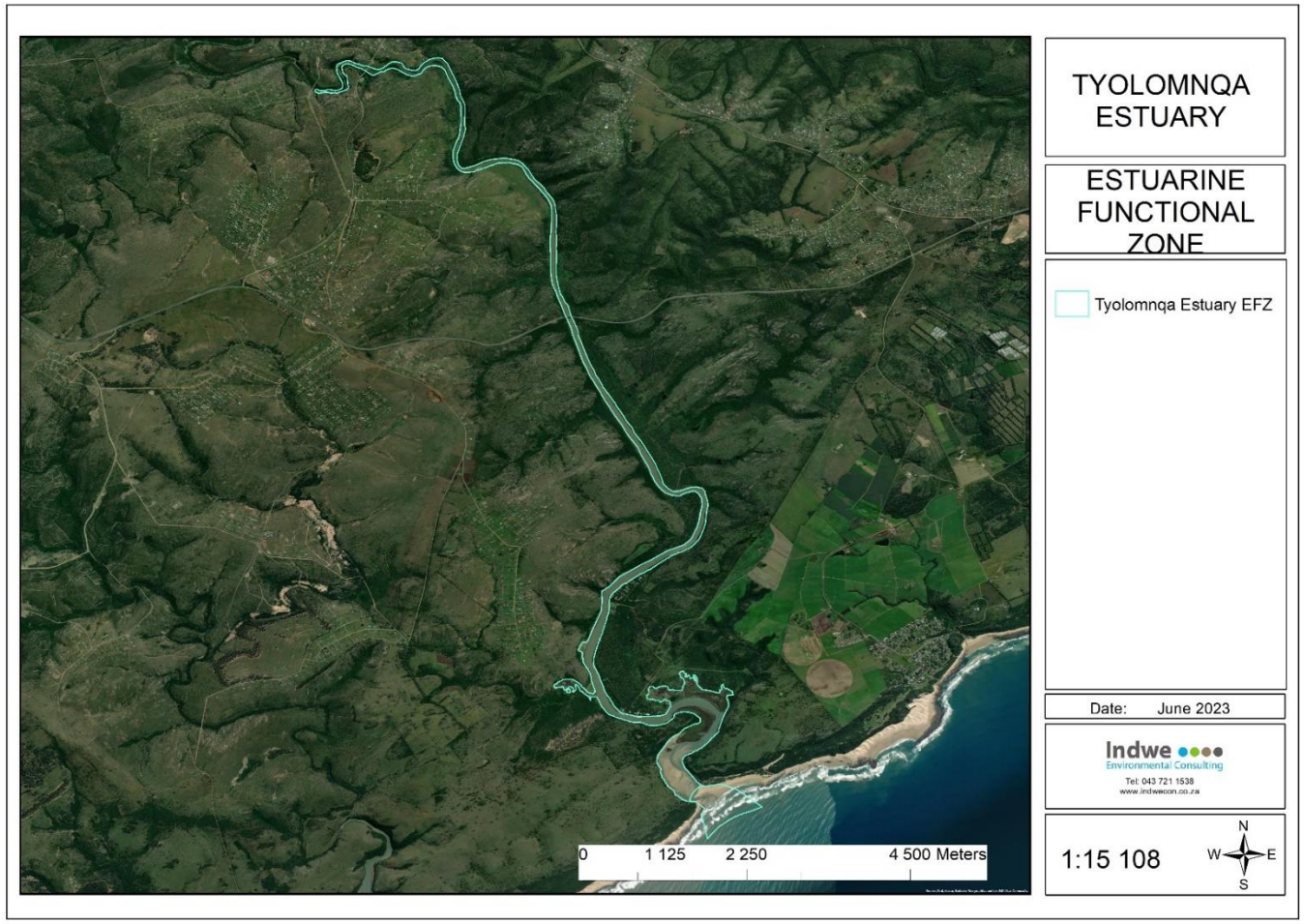

Figure 2: The Estuarine Functional Zone for the Tyolomnqa Estuary (blue outline area). The boundaries are set at the 5 m contour line as defined by the SANBI GIS National Estuaries Layer for South Africa's estuaries. The EFZ includes the shore from the base of the foredune to the back of the surf zone and alongshore to include the width of shore that includes the known variability in estuary mouth position.

4. Draft Vision for the Tyolomnqa Estuary

A vision is a high level statement which defines the strategic intent of a management intervention and it should align with the national vision for South African estuaries. The national vision for the management of South African estuaries is: *The estuaries of South Africa are managed in a sustainable way that benefits the current and future generations.*

Based on the Situation Assessment, core values for the Tyolomnqa Estuary system are:

- A tidal estuary with several ecosystem types, a diverse fish and bird population and playing an important role as a fish nursery area
- A relatively natural and unmodified estuarine system
- Highly rated aesthetic qualities in terms of sense of place, nature, peace and quiet
- A system that hosts biological resources that meet livelihoods and recreational needs
- An estuary that has unexplored opportunities for tourism and recreation

A proposed Draft Vision is: *To conserve and cooperatively manage the Tyolomnqa Estuary thereby maintaining a healthy functional estuary that retains or improves its ecological status while providing recreational, social, and aesthetic benefits and sustainable livelihoods through a balance of sustainable use, conservation, and development for present and future generations*.

The Vision captures the need to maintain the natural functioning and biodiversity of the Tyolomnqa Estuary involving all stakeholder groups in its management and identifies that the estuary serves multiple functions including providing essential food, providing recreational benefits, and contributing to the quality of life for a range of user groups.

5. Key Management Objectives

Comment: *Key management objectives for the Tyolomnqa Estuary will be agreed in the course of stakeholder meetings and communications with the residents of the estates on the eastern bank of the estuary, fishing clubs and members of the public who utilise the estuary recreationally, the provincial department of environment affairs who are responsible for estuarine management in the Eastern Cape, other institutional interests associated with the estuary, and members from the Phozi, Tsaba, Mphintsho, and Sandile communities who use the resources of the estuary for commercial and subsistence purposes*. Draft Management Objectives are proposed here on the basis of stakeholder issues that emerged from meetings that presented the Situation Assessment report. Main Stakeholder issues are outlined below:

- Estate residents: Wish to conserve the biodiversity of the estuary and preserve the ecosystem processes and continued natural ecological functioning as part of a real interest in conservation of the

environment but also as the key to preserving the aesthetic qualities of a place which contributes to their quality of life.

- Recreational users (mainly angling clubs and individuals): Chief concern was to be able to pursue fishing activities in a place where catch per unit effort was good and desirable species (principally kob, grunter and white steenbras) were relatively abundant. Improved access to the estuary for boats and shore anglers was a key issue.
- Community members: Key concerns were livelihoods based. Community members required ongoing access to the estuary in order to catch fish and mud crabs for sale and subsistence purposes.
- Community members: Unemployment in the communities is very high. Access to the estuary should be improved in order to promote income generating tourism and recreation opportunities.
- Conservation and management authorities: Key concerns focussed on being able to conserve biodiversity and ecosystem processes in order to maintain the B category status of the estuary while at the same time ensuring that access to the estuary and its resources was equitable, and livelihoods concerns were addressed. Lack of enforcement capabilities and illegal fishing were priorities that needed to be addressed.
- Stakeholders in general: Most stakeholders expressed concern that erosion would affect water quality and commercial sand mining could negatively impact many aspects of the estuary.

Clearly, all of these concerns and requirements are interlinked. Unless biodiversity and ecosystem processes are conserved and the natural ecological functioning of the estuary maintained, the estuary will deteriorate, losing its current ecological status rating and aesthetic appeal and undergoing a loss in productivity which will negatively impact recreational and livelihoods activities.

In order to achieve the vision for the Tyolomnqa Estuary and to address the key concerns of the major stakeholder groups it is suggested that the following Strategic management objectives that address Key Result Areas generally requiring management attention in an estuary should be considered. Seven Strategic Management Objectives under seven Key Management Result Areas are identified (in no particular order). The Strategic Management Objectives are outlined below and management strategies that will help to achieve those objectives are defined. In the Implementation Framework the management actions required to implement the strategies are outlined. It must be reiterated that these are Draft Management Objectives, Strategies and Actions and they will be refined or revised in the course of stakeholder consultations.

Table 1: Key Result Area 1- Institutional Arrangements and Management Structures

KEY RESULT AREA 1: Iinstitutional arrangements and management structures	
STRATEGIC MANAGEMENT OBJECTIVE	MANAGEMENT STRATEGIES
The Tyolomnqa Estuary is cooperatively and effectively managed by the relevant government institutions and civil society including local communities	1.1 Set up and maintain a representative and functional Tyolomnqa Estuary Advisory Forum (EAF) made up of relevant government, community and other civil society representatives, to undertake the management of the Tyolomnqa Estuary 1.2 Identify and reduce conflict among stakeholders of the Tyolomnqa Estuary 1.3 Establish and maintain an effective law enforcement and compliance capacity at the Tyolomnqa Estuary 1.4 Secure funding for EAF activities and day to day estuary management

Table 2: Key Result Area 2- Biodiversity and Conservation

KEY RESULT AREA 2: Biodiversity and Conservation	
STRATEGIC MANAGEMENT OBJECTIVE	MANAGEMENT STRATEGIES
The biodiversity, ecosystems and ecological processes of the Tyolomnqa Estuary are conserved and protected	2.1 Conserve and manage biodiversity, ecosystems and ecological processes in the Tyolomnqa Estuary to ensure their long-term persistence. 2.2 Allow controlled resource use in the Tyolomnqa EFZ in a manner permitted by the MLRA regulations so that the ecological integrity of the estuary is not compromised. 2.3 Contain the spread and impacts of invasive alien vegetation in the estuary EFZ.

Table 3: Key Result Area 3- Social Economic and Local livelihood aspects

KEY RESULT AREA 3: Social, Economic and Local livelihood aspects	
STRATEGIC MANAGEMENT OBJECTIVE	MANAGEMENT STRATEGIES
Sustainable socio-economic benefits that do not compromise the ecological integrity of the estuary are identified, promoted and regulated	3.1 Promote and support recreation and tourism activities that benefit local communities and sustainably balance the exploitation of living resources and the ecological and aesthetic features of the estuary 3.2 Establish and maintain safe and equitable access to the estuary on both the east and west banks 3.3 Develop and implement a focused and cost-effective marketing and awareness-raising programme for the Tyolomnqa Estuary.

Table 4: Key Result Area 4- Water Quantity and Quality

KEY RESULT AREA 4: Water quantity and quality	
STRATEGIC MANAGEMENT OBJECTIVE	MANAGEMENT STRATEGIES
Freshwater resources, waste disposal and land use in the Tyolomnqa River catchment are effectively managed so they do not compromise the quantity and quality of freshwater reaching the estuary	4.1 Determine and protect water quantity requirements for the Tyolomnqa Estuary to ensure that biodiversity and ecological processes are sustained 4.2 Maintain water quality in the Tyolomnqa Estuary

Table 5: Key Result Area 5- Land use Development and Infrastructure Planning

KEY RESULT AREA 5: Land use, development, and infrastructure planning	
STRATEGIC MANAGEMENT OBJECTIVE	MANAGEMENT STRATEGIES
All development activities in and around the Tyolomnqa Estuary are controlled and managed so as to retain the Present Ecological Status of the estuary and sustain and improve livelihoods	5.1 Use existing legislation to control and manage all development activities in and around the Tyolomnqa Estuary 5.2 Minimise the impacts of predicted climate change

Table 6: Key Result Area 6- Engagement and awareness raising

KEY RESULT AREA 6: Engagement and awareness raising	
STRATEGIC MANAGEMENT OBJECTIVE	MANAGEMENT STRATEGIES
Awareness and understanding of the ecological value of the Tyolomnqa Estuary, and the social, livelihoods and economic benefits associated with the estuary are widely understood	6.1 Stakeholders and visitors are made aware of the social importance, and ecological and economic value of the estuary, know the regulations, and understand the rationale for management measures.

Table 7: Key Result Area 7- Research and Monitoring

KEY RESULT AREA 7: Monitoring and Research	
STRATEGIC MANAGEMENT OBJECTIVE	MANAGEMENT STRATEGIES
Research and monitoring necessary to assess estuary health and guide management are implemented and maintained	7.1 Support research that increases understanding of the ecosystems, biodiversity and benefits of the estuary including research on climate change, the importance of the estuary in community livelihoods and the impacts of human activities on habitats and biodiversity 7.2 Develop and maintain a monitoring programme that provides management with information on the state of the estuary and the potential threats to achieving the estuary management objectives.

6. Implementation Framework

Key Result Area 1: Institutional Arrangements and Management Structures

Strategic Management Objective: The Tyolomnqa Estuary is cooperatively and effectively managed by the relevant government institutions and civil society including communities.

Provincial and local government agencies closely implicated in management of the Tyolomnqa Estuary include DEDEAT and BCMM. Nationally, the Department of Forestry, Fisheries and the Environment (DFFE; fisheries resources), the Department of Minerals and Energy, (DMRE; sand mining), the Department of Water and Sanitation (DWS; catchment management) and the Department of Agriculture, Land Reform and Rural Development (DALRRD; catchment management) also have a role to play in the management of the estuary. In addition to Government authorities, the ICM Act requires cooperative governance that is widely representative of all coastal stakeholders. Because of the large number of agencies and the wide range of stakeholder interests in most estuaries, there is a critical need for the formation of clearly defined institutional arrangements and ongoing communication and coordination among institutions and other stakeholders playing a role in the management of an estuary.

DEDEAT is the mandated management agency for the Tyolomnqa Estuary and BCMM will support management of the estuary where it can. DFFE will be critical in the management of the difficult fishery issues facing the estuary. DEDEAT, DFFE and BCMM have limited capacity and resources to manage a rural estuary. Thus a properly constituted and functional Estuary Advisory Forum (EAF)will be a critical factor in the effective management of the estuary (see Institutional Arrangements: Section 10). The purpose of the EAF is to provide a platform through which stakeholders with responsibility for various aspects of the implementation of the

EMP can exchange information and ideas and reach agreement on the appropriate action for the effective management of the estuary. At a minimum the EAF should include a representative from relevant Local and Provincial Government Departments, representatives from relevant National Government Departments, as well as representatives from east bank Residents Associations, the west and east bank local communities and fishing clubs. However, it is important that the EAF is not too big. Ideally only those individuals and government agencies that will play a meaningful role in the management of the estuary should be involved in the EAF. It is essential that the various elements of the EAF work co-operatively to ensure the vision and defined management objectives are realised.

Individual agencies may have to make provision for the funding required to fulfil their estuary management obligations in the medium and long-term. Ideally a sustainable funding model should be developed. The status, authority and responsibilities of the EAF, its composition, and the terms of office need to be formalised so that it has a clear and defensible mandate. Formally mandated sector representatives should regularly liaise with their respective sectors. It is proposed that the EAF should meet at least four times per year. It is important that the EAF annually reviews management effectiveness and progress towards achieving management objectives and it is a requirement that the EAF compiles annual implementation reports which must be submitted to the MEC. It is also critical that every two years the EAF reviews its functionality and relevance.

The provision of effective staffing capacity to undertake or facilitate management actions outlined in the EMP is a critical requirement for effective governance. In the case of the Tyolomnqa Estuary, the appointment of a local person to enforce resource use regulations and zoning, establish relationships with stakeholders and install and maintain information signage would contribute significantly to effective management. However, provincial fiscal challenges suggest that creative ways of funding such a post would have to be explored.

The focus of the Institutional Arrangements and Management structures for the Tyolomnqa Estuary is i) To set up and maintain a representative and functional Tyolomnqa Estuary Advisory Forum (EAF) made up of relevant government, community and other civil society representatives, to undertake the management of the Tyolomnqa Estuary, ii) To identify and reduce conflict among stakeholders of the Tyolomnqa Estuary, iii) To establish and maintain an effective law enforcement and compliance capacity at the Tyolomnqa Estuary and iv) To secure funding for EAF activities and day to day estuary management.

Table 8: Management Actions and Targets associated with Key Result Area 1

Key Result Area 1: Institutional Arrangements and Management Structures

Strategic Objective: The Tyolomnqa Estuary is cooperatively and effectively managed by the relevant government institutions and civil society including local communities.

Strategy 1.1: Set up and maintain a representative and functional Tyolomnqa Estuary Advisory Forum made up of relevant government, community and other civil society representatives, to participate in the management of the Tyolomnqa Estuary.

Management action	Priority	Management targets	Key performance indicators	Responsibility	Time frame (years)				
					1	2	3	4	5
(i) Establish an Estuary Advisory Forum (EAF) with representative members of stakeholder groups and government agencies		Functional Estuary Advisory Forum that meets four times a year in the first year and at least twice a year thereafter	Minutes and reports of meetings	DEDEAT/ BCMM/ EAF					
(ii) Establish formal terms of reference (TOR) and mandates for the Estuary Advisory Forum									
(iii) Coordinate and attend regular Advisory Forum meetings				DEDEAT					
(iv) Review (every two years) the EAF usefulness, structure, representation, TOR and on-going relevance. Amend or revise as required.									
(v) Secure funding for estuary management (see Strategy 1.4)				DEDEAT/ BCMM/ EAF					
(vi) Develop and maintain effective ways of communicating with stakeholder groups				EAF					
(vii) Regularly update stakeholders on all management issues, challenges, and research developments in the estuary									
(viii) Build capacity to improve the effectiveness of the Estuary Advisory Forum				DEDEAT/ BCMM/ EAF					
(ix) Regularly evaluate management effectiveness									

Strategy 1.2: Identify and reduce conflict among stakeholders of the Tyolomnqa Estuary

Management action	Priority	Management targets	Key performance indicators	Responsibility	Time frame (years)				
					1	2	3	4	5
(i) Provide all stakeholders with clear information on the conservation		No long-term conflict	Estuary specific	EAF					

management, zoning and resource use measures in the estuary EFZ including compliance requirements as laid out in the regulations and EMP		among stakeholders	behaviour rules developed in conjunction with fishing groups/clubs, communities, residents and recreational/visitor user groups						
(ii) Build support for the management of the estuary through awareness raising (see Strategy 6.1) and by promoting cooperative development of rules for fishing clubs, residents and any future recreation/visitor user groups									

Strategy 1.3 Establish and maintain an effective law enforcement and compliance capacity at the Tyolomnqa Estuary

Management action	Priority	Management targets	Key performance indicators	Responsibility	Time frame (years)				
					1	2	3	4	5
(i) Evaluate the compliance and enforcement needs, challenges and opportunities associated with the Tyolomnqa Estuary		No illegal activities in the estuary and EFZ	Monthly record of number of patrols, inspections, etc Monthly record of the number of illegal activities occurring in the estuary Number and state of informative signage	DEDEAT/ BCMM/ EAF					
(ii) Develop a compliance and enforcement strategy for the estuary, including schedules, funding, equipment and personnel requirements and any potential cooperative arrangements									
(iii) Ensure compliance and enforcement personnel have sufficient resources, training and legal status to implement compliance strategy									
(iv) Develop suitable regulations signage and erect signboards at key access points				EAF					
(v) In the long term develop relationships with stakeholders that encourage self-policing and respect for the estuary regulations									

Strategy 1.4: Secure funding for the management of the Tyolomnqa Estuary

Management action	Priority	Management targets	Key performance indicators	Responsibility	Time frame				
					1	2	3	4	5
(i) Assess the likely management costs of the estuary		Sufficient long-term funding to enable effective estuary management	Long-term finance plan confirmed	DEDEAT/ BCMM/ EAF					
(ii) Determine funding required to make up shortfall between estimated management costs and any municipal/provincial funding allocation									
(iii) Investigate ways to secure the use of funds generated locally through boat licenses and registration, access and launching fees, leasing fees (property and structures), levies on events and future tourist facilities and permits for future business/tourism operations									

Key Result Area 2: Biodiversity and Conservation

Strategic Objective: The biodiversity, ecosystems and ecological processes of the Tyolomnqa Estuary are conserved and protected.

The Tyolomnqa Estuary is one of relatively few South African estuaries that has not been badly impacted by anthropogenic activities. From an ecological perspective it is therefore important to retain the current functionality of the estuary by ensuring that the diversity, distribution and abundance of plant, animal, bird, fish and benthic invertebrate communities as well as the ecosystems and ecological processes that sustain them is maintained. Changes to the estuaries throughout the south and east coast of South Africa may result from climate change and it is important to have a benchmark by which the extent of those changes can be measured.

Because the estuary is largely natural, it is an important lifestyle feature for the east bank residential communities. However, the estuary is also a source that supports livelihoods of west bank communities, and as a recreational resource for regional anglers. In order to conserve biodiversity in the Tyolomnqa Estuary it is particularly important to provide for the sustainable use of natural resources in relation to the fishing activities taking place in the estuary. Given the history of resource use in the area, the poverty and unemployment levels, and the persistent challenges associated with controls, it is one of the more difficult management strategies to implement.

Mud crab exploitation and gill net fishing in the Tyolomnqa Estuary are likely to be the most contentious compliance issues faced by the management authority. DFFE (Branch: Fisheries Management) is the authority responsible for implementing fishery control measures in both fisheries. MLRA size and bag limits for mud crabs are ignored. The gill net fishery is illegal and impacts negatively on the survival of both the estuarine dependant juvenile fish populations and the adult populations. There are no hard data on quantities or species caught in both fisheries, nor on the income derived from catches. Gill net fishers are apparently not local community members and are recruited from outside the area, so economic benefits to local communities from the fishery are minimal. Mud crab fishers are local community members and it may be possible to explore offsets that exchange crab fishing for other community benefits. A management priority should be the elimination of gill net fishing in the estuary. Mud crab fishing must align with the control measures of the MLRA. These issues must be explored in discussions with stakeholders before the EMP is finalised.

Motorised boating on the estuary for fishing and recreational purposes has the potential to negatively impact estuary biodiversity and ecological processes. Using the space standards for recreational water activities advocated by Sowman and Fuggle (1987) and outlined in a report to address boat congestion in the Sundays River Estuary (Lee & Du Preez 2015), assuming the open water habitat of the Tyolomnqa Estuary is 86 Ha (Table 2: Situation Assessment), and the entire extent of the habitat is used, a maximum of 51 boats should be accommodated on the estuary at any one time. Of these, a maximum of 4 should be fishing, 46 should be leisure boating and 1 should be skiing (estimates made using the model of Lee & Du Preez 2015). Other

estimates of boat carrying capacity at any one time for the Tyolomnqa Estuary (based on an open water area of 86 Ha and calculated from data in Bosley 2005; CSIR 2007; CDM Smith2017) are: 26 – 35 motorised general use or 12 water skiing; 8 – 41 boats motorised general use or 7 water skiing; 17 motorised general use. Clearly there is a wide range in these estimates and stakeholders should discuss boat carrying capacities. Recreational carrying capacity is discussed in more detail in Section 7 (Zoning).

Zoning allows for protection in sanctuary areas which helps achieve sustainable resource use, but no control measures are effective if there is no effective enforcement and compliance capability. Effective enforcement and compliance will require at least one properly equipped and trained person and/or creative ways to ensure compliance.

The focus of biodiversity and conservation in the Tyolomnqa Estuary will be to i) Conserve and manage biodiversity, ecosystems and ecological processes in the Tyolomnqa Estuary to ensure their long-term persistence, ii) Allow controlled resource use in the Tyolomnqa EFZ in a manner and in areas permitted by the regulations so that the ecological integrity of the estuary is not compromised and iii) Containing the spread and impacts of invasive alien vegetation in the estuary EFZ.

Table 9: Management Actions and Targets associated with Key Result Area 2

Key Result Area 2: Biodiversity and Conservation

Strategic Objective: The biodiversity, ecosystems and ecological processes of the Tyolomnqa Estuary are conserved and protected.

Strategy 2.1: Conserve and manage biodiversity, ecosystems and ecological processes in the Tyolomnqa Estuary to ensure their long term persistence

Management action	Priority	Management targets	Key performance indicators	Responsibility	Time frame (years)				
					1	2	3	4	5
(i) Based on the EMP Situation Assessment, identify and prioritise the estuary's biodiversity management requirements in terms of baseline information, research and monitoring		Zonation plan for the estuary approved and implemented Ongoing research in the estuary	Zonation plan for the estuary approved and implemented Number of registered research programmes No. of monitoring programmes in place	DEDEAT/ BCMM/ EAF and partner research institutions					
(ii) Approach Research institutions/NGOs/ DFFE/DWS to collect key baseline biodiversity/ecosystem data for the estuary (prioritising extent and density of mangroves, extent and density of sand and mud prawn populations, estuary depth profiles, extent and type of natural resource use, temperature and rainfall data, fish recruitment data and information on land- river-estuary-sea connectivity)									
(iii) Establish and implement an effective zonation policy in the estuary that addresses both resource use and conservation requirements (see Zoning)									
(iv) Secure an adequate freshwater supply into the estuary (see Water Quantity and Quality)				DWS					
(v) Control development in the EFZ (see Land Use, development, and Infrastructure planning)				DEDEAT					
(vi) In the long term, rehabilitate any estuarine habitat damaged by historic agriculture activities, illegal recreational and tourism developments, and sand mining operations				DEDEAT/ BCMM/ EAF					

Strategy 2.2: Allow controlled resource use in the Tyolomnqa EFZ in a manner and in areas permitted by the regulations so that the ecological integrity of the estuary is not compromised

Management action	Priority	Management targets	Key performance indicators	Responsibility	Time frame				
					1	2	3	4	5

(i) Install signage at access points providing resource users with clear information on compliance requirements as laid out in the MLRA regulations		Levels of estuary natural resource use by all stakeholders are ecologically sustainable	No illegal fishing/bait collecting activities Number and state of informative signage Database on resource users and extent of resource use	EAF					
(ii) Develop and implement an ongoing engagement and awareness raising programme prioritising permanent residents, fishing clubs and local communities (see Strategy 6.1)									
(iii) Establish and implement an effective zonation plan in the estuary that addresses both resource use and conservation requirements (see Zoning)				DEDEAT/ BCMM/ EAF					
(iv) Establish and maintain an effective enforcement and compliance capacity that controls recreational and illegal fishing activities and bait collection by enforcing DFFE licence requirements and the MLRA regulations (see Strategy 1.3)									
(v) Establish and enforce limits on the number of motorised boats operating on the estuary at any one time									
(vi) Explore offset possibilities with local communities (e.g provision of community facilities in return for compliance with mud crab size and bag limits).				EAF					
(vii) Implement effective catch data collection programmes prioritising mud crab offtake and recreational fishing (see Strategy 7.2)				DFFE					
Strategy 2.3: Contain the spread and impacts of invasive alien vegetation in the estuary EFZ									
Management action	**Priority**	**Management targets**	**Key performance indicators**	**Responsibility**	**Time frame (years)**				
					1	**2**	**3**	**4**	**5**
(i) Map the types and extent of invasive alien plants in the Tyolomnqa Estuary EFZ		No seeding invasive alien plants within the estuary EFZ	Extent, by density and area, of invasive alien plants	DEDEAT/ BCMM/ EAF					
(ii) Explore partnerships with funding and implementing agencies (.e.g. BCMM, DEDEAT, DEA) to help fund invasive alien plant control programme using local labour									
(iii) Eradicate, on an ongoing basis, targeted invasive alien plant infestations occurring within the estuary EFZ, with a primary focus on prickly pear				EAF					
(iv) Every two years update the maps of the types and extent of invasive alien vegetation in the Tyolomnqa Estuary EFZ									

Key Result Area 3: Social, Economic and Local livelihood aspects

Strategic Management Objective: Sustainable socio-economic benefits that do not compromise the ecological integrity of the estuary are identified, promoted and regulated.

Although there are economic benefits derived from the existence of residences on the east bank of the Tyolomnqa Estuary these do not really filter through to a much larger stakeholder group made up of the low income communities on the west bank. Currently, the major economic benefit derived from the resources of the estuary appears to be from the capture and sale of mud crabs, which has the potential to harm the ecology of the estuary. No direct economic benefit accrues to the estuary from recreational fishing.

The Tyolomnqa Estuary and its surroundings have considerable ecotourism potential opportunities related to fishing, hiking, river cruises, and birding but there is currently very little in the way of tourism and recreation infrastructure in or near the estuary. A lack of access to the estuary and its surrounds is a key factor in limiting tourism and recreational activities. The east bank is inaccessible because the land is all privately owned and fenced. On the west bank there are no safe and surfaced roads to the estuary and no facilities (parking areas, ablutions) for any visitors. In terms of the ICM Act, controlled access to coastal public property (including estuaries) is a right, and access to both sides of the Tyolomnqa Estuary should be improved to enable public use of the estuary and its features, and to promote the development of ecotourism opportunities that might generate economic benefits for the estuary stakeholders. Clearly, such development requires funding and expertise and the management authority should support ecotourism development proposals that present a viable business plan. Additionally, the Tyolomnqa Estuary and the adjacent East London Coast Nature Reserves and their surrounds need to be marketed in BCMM visitor information brochures and corporate, regional and provincial tourism marketing products and materials. Estimates of motorised boat carrying capacity for the estuary are provided in Key Result Area 2. Limits on the number of motorised recreational boats operating on the estuary at any one time need to be established and enforced.

The Sandile community boat launch ramp (2.3 km upstream of the R72 road bridge; 33^0 8.820S 27^0 33.519E) used to provide access to the estuary for recreational anglers. The community provided parking and car/trailer guarding services as well. This economic stream was shut down because the launch ramp was not formally gazetted in terms of ICM Act: Management of Public Launch Sites in the Coastal Zone Regulations. Formal gazetting of the launch site above the R72 would reinstate employment opportunities in the form of car guarding and launch site management services to recreational anglers. The EAF should approach DEDEAT to gain clarity on the steps required to have the launch site formally approved (EIA processes, Section 24G, Sea Shore Act Lease application). Thereafter, the EAF must liaise with the Sandile community to take the process forward. It would be important to collect data relating to use of the launch site and fish caught by boat anglers. There are also opportunities for satellite services associated with managing the launch site (e.g. the provision of food and cold drinks).

Management of the Tyolomnqa Estuary could provide some employment opportunities – compliance activities, alien vegetation clearing, developing and servicing access and tourism infrastructure. Employment

in these fields can increases awareness of the estuary and its potential economic benefits. A sustainable funding model is required in order to develop these management related economic benefits.

The focus of this Management Objectives is to i) Promote and support recreation and tourism activities that benefit local communities and sustainably balance the exploitation of living resources and the ecological and aesthetic features of the estuary ii) Establish and maintain safe and equitable access to the estuary on both the east and west banks and iii) Develop and implement a focused and cost-effective marketing and awareness-raising programme for the Tyolomnqa Estuary.

Table 10: Management Actions and Targets associated with Key Result Area 3

Key Result Area 3: Social, Economic and Local livelihoods aspects

Strategic Objective: Sustainable socio-economic benefits that do not compromise the ecological integrity of the estuary are identified, promoted and regulated

Strategy 3.1: Promote and support recreation and tourism activities that benefit local communities and sustainably balance the exploitation of living resources and the ecological and aesthetic features of the estuary

Management action	Priority	Management targets	Key performance indicators	Responsibility	Time frame				
					1	2	3	4	5
(i) Establish and implement an effective zonation plan in the estuary (see Zonation)		Estuarine based ecotourism enterprises provide employment in surrounding local communities	New estuarine based locally owned ecotourism enterprises are established and operating	DEDEAT/ BCMM/ EAF					
(ii) Establish and enforce limits on the number of motorised boats operating on the estuary at any one time. In the medium term develop and implement a by-law to control power boating, thereby limiting wildlife disturbance and bank erosion, promoting sustainable resource use and maintaining aesthetic attributes of the estuary				BCMM					
(iii) Establish an effective enforcement and compliance capacity (see Strategy 1.3)									
(iv) Support opportunities for local communities to participate in the provision and management of tourist and recreational products. Prioritise licensing and management of the Sandile community boat launch site (see Strategy 3.2)									
(v) Promote low-impact, non-consumptive activities such as hiking, bird watching, canoeing									
(vi) Explore and where possible support the participation of local community members in conservation opportunities around the Tyolomnqa Estuary such as road maintenance, cleaning services, fencing, security, fire management, invasive alien plant and bush encroachment control, security, and tourism infrastructure development									

(vii) Ensure all visitors are provided with clear information (informational signage, brochures, boundaries of sensitive areas demarcated etc.) on the conservation management measures in the estuary including zoning, power boating, and compliance requirements as laid out in the regulations (see Strategy 6.1)				EAF					
(viii) Determine what quality and quantity of visitor facilities (ablutions, parking, etc.) are sufficient to meet visitor standards and requirements. Implement requirements									
(ix) Ensure visitor facilities are maintained in good condition									
(x) Facilitate development of complementary livelihood options e.g. farming				DEDEAT/ BCMM/ EAF					
Strategy 3.2: Establish and maintain safe and equitable access to the estuary on both the east and west banks									
Management action	**Priority**	**Management targets**	**Key performance indicators**	**Responsibility**	**Time frame**				
					1	**2**	**3**	**4**	**5**
(i) Promote equitable and controlled access to coastal public property as defined in the ICM Act (Chapter 2, Sections 7 and 13)		Equitable and controlled public access to both east and west banks of the Tyolomnqa Estuary	A plan for improving access and developing the Public Recreation Areas has been adopted and is being actioned.	DEDEAT/BCMM/ EAF					
(ii) Initiate discussions with the Tyolomnqa East Bank Residents Association/ east bank landowners with regard to providing public access servitudes for vehicle and pedestrian access to the estuary				EAF					
(iii) Initiate discussions with west bank communities to identify road alignments to provide improved access to the estuary									
(iv) Develop approved facilities that improve accessibility to the estuary for recreational users including access road, parking area, boat launch ramp, ablution facilities				DEDEAT/BCMM/ EAF					
(v) Initiate and facilitate processes necessary for registration of the Sandile boat launch site as a DEDEAT approved launch site (EIA, Section 24G, Sea Shore Act lease application).				EAF					
(vi) Promote development of facilities at Sandile launch site to enable proper management of the site									
Strategy 3.3: Develop and implement a focused and cost-effective marketing and awareness-raising programme for the Tyolomnqa Estuary									
Management action	**Priority**	**Management targets**	**Key performance indicators**	**Responsibility**	**Time frame (years)**				
					1	**2**	**3**	**4**	**5**
(i) Where possible provide updated information about the Tyolomnqa Estuary in the development of corporate, regional and provincial		Improved awareness of tourism and	Numbers of visitors to and users of the	DEDEAT/ BCMM/ EAF/ECPTA					

tourism marketing products and materials		recreation products in the area around Tyolomnqa	Tyolomnqa Estuary							
(ii) Advertise the features of Kaisers Beach, ECPTA Nature reserves and Tyolomnqa Estuary in BCMM visitor information brochures										
(iii) Establish links with local educational institutions in order to promote use of the estuary as an educational resource										

Key Result Area 4: Water quantity and quality

Strategic Objective: Freshwater resources, waste disposal and land use in the Tyolomnqa River catchment are effectively managed so they do not compromise the quantity and quality of freshwater reaching the estuary.

A key factor in maintaining the health of all estuaries is the continued supply of good quality freshwater flow into the system. The ecology of an estuary is adapted to freshwater input at intervals determined by prevailing rainfall patterns. Occasional flash floods flush systems, re-establish channels, clear floodplain vegetation, redistribute sediments and wash out accumulated nutrients and chemicals. The Tyolomnqa Estuary is fortunate in that freshwater flow in the Tyolomnqa River and into the estuary is only blocked in one place by a low weir. A minor amount of the MAR is retained in stock dams located in water courses in the catchment but current MAR is about 96% of historical levels. The Ecological Reserve has not yet been determined but currently there is minimal threat to the river and estuary from water storage or abstraction.

Although water quality data are few, existing research indicates that the water quality in the estuary is good but this is partly because it is a tidally dominated system with freshwater inflow only after significant rain in the catchment. There are no water quality data for the Tyolomnqa River but upstream of the weir at the head of the estuary, livestock trample the banks and drink from the river, introducing silt into the water. A field visit indicated possible nutrient enrichment immediately above the weir.

A lack of development planning and the natural expansion of the west bank communities and their livestock will degrade the catchment and its vegetation, resulting in siltation and a reduction in water quality in the river and estuary. Stock dams on some of the tributaries upstream of the weir probably act as nutrient sinks for contaminated run-off from the settlements lacking formal waste management services, and extensive dumping of waste occurs in the veld adjacent to communities. It is likely that some anthropogenically derived pollutants enter the Tyolomnqa River through the various drainage lines. A baseline water quality assessment in the Tyolomnqa River is priority.

Water quality in the estuary is affected by minor erosion along stock paths on the west bank, and potentially by inadequacies or failures of the sewage and wastewater disposal arrangements of the east bank residents. All the east bank residential developments are vulnerable to climate change induced sea level rise and flooding. Water quality monitoring in both the river and the estuary should be implemented as part of the EMP.

The focus of the Water Quality and Quantity Management Objective is to i) Determine and protect water quantity requirements for the Tyolomnqa Estuary to ensure that biodiversity and ecological processes are sustained and ii) Maintain water quality in the Tyolomnqa Estuary.

Table 11: Management Actions and Targets associated with Key Result Area 4

Key Result Area 4: Water quantity and quality

Strategic Objective: Freshwater resources, waste disposal and land use in the Tyolomnqa River catchment are effectively managed so they do not compromise the quantity and quality of freshwater reaching the estuary.

Strategy 4.1: Determine and protect water quantity requirements for the Tyolomnqa Estuary to ensure that biodiversity and ecological processes are sustained.

Management action	Priority	Management targets	Key performance indicators	Responsibility	Time frame				
					1	2	3	4	5
(i) In the long term, lobby DWS for the development of a Catchment Management Strategy (CMS) to control sediment run-off		Ecological Reserve determined and implemented	Desktop Ecological Reserve determination	DWS/EAF				■	■
(ii) Lobby DWS to determine the Ecological Reserve for the estuary (at least desktop). Implement Ecological Reserve.								■	■
(iii) Document and monitor water abstraction sites and volumes		No illegal/unlicensed /unregistered water use.	Number of infringements in terms of NWA	DWS	■	■	■	■	■
(iv) Enforce existing legislation in the catchment in terms of the National Water Act with respect to water use & licensing; Stream flow reductions; General authorisations, Catchment management and Prevention of pollution.					■	■	■	■	■

Strategy 4.2: Maintain water quality in the Tyolomnqa Estuary

Management action	Priority	Management targets	Key performance indicators	Responsibility	Time frame				
					1	2	3	4	5
(i) Engage BCMM to comply with the National Waste Management Strategy (2020) with regard to implementing solid waste management services in the Phozi, Tsaba, Sandile and Mpintsho communities with a primary focus on closing and rehabilitating all unregistered solid waste dump sites in the Tyolomnqa catchment and removing all solid waste to approved municipal waste management sites		Maintenance of good water quality in the Tyolomnqa River and Estuary	Solid waste management plan for the Tyolomnqa rural communities developed and implemented.	BCMM/EAF		■	■		
(ii) Review adequacy of existing sewage disposal arrangements in the residences along the east bank of the estuary.						■	■		
(iii) Enforce any required upgrades on inadequate sewage disposal systems			Water quality monitoring programme and reports.					■	
(iv) Promote and support proper development planning in community				DEDEAT	■	■	■	■	■

areas										
(v) Where possible, rehabilitate degraded and transformed areas in the catchment				EAF						
(vi) Lobby DWS to undertake a river water quality assessment upstream of the weir at the TR 14504 road bridge				EAF/DWS						
(vii) In conjunction with DWS, develop and implement a water quality monitoring programme in the Tyolomnqa estuary. Record and analyse results to provide regular updates (see Strategy 7.2)										

Key Result Area 5: Land use Development and Infrastructure planning

Strategic Objective: All development activities in and around the Tyolomnqa Estuary are controlled and managed so as to retain the Present Ecological Status of the estuary and sustain and improve livelihoods.

In common with much of rural South Africa, increasing rural populations and poorly implemented formal rural development planning in the Tyolomnqa catchment will lead to land degradation and increased erosion. This is likely to impact on the Tyolomnqa Estuary. In addition, both subsistence and commercial agriculture operations take place around the Tyolomnqa Estuary and have the potential to negatively affect river and estuary water quantity, quality and sediment loads, particularly if rainfall intensity increases as a result of climate change. Developments and land use in the catchment and estuarine area should not lower water quality or interfere with normal hydrodynamic or sedimentary processes and cycles in the estuary. It is thus critical that that BCMM incorporates all recommendations of the EMP into the SDF, IDP, Water Services Development Plan and all other planning documents. From a management perspective, the management authority would be expected to be aware of, and where necessary, be proactively involved in, any planning process involving the estuary and areas adjacent or close to the estuary where there is potential for negative or positive impacts on the estuary and its associated ecosystems.

Development proposals (including private developments and any proposed eco-tourism infrastructure developments) should be evaluated through the EIA procedure and guided by the EMP specifically and the broader BCMM coastal management plan and the Eastern Cape Biodiversity Conservation Plan. Several of the jetties on the east bank were constructed without environmental authorisation and have undergone a Section 24G process in terms of the EIA Regulations. The EAF should prioritise liaising with DEDEAT to conclude outstanding appeal processes and issue leases in terms of the Sea Shore Act.

The management agency must also develop and implement a long-term climate change strategy to minimise or mitigate the effects of climate change. Priority actions would be to research climate change vulnerabilities in the estuary, institute and maintain climate related monitoring, and protect coastal barriers and critical coastal ecosystems like mangroves, salt marshes and sea grass beds. Planning should allow for the maintenance of a riparian zone along the length of the estuary where sensitive habitats (e.g. wetlands, mangroves, supratidal saltmarsh and indigenous vegetation) occur. No additional development (structures) should be allowed on the floodplain (1:100 year flood line) for safety reasons and sense of place.

The focus of the Land Use and Development Infrastructure Planning Objective is to i) Use existing legislation to control and manage all development activities in and around the Tyolomnqa Estuary and ii) Minimise the impacts of predicted climate change.

Table 12: Management Actions and Targets associated with Key Result Area 5

Key Result Area 5: Land use, development and infrastructure planning										
Strategic Objective: All development activities in and around the Tyolomnqa Estuary are controlled and managed so as to retain the Present Ecological Status of the estuary and sustain and improve livelihoods.										
Strategy 5.1: Use existing legislation to control and manage all development activities in and around the Tyolomnqa Estuary										
Management action	**Priority**	**Management targets**	**Key performance indicators**	**Responsibility**	**Time frame**					
					1	**2**	**3**	**4**	**5**	
(i) Integrate the EMP into local and regional development planning (BCMM IDP and SDF, ECBCP, Provincial Coastal Management Programme)		No developments without EIAs Gazetted SDFs reflect requirements of Estuary Management Plan and Setback lines	Records of attendance and minutes of meetings (IDP, DEDEAT planning). RODs for developments Gazetted SDFs reflect requirements of Estuary Management Plan and Setback lines .	DEDEAT/ BCMM/ EAF						
(ii) Participate in local and regional conservation and socio-economic development initiatives that may impact the communities and ecosystems of the Tyolomnqa Estuary.										
(iii) Enforce existing legislation relevant to development activities that impact on estuary ecosystems and their functioning e.g. NEMA ICM and the EIA Regulations, ORV Regulations and CARA.										
(iv) Attend BCMM IDP meetings to lobby for the provision of municipal infrastructure and services that support local economic development initiatives in the Tyolomnqa communities and assist in managing the estuary				EAF						
(v) Ensure proper EIA process for all developments that might impact the estuary. Register as IAPs for any estuary related EIA and attend Public Participation meetings				DEDEAT/ BCMM/ EAF						
(vi). Conclude outstanding jetty appeal processes and issue all jetties and slipways with leases in terms of the Seashore Act (21 of 1935). Maintain database of jetties and slipways				DEDEAT						
(vii) Contest EIA approvals (DEA/DMRE) for any sand mining activities within 2 km of the estuary EFZ				DEDEAT/ BCMM/ EAF						

Strategy 5.2: Minimise the impacts of predicted climate change										
Management action	**Priority**	**Management targets**	**Key performance indicators**	**Responsibility**	**Time frame**				
					1	**2**	**3**	**4**	**5**
(i) Prohibit additional development (structures) on the floodplain within the 1:100 flood line and coastal protection zone including Critical Biodiversity Areas.		No negative impacts on the Tyolomnqa Estuary from factors and events associated with climate change	No further developments in areas identified in the Tyolomnqa Estuary as being vulnerable to coastal or estuarine flooding	BCMM/DEDEAT/ EAF					
(ii) When possible, institute and maintain relevant climate related monitoring necessary to increase understanding of climate change vulnerabilities in the estuary (see Strategy 7.2)									

Key Result Area 6: Engagement, awareness raising

Strategic Objective: Awareness and understanding of the ecological value of the Tyolomnqa Estuary, and the social, livelihoods and economic benefits associated with the estuary are widely understood.

Effective management of the Tyolomnqa Estuary will depend to a large extent on stakeholder buy-in, which will in turn depend on an improved awareness and appreciation of the ecological importance and functioning of the estuary and of the management requirements to improve and maintain such functionality. A key issue in the formal management of any ecologically sensitive area like an estuary is the general lack of understanding by key stakeholders of the ecological and economic benefits generated by the area, its legal context, and the obligations generated by such legal context. A lack of understanding complicates management and increases the need for expensive enforcement and compliance activities. Ongoing engagement with stakeholders, schools, and the general public can help to build relationships and develop a sense of care, custodianship, and responsibility for a particular ecological resource. Provision of interpretive and educational material can greatly enhance learning and draw attention to key aspects of the environment that are special or unique to the area. This material can also be used to highlight the impact of human activities on the environment.

Relevant stakeholders including communities and/or community structures should be involved in the design of awareness and outreach programmes and material to ensure that the knowledge and information shared is relevant, addresses stakeholder knowledge gaps and incorporates indigenous knowledge where necessary. Stakeholders contribute multiple forms of knowledge, can share ideas and potential solutions to emerging challenges, and have a key role in disseminating information more broadly. Clearly, it is important to direct resources at engaging with stakeholders in the management of the Tyolomnqa Estuary.

The focus of the Engagement and Awareness Raising Objective is that i) All stakeholders and visitors should be aware of the social importance, and ecological and economic value of the estuary, know the regulations, and understand the rationale for management measures.

Table 13: Management Actions and Targets associated with Key Result Area 6

Key Result Area 6: Engagement and awareness raising									
Strategic Objective: Awareness and understanding of the ecological value of the Tyolomnqa Estuary, and the social, livelihoods and economic benefits associated with the estuary are increased									
Strategy 6.1: All stakeholders and visitors should be aware of the social importance, and ecological and economic value of the estuary, know the regulations, and understand the rationale for management measures.									
Management action	**Priority**	**Management targets**	**Key performance indicators**	**Responsibility**	**Time frame**				
					1	**2**	**3**	**4**	**5**
(i) Develop a stakeholder Engagement and Awareness raising plan and appoint someone to implement the plan		Awareness raising materials outlining benefits, attributes and legal and regulatory context of the estuary developed and effectively distributed	Educational materials exist and are shared with stakeholders Stakeholders are sensitive to and aware of activities affecting health and functioning of the estuary, and management regulations governing use of the estuary	EAF					
(ii) Develop materials that improve understanding of the attributes, functions, legal context and potential benefits of the estuary for stakeholders and the general public, and the implications of poor compliance with regulations									
(iii) Evaluate the most effective distribution and communication formats for different groups and implement									
(iv) Standardise, source, install and maintain informational signage at relevant points along the estuary (see Strategy 1.3).									

Key Result Area 7: Monitoring and Research

Strategic Objective: Research and monitoring necessary to assess estuary health and guide management are implemented and maintained.

This management plan has been devised based on current understanding of the functioning of the estuary and its social and economic importance. Research related to the Tyolomnqa Estuary has been limited. Harrison et al. (1999) evaluated water quality, fish populations and some basic physical features of the estuary and there has been very limited research on some invertebrate species (Peer et al. 2018). Much of the other information is sourced from the latest National Biodiversity Assessment (NBA 2018) and the Buffalo City Metro Municipality- Economic Review and Outlook 2017 (ECSECC 2017). There are gaps in the understanding of the ecological functioning of the estuary, and there will be an ongoing need to improve understanding through research and monitoring, particularly if access to the estuary is improved, eco-tourism infrastructure is developed, and visitor numbers and resource use increase. Changes in freshwater supply from the catchment, and climate and sea-level change can impact on the health and ecological functioning of the estuary. Monitoring and research are essential to enable the estuary management agency to adapt management plans, strategies and management activities to changing circumstances. Research priorities include increasing understanding of the ecosystems, and biodiversity of the estuary and research on the likely impacts of climate change. It is also critically important to understand the impact that fishing practices have on the nursery function and biodiversity of the estuary. and the importance of the estuary in community livelihoods.

Ideally a community-based monitoring and data collection programme focused on community resource use activities and recreational linefishing catch and effort should be instituted.

The focus of this Monitoring and Research Objective is to i) Support research that increases understanding of the ecosystems, biodiversity and benefits of the estuary including research on climate change, the importance of the estuary in community livelihoods and the impacts of human activities on habitats and biodiversity and ii) To develop and maintain a monitoring programme that provides management with information on the state of the estuary and the potential threats to achieving the estuary management objectives.

Table 14: Management Actions and Targets associated with Key Result Area 7

Key Result Area 7: Research and Monitoring

Strategic Objective: Research and monitoring necessary to assess estuary health and guide management are implemented and maintained

Strategy 7.1: Support research that increases understanding of the ecosystems, biodiversity and benefits of the estuary including research on climate change, the importance of the estuary in community livelihoods and the impacts of human activities on habitats and biodiversity

Management action	Priority	Management targets	Key performance indicators	Responsibility	Time frame (years)				
					1	2	3	4	5
(i) Collate existing research and information and identify key knowledge gaps for the management of the estuary		Management related research requirements are identified and documented	Adequate research and monitoring is being conducted so that utilisation patterns and changes in abiotic and biotic health can be quantified, and benefits accruing to local communities can be measured	EAF					
(ii) Promote and support research in the estuary and surrounding area that addresses knowledge gaps and threats, and guides the management of the estuary									
(iii) Maintain a research register for all research programmes									
(iv) Assist with access, data collection and support for approved research projects									
(v) Ensure all research results are fed back to management									
(vi) Ensure research results are accessible and inform adaptive management									

Strategy 7.2: Develop and maintain a monitoring programme that provides management with accurate and timely information on the state of the estuary and the potential threats to achieving the estuary management objectives

Management action	Priority	Management targets	Key performance indicators	Responsibility	Time frame (years)				
					1	2	3	4	5
(i) Review and prioritise monitoring needs for the estuary		Monitoring plan that informs management developed and implemented	Monitoring plan and baseline data	EAF					
(ii) Establish relevant and logistically pragmatic ecosystem health indicators for monitoring									
(iii) Facilitate the collection of prioritised monitoring data									
(iv) Analyse monitoring data and apply appropriate management									

actions									

7. Proposed Zonation of the Tyolomnqa Estuary

For the purposes of this management plan the boundaries of the Tyolomnqa Estuary are defined by the 5m contour line (Figure 2). Most of the estuarine ecosystems are situated below this line and much of the land below this line is either within the 50 year flood line or is in danger of flooding as a result of climate change. The ICM Act defines a 1000 m Coastal Management Line as the coastal protection zone in rural areas where land not zoned as urban or township, and a 100 m Coastal Management Line in areas zoned for development. The ICM Act also provides for the establishment of Coastal Management Lines, designed to protect coastal public and private property as well as the coastal protection zone. No new development (construction) is permitted within Coastal Management Lines. The EIA Regulations (2014; as amended) stipulate that a coastal development setback zone of 100 m from the high water mark of the estuary be implemented. Apart from protecting developments and infrastructure from climate change related impacts, this development setback zone will serve to protect the vegetation along the edges of the EFZ, will protect the ecological functioning and integrity of the estuary, limit disturbances to estuarine flora and fauna, and will assist in retaining the wilderness character of the estuary.

These Coastal Management Lines described above provide a useful general zonation framework that is sufficient to control development activities on the estuary. Apart from these general restrictions, estuary management plans often include estuary specific zonation that is applied to restrict certain activities and protect sensitive or damaged ecosystems. Zonation is also used to separate incompatible activities like bird watching and water skiing. Activities on an estuary for which controls and restrictions can be considered include fishing, bait collecting, water skiing and power boating, ploughing and planting of agricultural land, and access to the water's edge for people and cattle. Zonation of the Tyolomnqa estuary is likely to be a sensitive and contentious issue because there is considerable use of the natural resources of the estuary by both community members living on the west bank, by recreational fishers from several angling clubs outside the area, and by members of the residents' associations living on the east bank.

A proposed zonation plan for the Tyolomnqa Estuary is presented in Figure 3. It must be stressed that this is simply a proposal and zonation of the estuary will depend entirely on the stakeholder input into the development of this management plan.

East bank residents and visitors collect bait and fish recreationally while enjoying the natural beauty of the estuary. They may use power boats for fishing, bird watching and activities like water skiing. Angling clubs based in the Amathole and Buffalo City area engage in intensive recreational and competitive fishing using skiboats, generally over weekends. West bank community members are to some extent dependent on the resources of the estuary for subsistence and livelihoods. They engage in bait collection and line fishing and the capture of large numbers of mud crabs for sale. Bait collecting in the estuary is limited, since anglers or their assistants mainly collect for own use. However, some bait collectors use spades to collect mud prawns and this practice erodes the edge of the saltmarsh where the prawns are generally found. Apart from voluntary compliance with the MLRA regulations, current aquatic activities on the estuary are essentially unrestricted.

There are four fishing related problem issues in the Tyolomnqa Estuary.

1) Angling clubs visit the estuary over weekends and fish from their skiboats for 48 hours continuously. Issues are lack of compliance with fishing regulations, noise, littering, and rowdy behaviour on the water resulting in a loss of sense of place.

2) Illegal gillnetting in the upper estuary unselectively captures large number of adult and juvenile fish, many of which use the estuary as a nursery area for several years before migrating to sea, where they become available to the commercial line fishery. The removal of large numbers of fish negatively impacts the ecology of the estuary and both subsistence and recreational fishers.

3) Large numbers of mud crabs are collected and sold. The removal of probably a significant proportion of the population of the top benthic predator has unknown ecological impacts.

4) Some bait collectors use spades to collect prawns from mudbanks at the edges of saltmarshes, causing erosion of the saltmarsh ecosystem.

Effective compliance should resolve regulatory problems like gill netting, bait collection with spades and the collection of mud crabs smaller than the minimum legal size. Behavioural problems can often be resolved by an effective engagement and awareness raising programme. The demarcation of a 'no fishing from boats' zone in front of the main residential area (Figure 3) would address behavioural issues associated with weekend ski boat anglers and would help to preserve the sense of place and the aesthetic qualities associated with the estuary. It is suggested that the area immediately in front of the main residential areas should also be designated a wake free zone since this is where recreational activities like swimming, canoeing etc. occur.

At present a 'gentleman's agreement' to refrain from night fishing would help to address boat related fishing issues, would reduce the fishing pressure on collapsed fish stocks and would probably improve compliance with the regulations (since fishing violations could not be hidden by darkness). Draft legislation to ban nighttime fishing in all estuaries across the nation is being revived and reviewed by DFFE (Oceans and Coast; Steve Lamberth, 2023 pers. comm.) and when gazetted would help to reduce fishing pressure in general and would afford extra protection to dusky kob which are very vulnerable to nighttime fishers.

It is suggested that a water skiing zone be defined between the northern and southern estates on the east bank (Figure 3). Water skiing is undertaken mainly by East Bank residents and the area between the estates on Plots 1252 and 1139 would appear to be easily accessible, have the least impact in terms of noise disturbance to residents, and be well away from the sensitive wetland ecosystems further downstream.

The impact of power boating on bank erosion is probably minor. Wind induced waves on the middle and lower reaches of the estuary are much larger than those caused by power boating. However, there is clear evidence of bank erosion and collapse particularly in the narrow middle estuary just seaward of the R72 road bridge and a wake free zone has been suggested in this area (Figure 3). Power boats also have noise impacts which can affect both the sense of place for other estuary users and the feeding and breeding behaviour of avifauna. It would probably be a useful intervention to define wake free zones in the areas where shorebirds mainly feed (saltmarsh and mud banks), and upstream and downstream of Kingfisher bend where several

species of birds nest in burrows in the vertical bank and where there is pronounced evidence of undercutting and bank collapse. Thus a wake free zone is proposed for the estuary from the R72 bridge to the start of the proposed water skiing zone (Figure 3).

Because of their sensitivity and ecological importance it is suggested that the salt marshes and mangroves on the eastern shore should be designated a sanctuary area (Figure 3). Consideration should be given to designating the entire salt marsh area a sanctuary but this would eliminate access to the main mud prawn collection area on the west bank of the estuary. Making the salt marshes on the western side of the estuary a part of the sanctuary zone would need to be discussed with all stakeholders.

Stakeholders have indicated that the recreational carrying capacity of the Tyolomnqa Estuary should be determined. Recreational carrying capacity is a complex concept, including elements like ecological, economic, physical, psychological, spatial, social and cultural carrying capacity (Sowman 1987; CSIR 2007; CDM Smith 2017). Carrying capacity in its basic form attempts to maintain the integrity of the resource base and at the same time provide a recreation experience of high quality to the user. Determining recreational carrying capacity is a complex activity (see Sowman 1987; CSIR 2007 and the Appendix 1: DWAF Recreational Water Use Manual Guideline: Methodology for Determining Carrying Capacity; CDM Smith 2017). There are no data that would allow such a determination for the Tyolomnqa Estuary. Given the lack of access to the estuary and its distance from a major urban centre, in the medium term the estuary is unlikely to be troubled by issues of over-burdened recreational carrying capacity. Estimates of proposed boating carrying capacity have been outlined in Key Result Area 2.

At this stage it is probably not necessary to define rehabilitation zones even though one of the biodiversity conservation strategies includes the removal of alien vegetation from the EFZ. It is felt that removal of alien vegetation is unlikely to cause serious erosion or bank collapse. Ploughing and planting at the water's edge do not appear to take place. Cattle access the river by way of a number of paths that have eroded over time, but the erosion appears to be relatively minor.

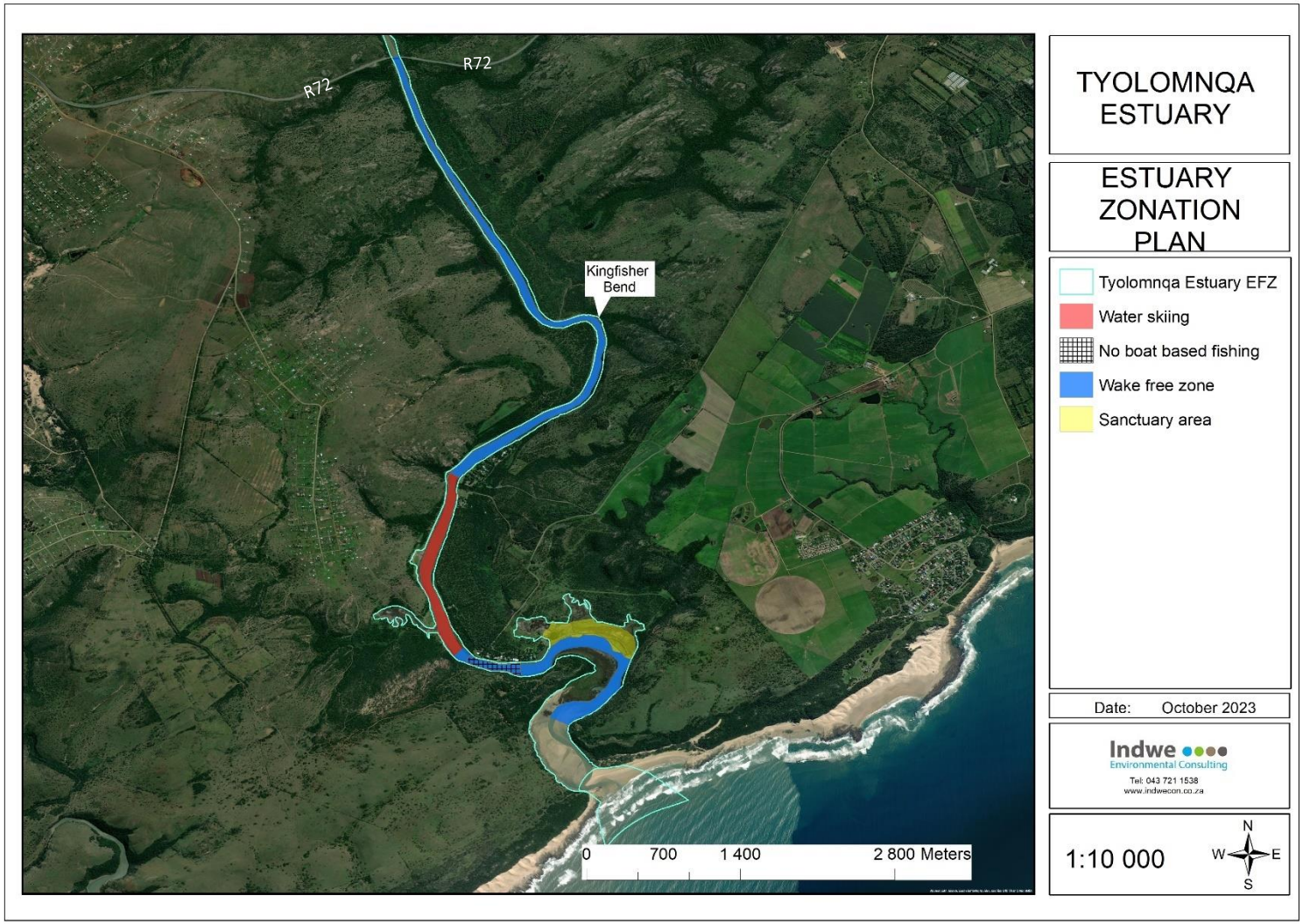

Figure 3: Proposed zonation of the Tyolomnqa Estuary seaward of the R72 road bridge. Upstream of the bridge no zonation is proposed.

8. Research

Although there is much recent research relating to ecological processes in estuaries in general and including estuaries of the Eastern Cape, there are limited data relating specifically to the Tyolomnqa Estuary. Given the difficulties associated with acquiring research funding, this situation is likely to persist because, although there is a range of ecosystem types in the estuary, the extent of these ecosystems is limited and the estuary itself is quite small. However, this should not prevent the Estuary Advisory Forum from approaching research institutions like SAIAB, SAEON, Rhodes Zoology and Ichthyology Departments and the Institute of Coastal and Marine Research (NMU) to undertake research in the estuary. The Tyolomnqa Estuary is an attractive research location because it is relatively close to both Rhodes and NMU Universities and it is in a nearly natural state.

Any research focusing on the collection of baseline biotic and abiotic data (topography, bathymetry and sediment movement and structure, mapping of macrophyte communities, invertebrates, fish and birds, biodiversity conservation) should be supported because this information informs adaptive management. Fish research that expands on the work of James and Harrison (2011, 2016) should be prioritised because of the critical role that estuaries (and particularly permanently open estuaries) play in the life cycles of many of the endemic fish species of the south and east coast. Many of the linefish species are currently listed as collapsed stocks so recruitment studies on fish are of particular importance.

Research related to climate change and the impact that higher water levels will have on the physical dynamics, and the ecosystems and ecological processes of the estuary is also a priority so that strategies for adaptation can be designed.

In the medium to long term it is important to obtain information relating to the distribution and abundance of invasive plant species in both the EFZ of the estuary and the Tyolomnqa catchment. There is concern among the Tyolomnqa residents that the mangroves that were introduced to the system by a resident about 15 years ago are causing accelerated siltation of channels on the east bank of the estuary. The colonisation of other parts of the Tyolomnqa Estuary by mangroves should be monitored and research to determine the impact of mangroves on the saltmarsh ecosystem in the estuary should be encouraged. Both mangroves and saltmarshes are considered important features that will help to reduce climate change impacts on estuaries. Other research that should be encouraged relates to:

- Basic stock assessment of bait organisms and other invertebrate organisms, their distributions, densities and use.
- Fish species present in the estuary on a seasonal basis.
- Priority research includes patterns of resource use and particularly of fish, mud crabs and bait organisms. Key elements include fishing effort, catch per unit effort, user dynamics, target fish species, catch composition, bait utilization, motivation for fishing, economic value of the fishery, extent of local community reliance on estuary resources, and degree of compliance with regulations.

Adams et al. (2020) make a strong case for a socio-ecological systems (SES) approach to research in estuaries, which necessitates cooperation between all role players and stakeholders of an estuary and requires data on a wide array of social and ecological processes. Scientific knowledge should be integrated with the societal systems to show the links between ecosystem functioning and the well-being of humans. In this way research would guide meaningful and implementable management and restoration interventions.

9. Monitoring

Monitoring of the general implementation of the EMP is outlined in Tables 8 to 14. Management targets and Key Performance Indicators are provided for each suite of management actions. DEDEAT, BCMM and the EAF should be responsible for evaluating the degree to which the Key Performance Indicators are attained. It is a useful management exercise to develop a standardised evaluation template which is used to compile an annual report that evaluates management effectiveness and progress and provides a platform for adaptive management (See KRA 1).

A more detailed data collection programme is generally required if the health and functionality of an estuary is to be maintained in the long term. Ideally, all estuaries should be monitored using standardised approaches, in order to streamline effort and increase comparability, but the number of estuaries is very large and DWS and most management agencies do not have the capacity to undertake monitoring to this extent. DWA (2010) have proposed that there is a minimum set of data that are fundamental to an understanding of estuary condition. The minimum data set includes monitoring of Hydrodynamics; Sediment dynamics; Water Quality; Microalgae; Macrophytes; Invertebrates; Fish; and Birds. Breen et al. (2004) propose a similar but expanded suite of indicators some of which are contained in the Management Implementation Framework in Tables 8-14.

More recently, Cilliers and Adams (2016) proposed a design for a National Estuarine Monitoring Programme for South Africa, which ensures i) that the mandate of DWS to provide useful water related information to decision makers and water practitioners (National Water Act), is achieved, and ii) that integrated co-operative coastal governance as per the ICM Act is supported. The proposed institutional responsibility chain to enable an estuary monitoring programme included:

- Capital equipment for monitoring provided by the Provincial lead agency for the implementation of the ICM Act or by the Municipality in which the estuary is located
- Sampling undertaken by SAEON or the Municipality
- Water quality analysis, Data management and Reporting provided by DWS.

The programme adopts a three-tiered approach that ensures that the aims and objectives of the national monitoring programme are achieved and ensures the programme is robust enough to adapt to changing situations (Cilliers and Adams 2016).

Tier 1: The collection of basic environmental data to develop a long-term database of the most important drivers of the estuary. Basic environmental data include Salinity, pH, Turbidity, Dissolved Inorganic Nitrogen, Soluble Reactive Phosphorus, Faecal coliforms and enterococci, water level and mouth condition and water flow above the head of the estuary. These data help to develop an understanding of the functioning of a system and to determine the level of environmental disturbances as a result of human-induced activities and/or natural phenomena.

Tier 2 has abiotic and biotic components, and the data determine estuarine freshwater requirements and provide an indication of the health of the system (see Taljaard et al. 2003; DWA 2008b). Biotic variables include Phytoplankton, Benthic microalgae, Macrophytes, Zooplankton, Benthic invertebrates, Fish and Birds. Abiotic variables include River flow, Estuary water level, Mouth condition, Bathymetry, Remote sensing, Sediment, Water quality in the river and estuary, and Toxic substances.

Tier 3 monitoring is designed to address specific management issues that may occur from time to time in an estuary e.g. pollution incidents, fish kills and specific developments that may influence the health of an estuary.

Recommended Tier 1 and Tier 2 sampling points for estuaries <30 km in length are at sites representative of the upper, middle and lower estuary and a site immediately upstream of the furthest point of tidal exchange (four sites; Cilliers and Adams 2016).

Recommended Tier 1 sampling frequency is monthly during first year on a spring high tide, starting 1 to 3 h after the onset of high tide to determine the extent of the saline intrusion. Thereafter, dependent on findings of first year, a minimum of at least during high river flow and low river flow or stable open and stable closed mouth phases, depending on the type of estuary. The temporal scale should be as frequent as practically possible within the limitations of the available budget and human resources.

Recommended Tier 2 sampling frequency is twice every 3 to 5 years during the high and low flow or stable open and closed phase, dependent on the type of estuary. A minimum of once during a stable phase, should there be budget limitations (Cilliers and Adams 2016).

The Tyolomnqa Estuary is not one of the estuaries prioritised for monitoring based on criteria proposed by Cilliers and Adams (2016). Given the poor status of Integrated Regional Water Monitoring Committees in the Eastern Cape and the lack of funding for water quality analysis, procurement of capital equipment and operational costs within DWS, it is unlikely that any institutional resources will be directed towards a monitoring programme in the Tyolomnqa Estuary. The responsibility for the implementation of a monitoring programme will fall mainly on the EAF which is likely to be limited with respect to capacity and funding. The EAF might approach permanent residents to undertake some monitoring since many of them are committed to preserving the health of the estuary. However, it should be noted that monitoring is useless unless data are recorded in a format that can be stored, analysed, made available to a the public and ultimately used to guide management. It is suggested that the EAF approach SAEON and/or the Institute for Coastal and Marine Research (Nelson Mandela University) to implement a useful monitoring programme.

Guided by the National Estuarine Monitoring Programme, Table 15 below outlines a basic monitoring programme that should be implemented for the Tyolomnqa Estuary. The programme includes the monitoring of recreational/livelihood use of the estuary's resourced as well as of rainfall, salinity and nutrients, freshwater inflow, extent of habitats and avian fish and invertebrate species and numbers. It is also important to record the time and duration of all mouth closure events or major changes in the mouth configuration. The programme is relatively simple to implement. It is suggested that the baseline monitoring programme outlined below is sufficient for the first five years of estuary management.

Table 15: Proposed monitoring programme for the Tyolomnqa Estuary

Aspect and Indicator	Objective	Frequency	Location	Staff required	Collection/Analytical method
Biological: Numbers and species of birds utilising the estuary for feeding and nesting. Fish sampling – species and sizes using the estuary Densities and location of mud and sand prawns	Determine baselines and responses to season, anthropogenic factors and any management interventions Monitor changes in populations	Annually mid-summer and mid-winter Every second year but at least during stable open and closed phases	Identification and count of open water and shoreline EFZ bird spp. Upper, mid and lower estuary Upper mid and lower estuary fixed sample sites,	1 +3	Standardised sampling procedure (time, weather, routes etc). Counts in the course of shoreline patrols and transect walks. Cast/seine netting for fish, quadrats and suction pumps for prawns. Species identification, numbers for fish/ densities for prawns; length frequencies for all.
Biological: Extent of alien and invasive vegetation in the EFZ Extent of salt marsh, mangroves, sand and mud banks	Monitor area colonised by alien and invasive plant spp. in the EFZ Monitor changes in area of ecosystems and open water	Every 3 years Every second year but at least during stable open and closed phases	EFZ	1	GPS and digital mapping techniques and/or Remote sensing imagery
Physical: Rainfall Mouth condition, Sand banks and sediment dynamics at mouth River flow	Monitor climate change Monitor long-term mouth sediment dynamics Monitor climate change, fresh water inflow	Daily Quarterly Flow data logged daily	East bank Residents Associations Lower estuary 1 km upstream of weir at head of estuary	1 1 1	Standard Rain Gauge GPS and digital mapping techniques and/or Remote sensing imagery Install flow meter and data recorder

Water Quality: Salinity or conductivity, pH, Turbidity, Soluble Reactive Phosphorous Dissolved Inorganic Nitrogen, *E. coli* bacteria and other pathogens, algal blooms.	Determine changes in water quality as a result of rainfall, catchment and local activities, housing developments.	Monthly Monthly	Lower, mid and upper estuary, and above TR 14504 bridge. Lower, mid and upper estuary, and above TR 14504 bridge	1	According to laboratory Specifications. According to laboratory Specifications
Water quantity: Fresh water flow into the estuary.	Detect changes in freshwater input into the estuary. Monitor climate changes	Continuous/ monthly :	Above TR14504 Bridge	1	Methods for the Determination of the Ecological Water Reserve for Estuaries (DWA, 2010).
Estuary water level	Monitor climate changes	Quarterly	Fixed points lower, mid and upper estuary	1	Standard marked water level gauge.
Depth of the estuary channels.	Detect potential sedimentation problems	Quarterly	Fixed points lower, mid and upper estuary	1	Standard marked depth gauge
Recreational/ Livelihoods: Use of the estuary.	Baseline and detect changes in type and level of anthropogenic pressures.	Randomised sampling program	Sites of main fishing/ bait collecting/ recreational activities.	1	Foot/ boat patrols. Data collected by permanent residents/ EAF

10. Institutional and Capacity Arrangements

In the Eastern Cape the management of the environment is delegated to the Department of Economic Development, Environmental Affairs and Tourism (DEDEAT). Where an estuary falls within the boundary of a municipality (as does the Tyolomnqa), the amended National Estuarine Management Protocol (2021) assigns the development and implementation of estuary management plans to provincial environmental departments in consultation with the affected municipalities and relevant national government departments. Thus, DEDEAT is the authority responsible for developing and over-seeing the implementation of the Tyolomnqa Estuary Management Plan. Provincial departments may enter into agreements with municipalities willing to take on the function of developing and implementing EMPs in terms of the 156 (4) of the Constitution. BCMM has limited capacity to effectively coordinate the implementation of estuary management plans even within its urban area but the Municipality will constructively engage with DEDEAT and other Government Departments required to play a role in the implementation of the Tyolomnqa Estuary Management Plan.

Given the limited capacity and resources of both DEDEAT and BCMM, a properly constituted and functional EAF will be critical factor in the effective management of the estuary. At a minimum the EAF should include a representative from relevant Local and Provincial Government Departments, as well as representatives from East Bank Residents Associations, the West bank local communities and fishing clubs. Ideally only those individuals and government agencies that will play a meaningful role in the management of the estuary should be involved in the EAF.

Terms and conditions and precise responsibilities for the EAF need to be negotiated with stakeholders and DEDEAT after the completion of the EMP. At a minimum the Terms of Reference (TOR) for the EAF should define the Aims and Objectives of the EAF, the status and authority of the EAF, the composition of the EAF, the selection of representatives in key sector categories, and the terms of office. The representatives selected by their respective sectors, should provide formal letters of mandate to the Forum indicating their mandate to participate in the Forum. Each representative would be required to represent and articulate the views and interest of their sectors. This will require that they regularly liaise with their respective sectors. It is proposed that the EAF should meet at least four times per year initially with less frequent meetings when properly established. It is important that communities understand that their nominated representatives are responsible for reporting back to their individual community governance structures. A commitment to transparency, the process to be followed when decisions must be made, the administration of the EAF, rules of communication, behavioural ground rules, and reporting structures should also be outlined in the TOR in order to avoid misunderstanding and conflict. The EAF must formally adopt/develop the TOR and sign off on it in order to be properly constituted. It is also proposed that the EAF elect a management sub-committee to attend to urgent *ad hoc* management matters.

11. Funding requirements

The funding of the various activities required to implement the Tyolomnqa estuary management plan is likely to be a problem issue. Adequate funding is of fundamental importance if the EMP is to be properly

implemented. At its most basic level the functionality of the EAF depends on some level of funding so that meetings can be organised and monitoring and administration can be undertaken. Many of the activities require the availability of equipment or the expenditure of time by members of the EAF. Most of the members of the EAF are not salaried employees of Government Departments.

As the agency responsible for the management of the estuary DEDEAT should provide budget to cover basic costs including the appointment a field ranger, the purchase of suitable compliance and enforcement capability (boat and fuel) and the furnishing of a basic ranger's office. Within DEDEAT a middle management staff member should be appointed to oversee the implementation of the EMP. The relevant authorities must be responsible for the funding of management activities within their mandates for managing the estuary. A draft budget to implement the EMP is provided in Table 16.

Table 16: Draft Budget for Implementation of the Tyolomnqa Estuary Management Plan

Budget Item	Start-up	Monthly cost	Annual Cost
Salaries			
Estuary manager		R10000	R120 000
Field ranger		R5000	R60 000
Capital expenses/Disbursements			
Office equipment			R10 000
Stationery/printing		R200	R1 200
Fuel		R4 000	R48 000
Boat & Engine		Boat licensing, Skipper licensing, Start up	R 120 000
Boat maintenance		R2 000	R24 000
Communication equipment			R10 000
Insurance		R6 000	R72 000
Training			R6 000
Uniforms/Patrol equipment		R2 000	R24 000
Meetings		R2 000	R24 000
		Total	**R524 000**

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