Western Cape Government

Department of Environmental Affairs and Development Planning

Piesang River Estuary Estuarine Management Plan

Date: 2022

DOCUMENT DESCRIPTION

Document title and version:

Piesang River Estuary Estuarine Management Plan (2022)

Authority reference:

17/10/1/ BB4/ Piesang Estuary

Developed by:

Coastwise Consulting & Royal HaskoningDHV

Date:

2022

This document should be referenced as:

Western Cape Government (2022). Piesang River Estuary Estuarine Management Plan (2022). Western Cape Department of Environmental Affairs and Development Planning.

I, Anton Bredell, Minister of Local Government, Environmental Affairs and Development Planning, hereby approve the Piesang River Estuary Estuarine Management Plan for implementation.

Anton Bredell

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Date:

Disclaimer

The Estuarine Functional Zone depicted in this estuarine management plan will be subject to change based on new data published from time to time.

EXECUTIVE SUMMARY

The National Environmental Management: Integrated Coastal Management Act (Act 24 of 2008) (ICMA) was developed to facilitate the sustainable use and management of South Africa's coastline and coastal and estuarine resources. The ICMA requires that estuaries within South Africa are managed in a co-ordinated and efficient manner, and in accordance with the National Estuarine Management Protocol (NEMP), the National Coastal Management Programme (CMP) and the Western Cape CMP, which lay out specific objectives for management of the South African coastline, including estuaries. This document represents the first-generation Estuarine Management Plan (EMP) for the Piesang River estuary developed under the auspices of the Western Cape Estuarine Management Framework and Implementation Strategy (EMFIS), a strategic project emanating from the provincial CMP, specifically priority area 7.

The purpose of this EMP is to provide the Vision of the future desired state of the Piesang River estuary and guide the management of human activities in and around the system by setting out strategic objectives, management priorities and detailed management strategies with actions/activities. The co-ordination of the implementation of the EMP vests with the responsible management authority (RMA) as per the NEMP.

Geographical Boundaries

The Piesang River estuary is defined in the 2018 National Biodiversity Assessment (NBA) (SANBI, 2019) as a large temporarily closed estuarine system located within the warm temperate biogeographic region on the Southern Cape coastline, within coastal town of Plettenberg Bay, Bitou Local Municipality (LM). The size of the estuary, as defined by the estuarine functional zone (EFZ), is approximately 92 ha, extending over a length of approximately 2 km.

Vision and Objectives

The following Vision for the Piesang River estuary was developed and adopted during a public meeting held in November 2017 and a second meeting held in August 2018, both in Plettenberg Bay.

> ***The Piesang River estuary is an urban transformed yet functional system that is beautiful, well-managed and preserved for current and future generations, with sufficient water for all purposes and balancing all its socio-economic and conservation needs***

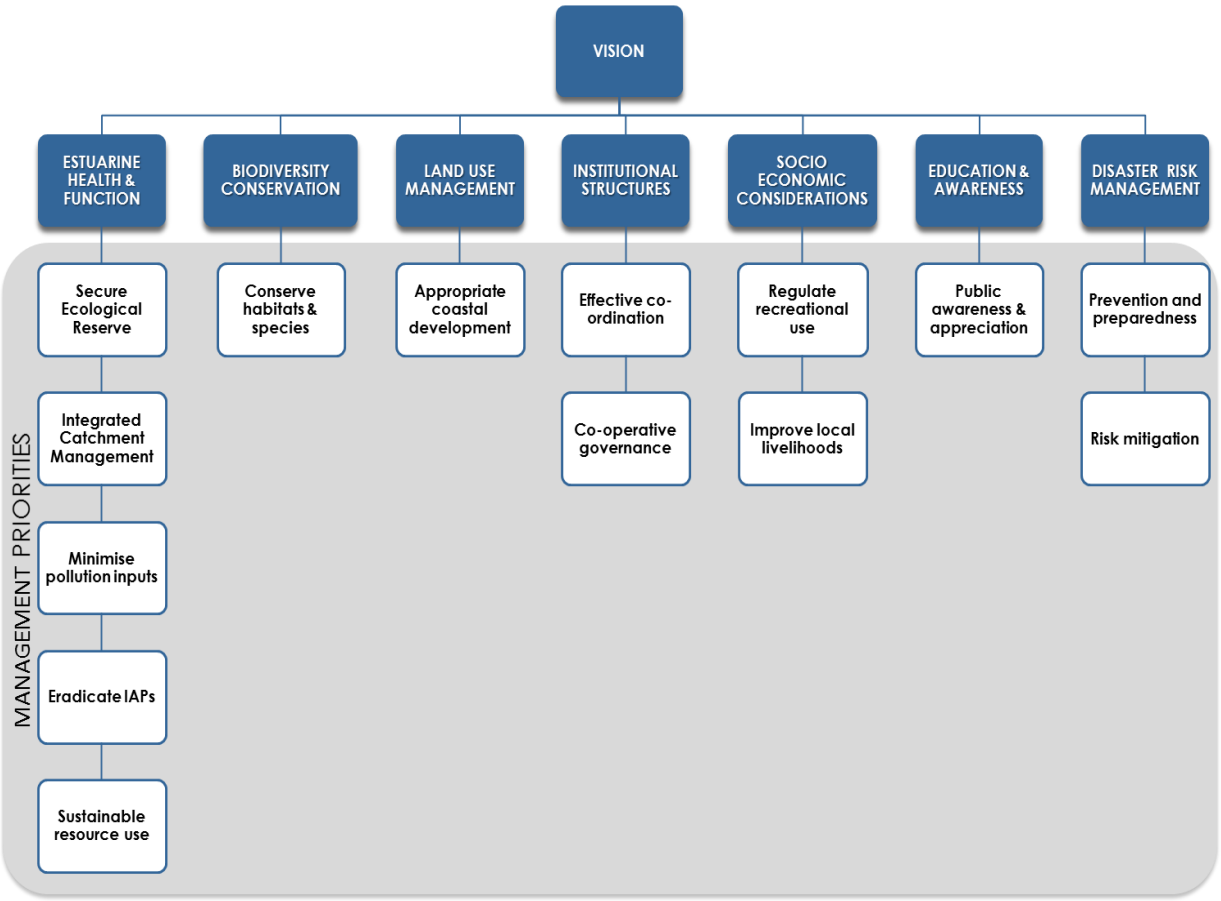
According to these categories, the strategic objectives for the Piesang River estuary are as follows:

	Sector / Category	Strategic Objective	Performance Indicator(s)	Priority
1	**Estuarine Health and Function**	The ecological health and natural functioning of the Piesang River estuary is improved and safeguarded, its negative trajectory reversed, living resources are sustainably managed and estuary nursery function protected	• Ecological condition improved from a D to a B/C • Ecological reserves for water quantity and quality are secured • Basewater flow restored • Effective mouth management as per the Mouth Management Plan (attached AS Appendix 5) • Estuary requirements are integrated into catchment processes • Pollution to the estuary is reduced, improved water quality • Water quality monitoring programme is in place • Invasive alien plant species are eradicated • Establishment of a no-take sanctuary zone, and sustainable use of estuarine resources • Reduction in illegal activities Nursery function of the estuary is improved • Ecological monitoring programmes are in place • Increase in number of research and monitoring projects	**HIGH**
2	**Biodiversity Conservation**	The biodiversity of the Piesang River estuary is conserved	• EMP incorporated into the Bitou IDP and SDF • EMP incorporated into the GRBR management plan • Spatial zonation plan is adopted and enforced • Environmental custodianship secured • Critical estuarine habitats and species are protected against negative impacts	**HIGH**
2	**Land-use and Infrastructure Planning and Development**	Impacts associated with developments and proposed changes in land-use, including infrastructure and agriculture, are minimised	• All development and land use changes surrounding and within the EFZ comply with environmental legislation and environmental best practice / risk aversion approach • No development in high risk areas • Further transformation/ degradation of estuary prevented	**MEDIUM**

			• Reduced negative impacts from urban, agricultural and industrial activities	
3	**Institutional and Management Structures**	The Piesang River estuary is well managed through effective co-operative governance	• EMP is seamlessly incorporated into the Bitou IDP and SDF • Estuary advisory committee is established, is effective and meets regularly • Estuarine bylaws are drafted • Mandated authorities and participating agencies are well capacitated, actions are fulfilled • Critical management networks are established	**MEDIUM**
4	**Socio-economic Considerations**	Socio-economic benefits are enhanced and regulated to ensure sustainable use of the Piesang River estuary and its resources.	• Carrying capacity is upheld • Illegal activities controlled • Increased livelihood opportunities for local historically disadvantaged communities • Environmental Protection and Infrastructure Programmes (EPIP) implemented and effective (such as the DFFE: Working for the Coast Programme)	**LOW**
5	**Education & Awareness**	Members of society are sensitive to, and aware of, the value and importance of the Piesang River estuary	• Awareness programme developed and successfully implemented on an on-going basis • Signage erected, information disseminated • Increase in number of research and monitoring projects	**MEDIUM**
6	**Disaster Risk Management**	Potential risks that could impact the Piesang River estuary are reduced (inclusive of climate change impacts)	• No further development in high risk areas • Flood disaster management plan developed • Contingency plans in place for high risk areas / activities • Disaster impacts are timeously and effectively mitigated	**HIGH**

Priority management objectives and associated activities

An illustrative overview of the priority management objectives is provided below. Detailed action plans were developed for each of these priority areas.



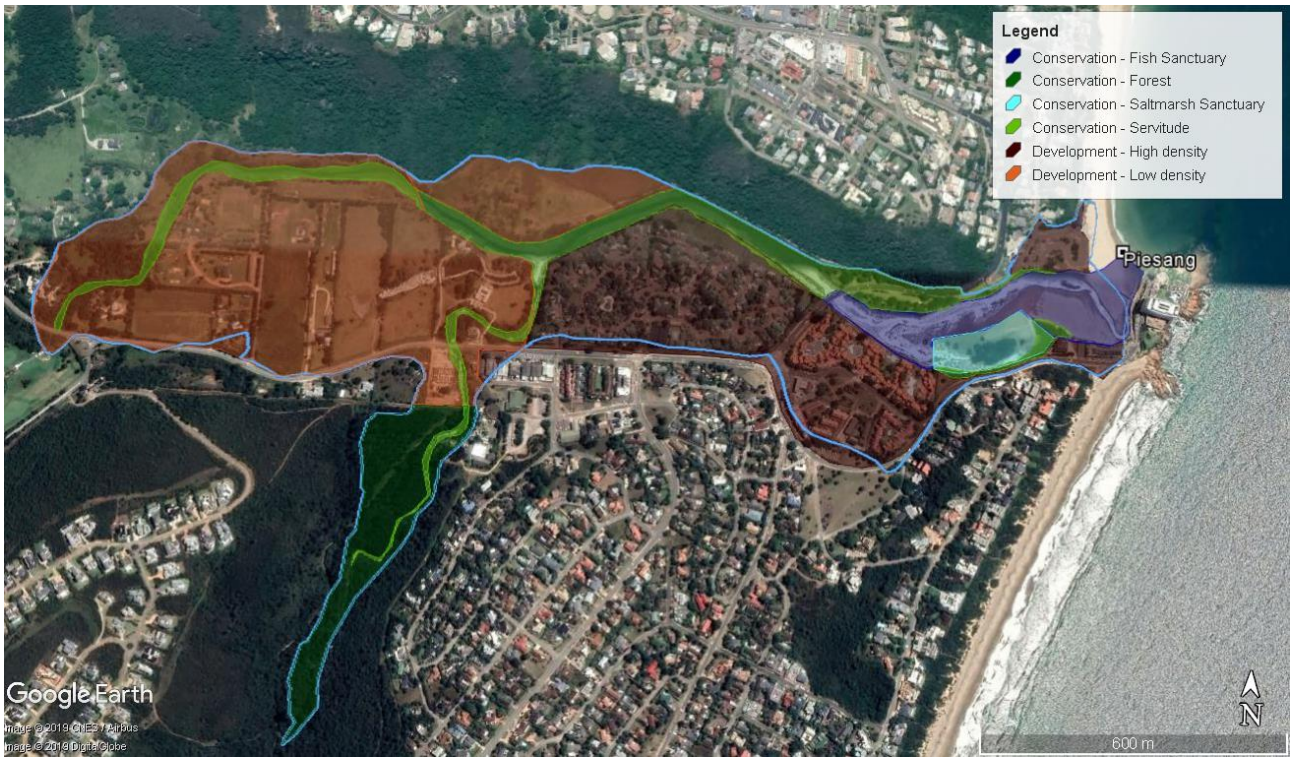
Proposed Zonation of activities

In general, spatial zonation of activities on an estuary is used to prevent user conflict and to guide sustainable utilization of resources without degradation of the estuarine environment. The proposed zonation of the Piesang River estuary is influenced by the level of habitat transformation of the EFZ, the recommendations of the 2012 National Estuarine Biodiversity Plan, the recommendations of the municipal spatial development framework and the current patterns of use. Five different zones are proposed as illustrated in the figure below:

- **Conservation zones** comprise three areas:
  - *Conservation Servitude* - It is recommended that Piesang River and estuary be designated a Conservation Servitude / Special Zone within the Town Planning Scheme, such that there is no further development or habitat transformation within 32 m of the water course. Specific development regulations with the aim of reducing impacts, reducing disturbance to the riparian edge, reducing pollution and rehabilitating where necessary, should be implemented.
  - *Fish Conservation Zone*– The purpose of this zone is the provision and conservation of healthy habitat for commercially important and estuarine-dependent fish species, while allowing for low-impact human interaction and activities. This zone includes the estuary basin, channel and riparian edge up to the Beacon Island road bridge. Low-impact recreational activities are permitted in this area; however, fishing is prohibited. That is, it is a no-take zone, under both open and closed mouth conditions.
  - *Saltmarsh / Bait Sanctuary* – This zone is proposed specifically for the protection of the only area of saltmarsh habitat occurring in the estuary basin, a portion of heavily

exploited sandprawn population, and shallow water fish nursery area. It is a no-go (no access) and no-take area.

- **Development (High Intensity)** - The zone extends along the southern shoreline from Beacon Island upstream to the confluence with the Klein Piesang River, and the beach parking area. It reflects areas of dense and mostly irreversible urban and tourism development and infrastructure, and thus the areas of greatest habitat transformation. No further development is recommended.
- **Development (Low Intensity)** – This zone includes the remaining land parcels on the northern and southern banks and part of the Klein Piesang River, mostly zoned as Agriculture and Public Open Space. It reflects the nature of the current development but has also a specific purpose, namely, to regulate the type of future development and activities that may take place within these private land parcels. Based on the above, it is recommended that these areas be reserved for either no development or very low-density development, tailored towards agriculture, conservation and eco-tourism.
- **Recreational Activities** – General recreational activities are permissible throughout the system except fishing below the road bridge and all activities in the Saltmarsh/Bait Sanctuary area. Motorised boats and jetskis are prohibited.



Proposed zonation of the Piesang River estuary

Integrated monitoring plan

Monitoring is a crucial aspect of the adaptive estuarine management planning process as the generated data will be used to inform and update management decisions. Three broad categories of monitoring are incorporated into an integrated monitoring plan, namely resource monitoring, compliance monitoring and performance monitoring.

The Department of Water and Sanitation (DWS) has a permanent water flow recorder, which monitors water flow continuously. Within the estuary, the Bitou LM monitors monthly

water quality and a basic water quality monitoring programme involving bi-monthly sampling is run by the Breede-Gouritz Catchment Management Agency.

There is little to no compliance and enforcement monitoring occurring in the Piesang River estuary in terms of the use of marine living resources, due to the lack of the capacity within the DFFE. In respect to the implementation of this EMP, compliance monitoring will be the responsibility of the Department of Environment, Forestry and Fisheries (DFFE) (or devolved to CapeNature) in terms of the Marine Living Resources Act (MLRA) and will be undertaken according to legislation and policies applicable and by means of law enforcement and compliance monitoring protocols.

A performance monitoring plan is used by the RMA, and/or identified implementing agents, to assess the effectiveness with which planned management activities contained in the EMP are being performed and ultimately to gauge progress in achieving the vision and objectives. This component utilises the performance indicators included for the various actions, specifically the management priorities, and includes a temporal scale or the frequency of the collection of the performance data and the targets that should be achieved.

Institutional Capacity and Arrangements

This EMP should be regarded as a strategic plan that can guide the detailing of management actions and identification of implementing agents. It does not specify the required resources (human and financial) required for effective management of the estuary but does provide for their prioritisation. Co-management and effective governance are vital aspects to the efficient and effective estuarine management and key role players in the management of the Piesang River estuary are identified.

The 2021 NEMP identifies the **Department of Environmental Affairs & Development Planning (DEA&DP)** (**provincial environmental department)**, or its assigned representative, as the RMA responsible for the co-ordination of the implementation of the Piesang River Estuary EMP. I**t is noted that the NEMP allocates such responsibilities to the DEA&DP (provincial environmental department) unless agreement / or until agreement is reached with the respective body to undertake the coordination of the implementation process. Ultimately, the role of the RMA must be designated through formal signed agreement.**

Specific implementation actions identified in this EMP remain the responsibility of mandated government agencies as well as respective departments within the RMA. As an example, the DWS and Bitou LM will monitor water quality, while the DFFE will ensure compliance with matters related to fisheries (unless devolved to CapeNature). It is crucial that champions/project leaders/teams are identified who will be responsible for the formulation of detailed project plans and the implementation thereof.

While the establishment of an Estuary Advisory Forum (EAF) for each estuary is no longer a requirement in the NEMP, the Western Cape Government still support their establishment and recommend that government, private entities and non-government organisations continue to play a supporting role in the implementation of this EMP. While the establishment of a regional EAF is generally preferred over numerous individual EAFs, the number of issues

and potentially affected citizens/stakeholders warrants an individual EAF for the Piesang River estuary. This is further detailed in the EMFIS stand-alone Institutional Framework for Estuarine Advisory Forums.

Key government departments and organs of state are identified, and a template provided for the conversion of the priority actions into detailed project plans, which must be prepared and adopted into the respective departmental implementation strategies.

In conclusion, the following items/issues are considered critical towards the ultimate achievement of the vision and should be immediately addressed and/or receive greatest effort in respect to human/financial resources:

- The impact of the desalination plant on the system must be determined and an appropriate response made;
- The mouth of the system must be effectively managed and a maintenance management plan drafted and approved should the mouth management plan indicate that artificial breaching is required to improve ecological functioning;
- No further development in the EFZ/ floodplain/ in high risk areas / below the Coastal Management Line should be supported;
- Both a fish sanctuary/no-take zone and saltmarsh sanctuary no-go/no-take zone must be established as part of the zoning scheme and incorporated into the SDF;
- The ecological health of the system must be improved by reducing pollution, appropriately dealing with urban runoff (recycle water and SUDS); responding to the continued run-off and contamination from the closed municipal dump; and upgrading pump station 5 located within the EFZ;
- In response to the requirement to partially protect the system, the remaining forest; northern bank plus the Klein Piesang must be protected and the estuary integrated into the Bitou 'Coming together' corridor;
- Every effort made to eradicate invasive alien plant and fish species; and
- The DEA&DP to consider the appointment of a Regional estuarine management co-ordinator/champion within either DEA&DP or CapeNature, to support the RMA.

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ACRONYMS AND ABBREVIATIONS

amsl	Above mean sea level
BGCMA	Breede-Gouritz Catchment Management Agency
CARA	Conservation of Agricultural Resources Act (Act No. 43 of 1983)
CBA	Critical Biodiversity Area
CFR	Cape Floristic Region
CMA	Catchment Management Agency
CML	Coastal Management Line
CMP	Coastal Management Plan
CMS	Catchment Management Strategy
CSIR	Council for Scientific and Industrial Research
DALRRD	Department of Agriculture, Land Reform and Rural Development
DAFF	Department of Agriculture, Forestry and Fisheries (now DFFE)
DEA	Department of Environmental Affairs (now DFFE)
DEA&DP	Western Cape Government's Department of Environmental Affairs & Development Planning
DFFE	Department of Forestry, Fisheries and Environment
DFFE: WftC	Department of Forestry, Fisheries and Environment: Working for the Coast
DFFE: WfW	Department of Forestry, Fisheries and Environment: Working for Water
DM	District Municipality
DMA	Disaster Management Act (Act No. 57 of 2002)
DST	Department of Science and Technology
DWS	Department of Water and Sanitation
EAF	Estuary Advisory Forum
EFZ	Estuarine Functional Zone
EIA	Environmental Impact Assessment
EMFIS	Estuarine Management Framework and Implementation Strategy
EMP	Estuarine Management Plan(s)
EPIP	Environmental Protection and Infrastructure Programmes
GRBR	Garden Route Biosphere Reserve
HWM	High Water Mark
I&APs	Interested and Affected Parties
IAPs	Invasive Alien Plants
ICMA	National Environmental Management: Integrated Coastal Management Act (Act No. 24 of 2008)
IDP	Integrated Development Plan
LM	Local Municipality
LUPA	Land Use Planning Act (Act No. 3 of 2014)
MEC	Member of the Executive Council
MLRA	Marine Living Resources Act (Act No. 18 of 1998) as amended
MMP	Mouth Management Plan
MOU	Memorandum of Understanding
MPA	Marine Protected Area
MSA	Municipal Systems Act (Act No. 32 of 2000)
NBA	National Biodiversity Assessment
NEM:BA	National Environmental Management: Biodiversity Act (Act No. 10 of 2004)
NEM:PAA	National Environmental Management: Protected Areas Act (Act No. 57 of 2003)
NEM:WA	National Environmental Management: Waste Act (Act No. 59 of 2008)
NEMA	National Environmental Management Act (Act No. 107 of 1998)
NEMP	National Estuarine Management Protocol (2013)
NWA	National Water Act (Act No. 36 of 1998)
PA	Protected Area
PAES	Protected Area Expansion Strategy
PES	Present Ecological Score
RDM	Resource Directed Measures
REC	Recommended Ecological Category

RMA	Responsible Management Authority
RQO(s)	Resource Quality Objectives
SAHRA	South African Heritage Resources Agency
SANParks	South African National Parks
SAR	Situation Assessment Report
SDF	Spatial Development Framework
SUDS	Sustainable Drainage Systems
TPC	Threshold of Potential Concern
WC BSP	Western Cape Biosphere Spatial Plan
WC PAES	Western Cape Protected Areas Expansion Strategy
WQ	Water Quality
WRC	Water Research Commission
WUA	Water Users Association
WUL	Water Use Licence
WWTW	Waste Water Treatment Works

1 INTRODUCTION

1.1 Background

The National Environmental Management: Integrated Coastal Management Act (Act 24 of 2008) (ICMA) was developed to facilitate the sustainable use and management of South Africa's coastline and coastal and estuarine resources. The ICMA requires that estuaries within South Africa be managed in a co-ordinated and efficient manner, and in accordance with the National Estuarine Management Protocol (hereafter referred to as the NEMP), the National Coastal Management Programme (CMP) and the Western Cape CMP, which lay out specific objectives for management of the South African coastline, including estuaries.

In response to the directive issued under the ICMA and the NEMP, the Western Cape Government, and specifically the Provincial Department of Environmental Affairs and Development Planning (DEA&DP), commissioned the development of the Western Cape Estuarine Management Framework and Implementation Strategy (EMFIS), a strategic project emanating from the provincial CMP, specifically Priority Area 7, to facilitate the consistent development and implementation of Estuarine Management Plans (EMPs) in the Western Cape Province.

This document represents the first generation EMP for the Piesang River estuary (Figure 1) developed under the auspices of the Western Cape EMFIS.

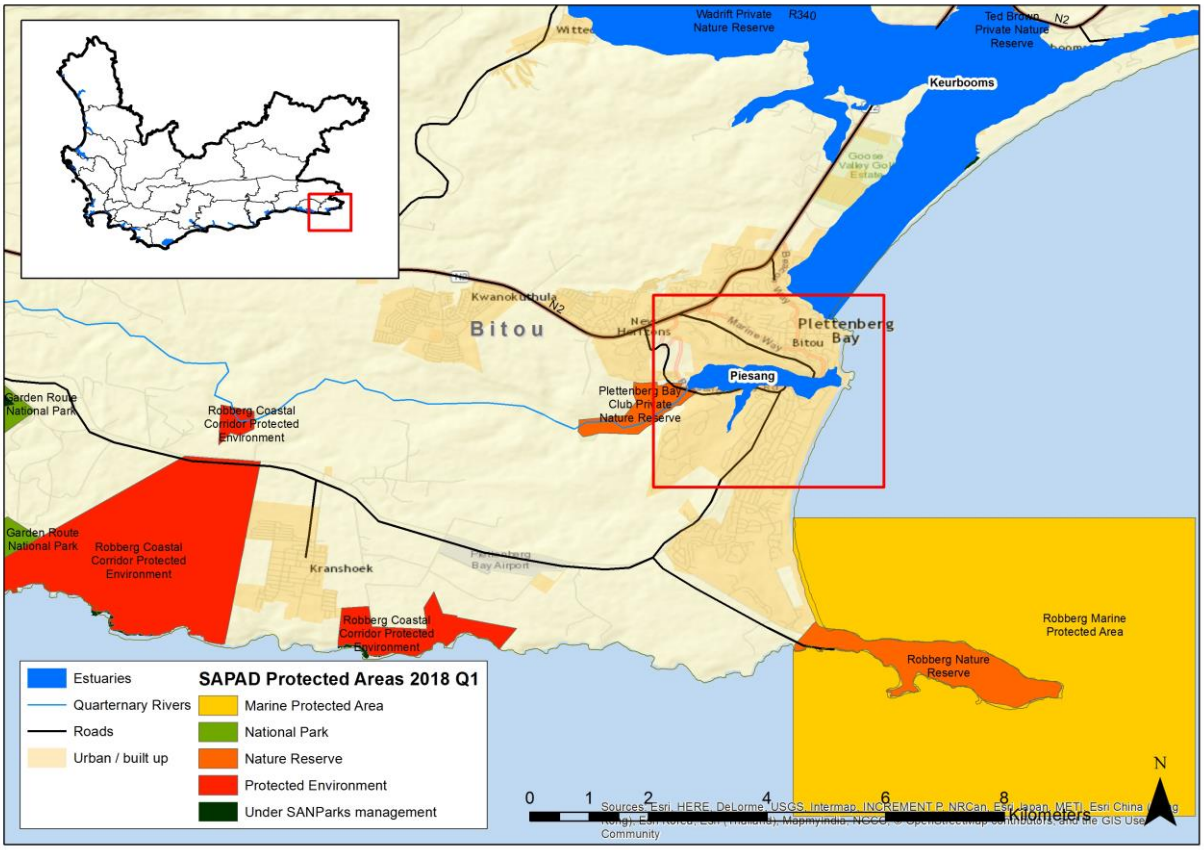

Figure 1: Location of the Piesang River estuary within the Bitou Local Municipality

1.2 Purpose of the EMP

The development of an EMP is a three-phase process, as illustrated in Figure 2, comprising an initial scoping phase, followed by an objective setting phase, and finally an implementation phase. An adaptive management approach should be adopted during the latter phase with detailed reviews bring conducted at five-yearly intervals.

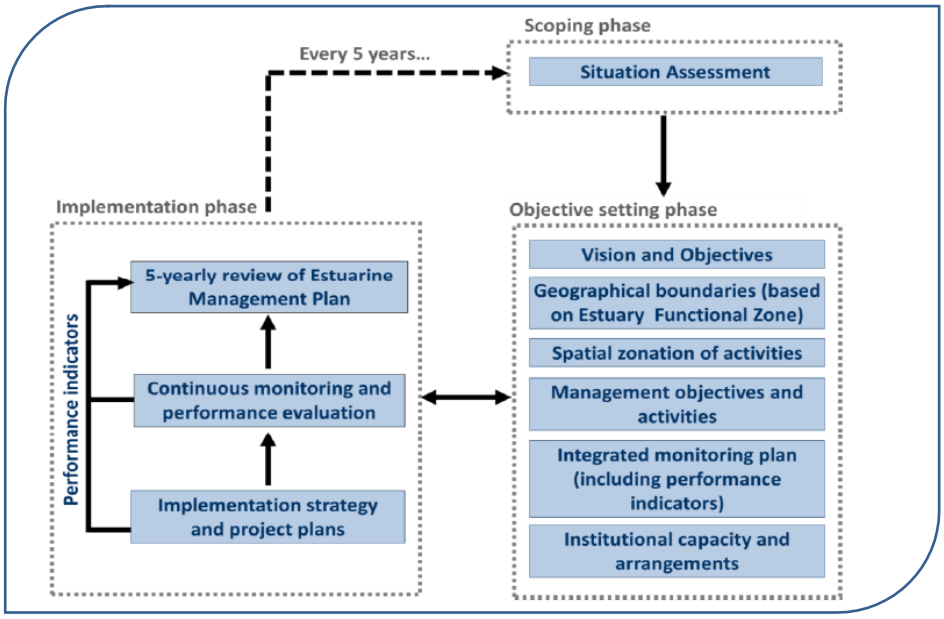

Figure 2: A framework for integrated estuarine management in South Africa

This report constitutes the second objective and core component of the estuarine management planning process, namely the EMP. The purpose of this component is to provide the Vision of the future desired state of the Piesang River estuary and guide the management of human activities in and around the system by setting out strategic objectives, management priorities and detailed management strategies with actions/activities.

Estuarine management is by definition not only focused on the Estuarine Functional Zone (EFZ) but inclusive of coastal hinterland and marine influences, shoreline status, catchment management, climate change and human development impacts such as tourism, recreation and agriculture, amongst many others. This EMP is the primary document for use by the identified responsible management authority (RMA) to facilitate coordination of the identified management interventions to ultimately ensure the longevity of the estuarine system concerned. This is also the critical reference document for the incorporation of estuarine management into the municipal Integrated Development Planning (IDP) and Spatial Development Framework (SDF) processes.

1.3 Mandate and responsibilities of the RMA

The co-ordination of the implementation of the EMP vests with the RMA as per the NEMP. One of the strategic objectives of this EMP is to promote and facilitate the cooperative

governance relationship between the RMA and an existing or new estuary advisory forum (EAF), or any other supporting structures or organisations with estuarine-related duties and functions.

The designated RMA is responsible for the development of the EMP and the overall co-ordination of the actions of other implementing agencies, and not necessarily the implementation actions themselves. Section 7.3 of the NEMP indicates that:

"…management actions…shall be translated into project plans by the responsible government department that is responsible for certain aspects of estuary management (as per legislative mandates…"

Specifically, the RMA responsibilities are described by the NEMP as:

Section 5:	*"…authorities are **responsible for the development of EMPs** and **coordination of the implementation process**…"*
Section 5(e):	*"The identified responsible management authority to develop the EMP needs to **budget accordingly for the development of these plans**."*
Section 8(1):	*"The responsible management authority developing an EMP must **actively engage all the relevant stakeholders** including government departments, non-government organisations and civil society in the development and implementation of the EMP."*
Section 9.1(1) and 9.2:	*"…it **must obtain formal approval** for the EMP…" and "Once approved…the EMP shall be… **Integrated**.." and "**incorporated** into into the Provincial Coastal Management Programme."*

The responsible body contemplated in Section 33(3)(e) of the ICMA who develops an EMP must:

a) follow a public participation process in accordance with Part 5 of Chapter 6 of the ICMA;
b) ensure that the EMP and the process by which it is developed are consistent with:
   i) the NEMP; and
   ii) the National CMP and with the applicable provincial CMP and CMP referred to in Parts 1, 2 and 3 of Chapter 6 of the ICMA;
c) If applicable, ensure that relevant legislation is enacted to implement the EMP; and
d) Submit an annual report to the Minister on the implementation of the EMP, the legislation and any other matter.

Coordination of the implementation actions by the RMA and its strategic partners can be supported by an EAF representing all key stakeholder groups on the estuary.

1.4 Structure of Report

This report is structured as follows:

- **Section 2** introduces the estuary and details the **geographical boundaries** of the estuary, i.e. the management area to which this EMP applies;
- **Section 3** provides a synopsis of the **situation assessment,** thereby providing context to the vision, strategic objectives and management objectives and management priorities;
- **Section 4** presents the **local vision and strategic objectives** as informed by the stakeholders, for the management of the Piesang River estuary. They collectively describe the desired future state at the end of the five-year period and provide the overarching logical framework for the action plans;
- **Section 5** prescribes the **management priorities and associated activities,** i.e. the required actions to be undertaken within the next 5 years, captured as individual action plans. This EMP contains refined or detailed management objectives accompanied by action plans to facilitate implementation, and in this manner, serves to mobilise and co-ordinate all relevant government departments, institutions and other role players to undertake specific actions within their mandate or sphere of influence;
- **Section 6** describes the various components and zones included in the proposed **spatial zonation** of the estuary;
- **Section 7** set out the **integrated monitoring plan** encompassing resource monitoring, compliance monitoring, as well as performance monitoring in respect to achieving the objectives of the EMP;
- **Section 9** details the **institutional capacity and proposed arrangements** that are required to implement the actions contained in the plan, including key role players and participating institutions, and the recommended projects provided for in the action plans; and
- **Section 9** details key **recommendations** and **concludes** the plan.

2 GEOGRAPHICAL BOUNDARIES

The Piesang River estuary is defined in the 2018 National Biodiversity Assessment (NBA) (SANBI, 2019) as a large temporarily closed estuarine system, located within the warm temperate biogeographic region on the Southern Cape coastline, within coastal town of Plettenberg Bay, Bitou Local Municipality (LM). The size of the estuary, as defined by the estuarine functional zone (EFZ), is approximately 92 ha, extending over a length of approximately 2 km. The geographical boundaries of the Piesang River estuary, delineating the EFZ, are provided in Table 1 and illustrated in Figure 3.

Table 1: Geographical boundaries of the Piesang River estuary

Downstream boundary	34.060418° S; 23.378177° E (estuary mouth)
Upstream boundary	-34.062389° S; 23.355953° E (head of estuary)
Lateral boundaries	Approximated by the 5 m above Mean Sea Level (amsl) contour along each bank

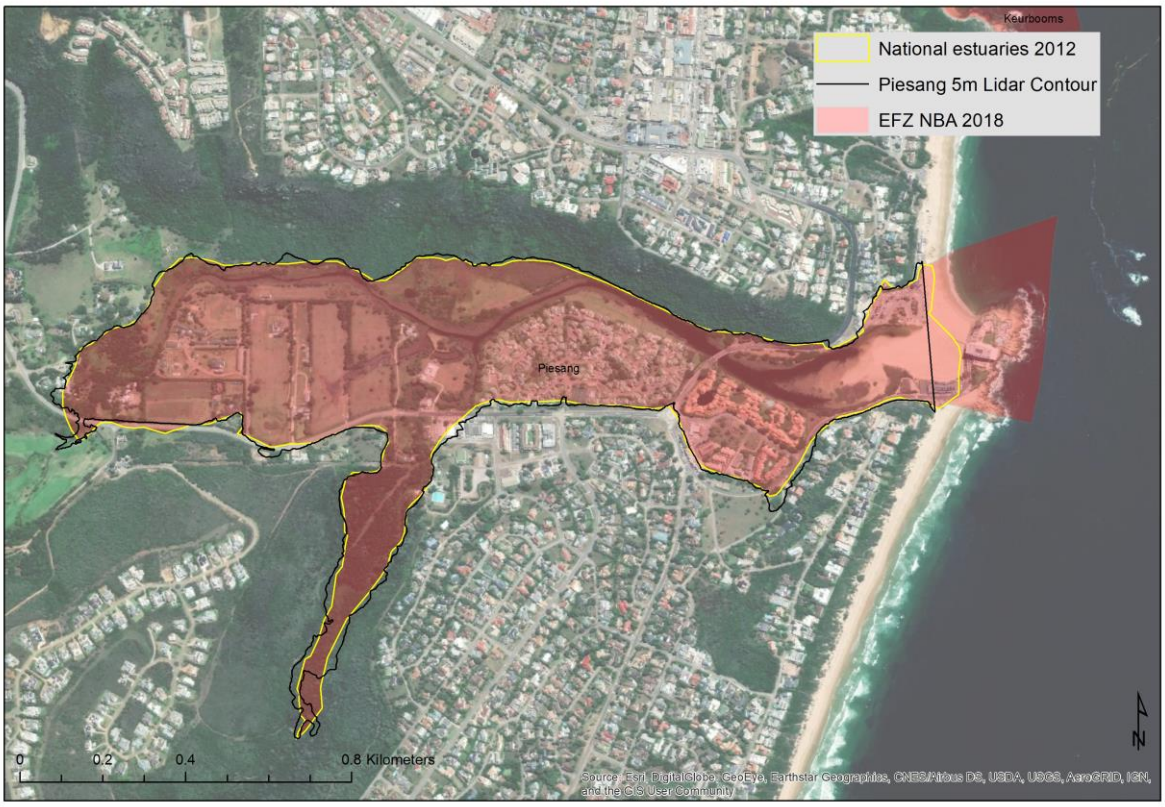

Figure 3: Geographical boundaries of the Piesang River EFZ showing the 5 m topographical contour and the 2018 NBA (SANBI 2019) EFZ boundary

3 SYNOPSIS OF THE SITUATION ASSESSMENT

Introduction

The Piesang River estuary is defined in the 2018 National Biodiversity Assessment (NBA) (SANBI, 2019) as a large temporarily closed estuary in the Garden Route (formerly Eden) District. Even with its location, in the coastal town of Plettenburg Bay on the Garden Route in South Africa's Western Cape Province, the popularity of this tourist destination and the recognition by the local community and authorities of the value of the ecosystem services that the Piesang River estuary provides, information pertaining to the estuary is relatively poor.

In accordance with the South African National Estuarine Management Protocol (NEMP), an estuarine management plan (EMP) is being prepared for the Piesang River estuary, following the prescribed estuarine management planning process. This is being conducted under the auspices of the Western Cape Estuarine Management Framework and Implementation Strategy (EMFIS) commissioned by the Western Cape Department of the Environmental Affairs and Development Planning (DEA&DP). This document, the Situation Assessment Report, documents the status quo of the Piesang River estuary and is the first outcome of the project for this system. It will serve as the platform for the development of the estuarine management plan.

Catchment Characteristics

The Piesang River estuary falls within the Bitou Local Municipality (LM) which experiences a warm and temperate climate. Average daily temperatures range from 10°C in winter to 22°C in summer. Highest rainfall occurs during the month of August (average 80 mm), while the lowest rainfall occurs in February (average 28 mm). The underlying geology of the Piesang River estuary comprises Table Mountain Quartzites of the Peninsula Formation as well as some areas of conglomerate, sandstone, silt and clay of the Enon Formation.

Bitou has one of the largest percentages of formally protected land of any municipality in South Africa, some 50% of the municipality is formally protected under the jurisdiction of SANParks and Cape Nature. These areas include the Garden Route National Park and comprises mountains, inland plateaus, a coastal corridor and a marine reserve. At least nine Protected Areas at located in Bitou, including the Tsitsikamma National Park, Keurbooms River Nature Reserve and the Robberg Nature Reserve. The reaming 50% of the municipal area is made up of extensive agriculture (veld management and stock farming), intensive agriculture (crop farming), and to a lesser extent wetland and river corridors, Critical Biodiversity Areas and urban development.

Abiotic Function

The catchment of the Piesang River estuary is estimated at about 35 km^2 with a total river length of about 17 km (Duvenage and Morant 1984). The Piesang catchment receives rainfall throughout the year, with peaks in autumn and spring. The Mean Annual Run-off (MAR) to the Piesang River estuary has been reduced by 34% to 3.4 x 10^6 m^3. This is due to major impoundments, abstractions in the catchment, including surface and groundwater abstraction, as well as smaller private dams. A broad assessment of

the changes in runoff to the estuary shows both a reduction in low and high flow months with a related increase in the low flow period. Concern has been raised regarding significant over abstraction of baseflow above the estuary.

Piesang River estuary is is defined in the 2018 National Biodiversity Assessment (NBA) (SANBI, 2019) as a large temporarily closed system. Historical imagery show that the Piesang River estuary channel meandered across the lower reaches of the stem in extensive s-curves and possibly opened on either side of Beacon Island. A large open water area existed in the lower estuary near the mouth and the system was predominantly open. In the present day, the road and other development connecting Beacon Isle now constrains the estuary mouth to opening on Central beach. Three large bridges obstruct natural water flow in the system. A concrete foot bridge 45 m long links the Beacon Island Hotel to Central Beach.

The Piesang River estuary stretches for about 2 km from its mouth at the Beacon Island to the upper road bridge below a golf estate. The river leaves the narrow valley at the Otto du Plessis bridge and enters and open basin, 200 by 600 m in extent behind the sand bars adjoining Beacon Island. A shallow channel, 0.5 to 0.75 m deep and about 20 m wide, scours its way to sea along the rocks at the landward side of the Beacon Island. This channel is kept open by river flow. The mouth is very constricted with tidal exchange generally very weak. During dry periods, mainly summer, the mouth closes. Historical breaching was undertaken to alleviate pollution.

More recently, a Reverse Osmosis (desalination) plant began direct abstraction of groundwater from the Piesang River estuary in December 2010. This had led to an increase in closed mouth conditions when it has been operational, and a decline in water levels under the closed mouth state. The average flow rate varied between 0.03 and 0.06 m^3/sec during 2010 to 2013, while during 2014 to 2017, flow rates varied between 0.04 and 0.05 m^3/sec. The operational period varied between 118 and 207 days, with the maximum period of 207 days (almost seven months) between December 2012 and June 2013. The maximum amount of water abstracted on record was 7 407 114 m^3 abstracted during the December 2014 to April 2015 period (127 days). From an examination of river flow rates, it is clear that the desalination plant is abstracting a similar volume of water to river input, and potentially exceeding river inflow during the months of January to March, when river inflow varies between 0.03 and 0.06 m^3/s. This is impacting on the water balance of the estuary and negatively influencing water levels and the frequency and duration of open mouth conditions (i.e. prolonged mouth closure and declining water levels).

In terms of water quality, the Piesang River estuary is a typical black water oligotrophic, acidic system. Historical data indicated that salinity in the estuary varied considerably from nearly fresh during the closed phase to very saline during the open state under low flow conditions. ph values ranged between 7.6 (1981) and 7.4 (1985), while water transparency was judged to be more than a meter. Temperature values between 13 °C and 24 °C were recorded for this system and dissolved oxygen was reported between 8.3 and 11.6 mg/l in 1981 pointing towards super saturation as a result of primary production. Nitrate values varied between 3.5 to 4 mg/l, while orthophosphates values

ranged from 0.2 to 0.24 mg/l. Nutrient enrichment is expected as a result of stormwater runoff and catchment practises.

Recent water quality sampling was undertaken in 2010, 2012 and 2018. In 2018, the water level in the Piesang River estuary was extremely low. The water column was relatively well mixed along the majority of the lower estuary with salinities ranging from 9.48 to 8.03 PSU. Some salinity stratification was noted in the middle reaches, with a surface and bottom reading of 1.26 and 7.31 PSU, respectively. The upper reaches were fresh. Surface waters in much of the estuary were well oxygenated, with dissolved oxygen (DO) concentration mostly >5 mg/l and saturation levels mostly >70%. Bottom DO levels, however, were generally much lower (<3 mg/l) and were considered detrimental to aquatic life.

In a general comparison, the estuary in 2018 was closed with little marine influence and low freshwater inputs creating stagnant conditions. In terms of salinity regime, the system was markedly different to the marine dominated estuary observed in 2012 after an extended period of drought, and when the estuary was open to the sea in 2010. Bottom temperatures were slightly warmer, and this was attributed to the lack of flushing by cooler seawater and shallow depth. Dissolved oxygen concentrations were also lower than previously recorded at certain sites.

In respect to water pollution, anecdotal reports received during the stakeholder meeting suggested that leachate, containing heavy metals, toxins and other contaminants from the old landfill site, is reportedly building up in Klein Piesang River and entering the estuary.

According to sampling undertaken in 2018, the sediment of the Piesang River estuary changes from coarse, well sorted marine sands near the mouth to finer, poorly sorted fluvial sand containing mud in the upper reaches. Total organic content was greatest in the middle reaches (10.47%) and positively correlated with mud content of the sediment. This coupled with an increase in particle size relatively to previous sampling periods was attributed to the closed mouth status, lower flushing rates, smaller estuary water area associated with drought conditions, and ongoing extraction that allowed accumulation of organic material.

Biotic Function

There are no historic data on the microalgae of the Piesang River estuary, however, *Noctiluca miliaris* was reported in the system. Present-day microalgae expected to have responded to increase retention and nutrient loading from the catchment.

Little natural riparian habitat remains at Piesang River estuary due to recreational and residential development and the stabilising/reclaiming of the estuary banks. The main macrophyte habitat was reeds and sedges with various assemblages occurring along the system. Common reed *Phragmites australis* fringed the open water in the middle and upper reaches. Reeds and *Typha capensis* occurred in a wetland area on the north bank in the upper reaches, fringed by sedges, namely *Cyperus laevigatus* and *Cyperus textilis*. *Triglochin elongata* occurred in the undergrowth of the reeds in the middle reaches opposite the townhouses above the Beacon Isle Drive bridge. *Juncus kraussii,*

Cyperus laevigatus and *Cyperus textilis* occurred on the north bank in the recreational area above the Beacon Isle Drive bridge. A small area of *Sarcocornia natalensis subsp. natalensis* and *Bassia diffusa* salt marsh occurred in the lower reaches of the estuary. At higher elevations *Sporobolus virginicus* covered the sand.

Invasive plants are extensive in the valley and the remaining forest habitat has been damaged by roads and tracks. The following invasive species were recorded on a dirt road through the forest on the north bank: *Acacia melanoxylon*, Spanish Reed *Arundo Donax*, Pampus grass *Cortaderia selloana*, *Lantana camara*, Syringa Berry *Melia azedarach*, Brazilian Pepper *Schinus terebinthifolius* and Cape Wattle *Paraserianthes lophantha* subsp. *lophantha*.

Very little historical information is really available on the invertebrates of the Piesang River estuary apart from Duvenage and Morant (1984) who reported 23 taxa of zooplankton. In recently sampling in 2010, 21 taxa were recorded, with lowest densities near the mouth where the sediment is coarse. In 2018, a total of 304 macrobenthic invertebrates representing 19 taxa were recorded. Taxa were primarily represented by polychaeta, amphipoda, isopoda, and Axiidae represented by one species. The average density across all five sites of 796 ind.m^{-2} highlights a decrease from 2 308 ind.m^{-2} in the 2012 monitoring survey and 1 650 ind.m^{-2} in the 2010 baseline survey. Species richness among sites varied from year to year but an overall decrease in diversity occurred from 2010 to 2018. During the baseline survey of 2010, amphipoda and isopoda dominated the Piesang macrofaunal community, whilst in 2018 polychaete worms and sand prawns *Callichirus kraussi* were more abundant. The observed changes in the macrofaunal community of the Piesang are probably linked to the changes in sediment particle size, freshwater and tidal flows (and hence salinity and primary productivity) recorded in the estuary.

Historical fish data on the Piesang is limited. Between 7 and 13 species have been recorded in the system. Mullet was abundant in the estuary in 1980, with about 500 juveniles Sea Barbel caught in a short trawl net sampling session. At least five species estuarine-dependent species were recorded in February 2004. During the September 2010 baseline survey, a total of 2 623 fish representing 13 species were collected, in February 2012 a total of 1 286 fish representing 21 species were recorded, and in 2018, a total of 6 770 fish representing 18 species were recorded. The large increase in diversity between 2010 and 2012 was attributed to more marine species in catches, whilst the large decrease in abundance was attributable to substantial declines in the abundance of some estuarine-dependent species, namely estuarine round herring, freshwater mullet and white Steenbras. The large increases in the catch of some estuarine resident and dependent species, particularly in the middle and lower estuary was attributed to substantially lower water level and remaining open water area resulting in the concentration of fish, thus increasing the seine netting sampling efficacy. The changes in diversity, abundance and distribution of the Piesang estuary fish community between the 2010 baseline and the 2012 monitoring survey was clearly indicative of the estuary being more marine dominated during the February 2012 monitoring survey, whilst the 2018 monitoring survey reflected a shift back towards an estuarine-dependent fish community. Due to the high diversity and density of estuarine-

dependent fish, it was concluded that the Piesang River estuary was an important nursery for fish in the region. The loss of catadromous (migratory) species and the decline in marine species since 2012 is likely attributable to the extended closed mouth phase during 2018 (a direct result of prevailing drought conditions and ongoing water extraction from the estuary) and the absence of outlet channel to the sea for fish in the estuary.

Limited information is available on the birds of the Piesang River estuary in the past the following species were reported: 2 Pied Kingfishers, 4 Cape Wagtails and 140 Black Backed Gulls. Currently 17 species have been reported which is relatively high for a system this size. Bird counts of the Piesang River estuary in September 2010 (two counts) yielded a total of 220 birds representing 17 species, in February 2012 (single count) recorded 162 birds representing 27 species, and in March 2018 (single count) 149 birds from 12 species were recorded. The increased species count for the 2012 monitoring survey probably reflects natural seasonal changes both in bird distributions and activity as many of the new species were not specifically estuary associated. Birds populations shifted along the estuary depending on the marine or freshwater dominated state. Migratory waders were entirely absent indicating that in its current state the Piesang River estuary is not an important foraging area for waders. Despite the large reduction in open water area in the lower estuary, there has not been a decline in bird numbers overall in this area. However, the bird count in all surveys was dominated by black backed gulls, and in 2018 a large number of greater white egrets were recorded, which masks the substantial decline in water birds, such as coots and reed cormorants, that took place between the baseline and subsequent monitoring surveys.

Ecological Health Status, Importance, Recommended Future State, and Ecosystem Services

The overall ecological health of the Piesang River estuary is in a D Category (i.e. Largely Modified with a loss of process/pattern). The following key pressures considered as contributing factors to this determination during the reserve determination process: reduction in baseflows and floods; direct abstraction of water from the mouth region for the reverse osmosis plant; loss of tidal flows and habitat as result of bridge construction; a decline in water quality as a result of urban runoff; significant development in the EFZ and related loss of habitat; limited fishing effort; and human disturbance (which influences bird abundance).

While the Piesang River estuary is not included in the Western Cape Protected Area Expansion Strategy (Maree *et al.,* 2015), nonetheless, it forms part of the core set of priority estuaries in need of protection to achieve biodiversity targets in the National Estuaries Biodiversity Plan. The Plan recommends that the Piesang River estuary be partially protected, and that 50 % of the estuarine margin be undeveloped. Due to its transformed state the Recommended Ecological Category (REC) was set as a Category B/C. The motivation being that the estuary is of high conservation importance with the reserve process requiring maintaining present flow, improving water quality and removing the reverse osmosis plant. However, it is noted that the 2018 NBA (SANBI 2019) suggests a Category D.

Estuarine habitats and the species they contain provide a host of important ecosystem

services. The level of provision for most of the ecosystem services by the Piesang River estuary is low, except for cultural services (e.g. recreational use) and the export of materials and nutrients to the marine environment, which are rated as low to medium, while the nursery function, is rated as medium. Numerous recreational activities take place in and around the Piesang River estuary, which are most intense during the peak holiday periods.

Impacts and Potential Impacts

The environmental processes, activities and developments that pose a threat to the Piesang River estuary include the following:

- *Environmental hazards* – drought, floods and climate change impacts;
- *Land-use and infrastructure development* – extensive development occurs within the estuary functional zone; and
- *Water quality and quantity issues* - sewage pump stations located adjacent to the estuary and industrial wastewater discharge cause pollution and three bridges, the Roodefontein Dam, as well as several smaller private dams, and a Reverse Osmosis Plant impede and reduce natural water flow in the system.

Socio-economic Context

The Piesang River estuary and its catchment falls within the Bitou LM, within Plettenberg Bay, an urban settlement with a caravan park, small farmlands and a golf course situated along the river. Bitou LM has a total estimated population of 59 157 (StatsSA, 2016) and an average growth rate of 5.22% (StatsSA, 2011), making up approximately 9.67% of the total population of the Garden Route (formerly Eden) District Municipality (DM) (StatsSA, 2016).

Of those population aged 20 years and older, 2% have no formal schooling. There are 21 914 households in the Bitou LM, of which 61% have access to piped water within their dwellings. Electricity for lighting is provided to 97% of all households. Approximately 23 599 people are economically active, with an overall unemployment rate of 30.1%, and a youth unemployment rate of 37.9%. Approximately 26% of the population earns an average household income of less than R38 200 per annum, while a further 18.1% receive no income at all.

The Piesang River estuary and its catchment falls within the developed Ward 1 of the Bitou LM, which has a total population of 6 298. A small amount, some 125 individuals (6%) do not earn an income, and 467 individuals (10.7%) are unemployed. The estuary itself is located within Plettenberg Bay, an urban settlement with a caravan park, small farmlands and a golf course situated along the river.

At the end of 2015, the Bitou LM contributed 7.3% (R 2,189 billion) to the Garden Route DM Gross Domestic Product (GDP), and GDP growth of 3.6 percent annum over the period of 2005 – 2015. The municipal economy is based on wholesale and retail trade, catering and, accommodation; construction; finance, insurance, real estate and business services; community, social and personal services; and the agriculture and

fisheries sectors, and all of these are driven by tourism, as the main economic driver (Bitou LM IDP, 2017). An important objective for the Bitou LM is diversification of the economy as it is largely based on tourism. The Municipality aims to increase opportunities for permanent residency, improve IT platforms, road and air travel infrastructure (Bitou LM IDP, 2017).

The direct and indirect benefits derived from estuarine ecosystems services are manifested directly or indirectly in tangible income and employment. The Piesang River estuary holds high socio-economic value in terms of tourism value, and the economic sectors that support tourism in the area. The key opportunities for investment in the Piesang River estuary zone has been identified as the development and densification of the current urban settlements to accommodate and simulate increasing tourism activity. It is also planned that the Piesang River estuary will be integrated into the Bitou 'Coming Together' corridor in the Bitou Coming Together Urban Integration and Regeneration Strategy, a developmental strategy aimed at harnessing and bringing together 'best planning practices' for application in the local context of Bitou (Bitou LM, 2019).

Legislative Instruments and relevant Strategies, Plans and Policy Directives

The legislative framework specific to estuarine management is the Integrated Coastal Management Act and the accompanying NEMP. The NEMP provides national policy and ensures alignment by providing a national vision and objectives for achieving effective integrated management of estuaries, amongst other things. The NEMP identifies the responsible management authority per estuary, in this instance **allocates such responsibilities to the provincial environmental department unless agreement, or until agreement, is reached with the respective municipality to undertake the coordination of the implementation process.** Key legal instruments that are applicable to estuarine management are then described, and include national, provincial and local management documents.

Opportunities and Constraints

Based on the available information for the Piesang River estuary, the current strengths, weaknesses, opportunities and threats assessment was undertaken. Key strengths of the Piesang River estuary are that its high-quality natural environment increases the municipal rates base due to views and proximity to the system, portions of the estuary margin remain undeveloped and the neighbouring urban areas are connected to water borne sewage system. Another strength is its links to the Plettenberg Bay Community Environment Forum. The Piesang River estuary also forms part of the core set of national priority estuaries and needs partial protection to meet biodiversity targets. Opportunities exist for local socio-economic development and employment related to eco-tourism and recreational activities, the proposed upgrade of the malfunctioning sewer infrastructure as well as the Municipality's desire to recycle all water used.

Constraints include its current highly transformed, disturbed and degraded state, its impoundments and continued abstraction of water, its natural flow and tidal exchange is impeded by bridge infrastructure as well as the impact of the desalination plant on

both the estuary and its biota. Weaknesses include the potential for further decline in water quality, possible plans to densify development in the node, the continued impacts of the desalination plant, continued discharge of leachate from closed municipal dump as well as the continued accumulation of sand in the estuary mouth.

Information Gaps and Recommendations

There are also significant information gaps with regard to baseline information available on the biophysical aspects of the Piesang River estuary. No recent surveys on the majority of the fauna or flora has been undertaken within or surrounding the estuary. It is recommended that a regular monitoring programme be put in place for the estuary, and research be undertaken on the following aspects:

- Hydrology
- Mouth dynamics;
- Water quality, particularly pollution inputs;
- Microalgae;
- Invertebrates; and
- Fish.

4 LOCAL VISION & OBJECTIVES

4.1 Vision

The Vision for an estuary should be inspirational, representing a higher level of strategic intent and aligned with the strategic objectives of the NEMP, Western Cape CMP and the greater Cape Floristic Region (CFR). The National Vision and Vision of the Estuaries of the CFR are as follows:

The estuaries of South Africa are managed in a sustainable way that benefits the current and future generations

The estuaries of the CFR will continue to function as viable systems which are beautiful, rich in plants and animals, attract visitors, sustain our livelihoods and uplift our spirits

The 2016 Western Cape Provincial Coastal Management Programme (PCMP), identifies estuarine management as one of its nine priority areas and sets out the goal for the Western Cape as:

Co-ordinated and integrated estuarine management which optimises the ecological, social and economic value of these systems on an equitable and sustainable basis

The following Vision for the Piesang River estuary was developed and adopted during a public meeting held in November 2017[1] and a second meeting held in August 2018, both in Plettenberg Bay[2].

The Piesang River estuary is an urban transformed yet functional system that is beautiful, well-managed and preserved for current and future generations, with sufficient water for all purposes and balancing all its socio-economic and conservation needs

The vision highlights the following aspects of the estuary that are valued and need to be preserved or enhanced:

- The estuary remains functional despite being transformed from its natural pristine state and subject to urban impacts;

[1] Minutes of the public meeting for the Piesang River estuary, 15 November 2017, at the Piesang River Community Hall, Plettenberg Bay

[2] Minutes of the 2nd public meeting for the Piesang River estuary, 29 August 2018, at the Piesang River Community Hall, Plettenberg Bay

- The beauty and aesthetic appeal of the estuary;
- There is ample water in the estuary to provide for the ecological needs of the system as well as the anthropogenic needs;
- The role the estuary plays in terms of [biodiversity] conservation; and striking a balance with its predominantly urban nature;
- The value of the estuary to society and the economy; and
- The need to manage activities and sustainable use in and around the estuary effectively to ensure the longevity of the system.

4.2 Strategic Objectives

Objectives are qualitative statements of the values derived from the vision and typically reflect the overarching issues. They should answer the following question, *"How will you know when you have achieved the Vision?"*. The strategic objectives inform the development of the detailed management strategies that are carried forward as plans of action.

The strategic objectives for the Piesang River estuary were discussed at the stakeholder meeting. Based on the feedback received from the participants, the strategic objectives for the Piesang River estuary align with the following identified sectors or categories of issues:

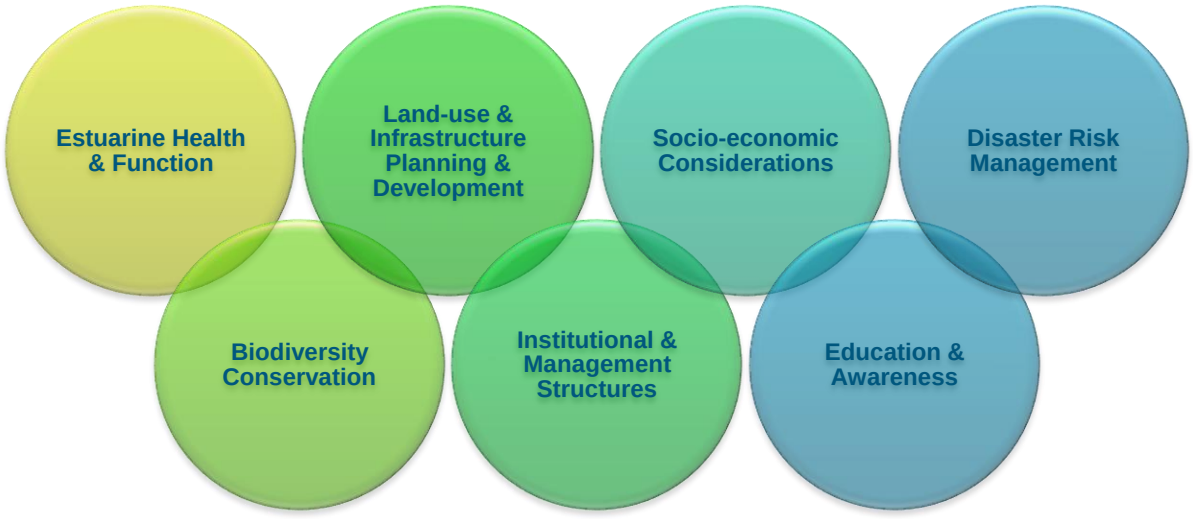

Figure 4: Sectors or categories of issues relevant to the management of the Piesang River estuary

According to these categories, the strategic objectives for the Piesang River estuary are as follows:

Table 2: Strategic Objectives for management of the Piesang River estuary, their indicators and level of priority

	Sector / Category	Strategic Objective	Performance Indicator(s)	Priority
1	**Estuarine Health and Function**	The ecological health and natural functioning of the Piesang River estuary is improved and safeguarded, its negative trajectory reversed, living resources are sustainably managed and estuary nursery function protected	• Ecological condition improved from a D to a B/C • Ecological reserves for water quantity and quality are secured • Basewater flow restored • Effective mouth management • Estuary requirements are integrated into catchment processes • Pollution to the estuary is reduced, improved water quality • Water quality monitoring programme is in place • Invasive alien plant species are eradicated • Establishment of a no-take sanctuary zone, and sustainable use of estuarine resources • Reduction in illegal activities • Nursery function of the estuary is improved • Ecological monitoring programmes are in place • Increase in number of research and monitoring projects	**HIGH**
2	**Biodiversity Conservation**	The biodiversity of the Piesang River estuary is conserved	• EMP incorporated into the Bitou IDP and SDF • EMP incorporated into the GRBR management plan as well as District and Local CMP • Spatial zonation plan is adopted and enforced • Environmental custodianship secured • Critical estuarine habitats and species are protected against negative impacts	**HIGH**
3	**Land-use and Infrastructure Planning and Development**	Impacts associated with developments and proposed changes in land-use, including infrastructure and agriculture, are minimised	• All development and land use changes surrounding and within the EFZ comply with environmental legislation and environmental best practice / risk aversion approach • No development in high risk areas	**MEDIUM**

			• Further transformation/ degradation of estuary prevented • Reduced negative impacts from urban, agricultural and industrial activities	
4	**Institutional and Management Structures**	The Piesang River estuary is well managed through effective co-operative governance	• EMP is seamlessly incorporated into the Bitou IDP and SDF • Estuary advisory committee is established, is effective and meets regularly and reports to the Municipal Coastal Committee • Estuarine bylaws are drafted • Mandated authorities and participating agencies are well capacitated, actions are fulfilled • Critical management networks are established	**MEDIUM**
5	**Socio-economic Considerations**	Socio-economic benefits are enhanced and regulated to ensure sustainable use of the Piesang River estuary and its resources.	• Carrying capacities determined and upheld • Illegal activities controlled • Increased livelihood opportunities for local historically disadvantaged communities • Environmental Protection and Infrastructure Programmes (EPIP) implemented and effective	**LOW**
6	**Education & Awareness**	Members of society are sensitive to, and aware of, the value and importance of the Piesang River estuary	• Awareness programme developed and successfully implemented on an on-going basis • Signage erected; information disseminated • Increase in number of research and monitoring projects	**MEDIUM**
7	**Disaster Risk Management**	Potential risks that could impact the Piesang River estuary are reduced (inclusive of climate change impacts)	• No further development in high risk areas • Flood disaster management plan developed • Contingency plans in place for high risk areas / activities • Disaster impacts are timeously and effectively mitigated	**HIGH**

5 PRIORITY MANAGEMENT OBJECTIVES AND ASSOCIATED ACTIVITIES

After the review of the background information, as well as after conducting stakeholder engagement, a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis of the Piesang River estuary under the current management practices has been prepared (Table 3).

Table 3: SWOT Analysis

STRENGTHS *(highlights, uniqueness?)*	**WEAKNESSES** *(what could you improve?)*
• Dependence on the high quality of the natural environment for the main economic activity / tourism (high tourism value) • Many of Garden Route District's Strategy Documents and Plans have been developed to ensure that commitments for the region are met • A key implementation priority of the Garden Route Coastal Management Programme is the prevention of the contamination of marine and estuarine waters • Biodiversity Sector Plan for the Bitou area has been developed • The marine extension of the Piesang River Mouth at Plettenberg Bay has been delineated as a marine CBA (Garden Route Biosphere Spatial Plan) • One of the national priority estuaries to meet biodiversity targets • System rated as very important from a nursery perspective (high nursery value) • Recognition by both community and authorities of the value of the system • Plettenberg Bay Community Environment Forum proposed botanical garden (however no progress made to date) • System needs partial protection to meet national biodiversity targets • Portions of the estuary margin undeveloped (northern bank, Klein Piesang) • Increased rates base for the municipality due to views and proximity to the system • Urban area connected to water borne sewage system) • 4 species of kingfisher and both grassveld and grass owls noted	• Highly transformed, disturbed, degraded state • A large percentage of the EFZ is already developed and transformed; little natural riparian habitat is remaining • Degraded ecosystem services • Natural flow and tidal exchange impeded by bridge infrastructure • Impoundments and abstraction of water • Unlawful artificial breaching • Municipal water supply augmented by operation of desalination plant in the estuary mouth in peak seasons • Impact of the desalination plant on the estuary – increased mouth closure, reduced marine inflow, low water levels • Impact of the desalination plant on the estuary biota – invertebrates and fish are sensitive to physico-chemical changes • Increased size of sand bar and infiltration of sand up and into the system • High level of development around the estuary • Numerous sources of water pollution including, brine, landfill leachate, sewage leaks, backwash water, contaminated stormwater, etc. • Invasive alien plant infestation along Klein Piesang River and in forest on north bank • Kariba weed and *Phragmites* closing/choking the system • Algal blooms (*Enteromorpha*) causing foul odours • Monitoring information available in raw format, should be incorporated into the reserve determination or national biodiversity assessment processes

OPPORTUNITIES *(Opportunities for positive change)*	**THREATS** *(what could prevent the EMP from working?)*
• Potential opportunities for local socio-economic development related to eco-tourism and recreational activities • Opportunities for employment through environmental management initiatives for the estuary • High fish nursery value denotes potential opportunities for protected area status • System needs partial protection in order to meet national biodiversity targets • Any new development within EFZ to be guided by coastal management line • Stewardship / local buy-in / custodianship programmes supported • Upgrade of malfunctioning sewer infrastructure (pump station 5) proposed • Municipality's desire to recycle all water used	• Further decline in water quality (sewage pump stations, reverse osmosis plant) • Plans to increase/densify development in the Bitou area may cause more environmental degradation • Climate change and loss of aquatic ecosystem • The system could be targeted for further water resource development. • High level of development around the estuary • Continued impacts of desalination plant • Continued discharge of leachate from closed municipal dump • Present ecological health rated as D • System vulnerable to flood damage and unnatural erosion • Periodic sea surges • Continued accumulation of sand at the mouth • Stormwater management not keeping up with urban development • Location of pump station 5 within the EFZ • Further abstraction and impoundments • Densification of development proposed in node

The management objectives detailed below were informed by the SWOT analysis and critical issues identified as part of the scoping phase. They represent the focus areas for the 5-year cycle of this EMP. An illustrative overview of the priority management objectives for the Piesang River estuary is provided in Figure 5 below.

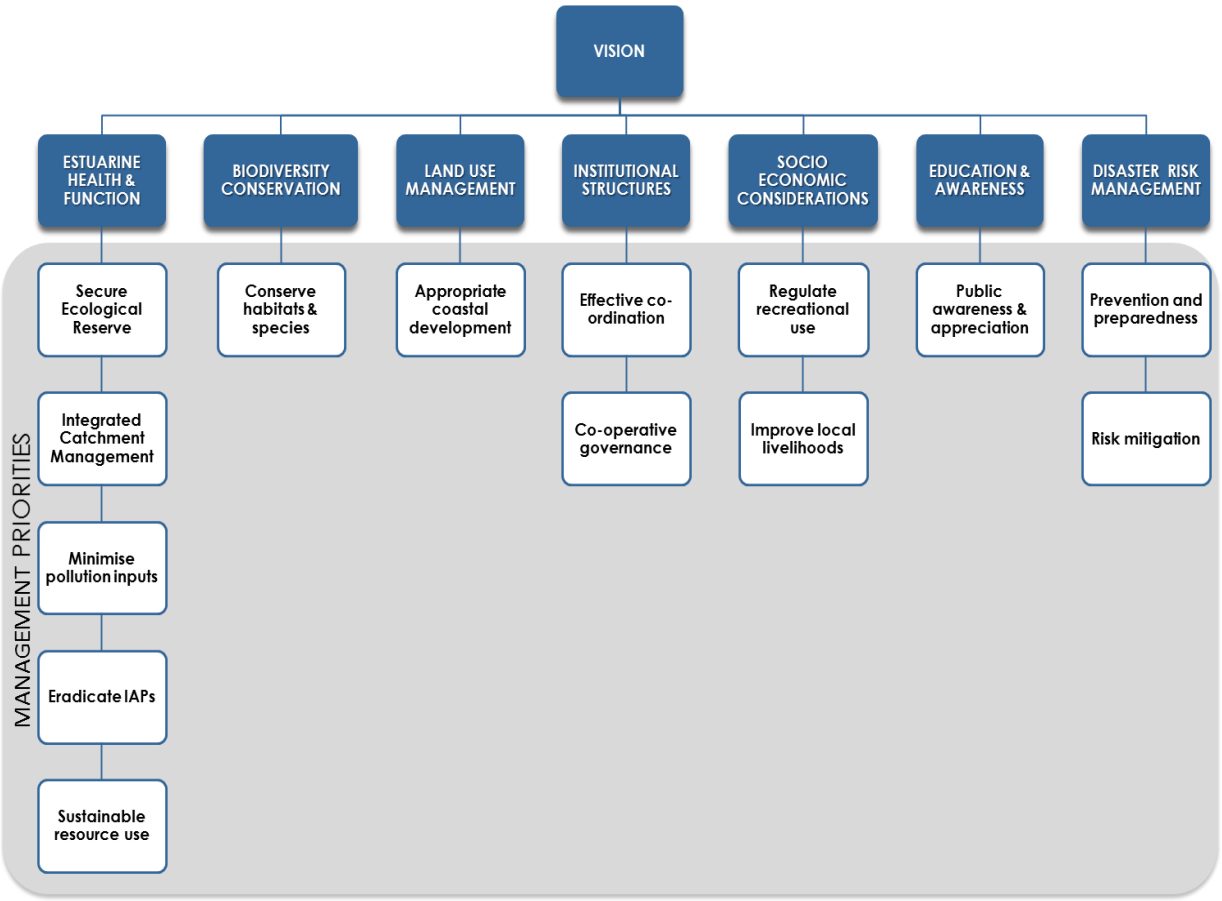

Figure 5: Summary of priority management objectives per management sector

5.1 Estuarine Health and Function

<u>Strategic Objective 1</u>: The ecological health and natural functioning of the Piesang River estuary is improved and safeguarded, its negative trajectory reversed, living resources are sustainably managed and estuary nursery function protected

Table 4: Management Objectives and Actions for Estuarine Health and Function (includes water quantity and quality as well as utilisation of living resources)

	Action	Relevant Legislation	Performance Indicator	Priority	Responsibility
Management Objective 1.1: Secure adequate quantity and quality of freshwater input to improve and maintain ecosystem health and functioning					
a.	Lobby Department of Water and Sanitation (DWS) Minister to sign off the recommended freshwater reserves, ensuring that the minimum flow requirement (baseflow) for the estuary is restored	National Water Act (NWA)	• Meetings held; correspondence written • Recommended reserve(s) signed off • Revised dam releases • Baseflow is restored • Ecological condition improved from a D to a B/C	HIGH	Breede-Gouritz Catchment Management Strategy (BGCMA), Responsible Management Authority (RMA)
b.	Once classification study signed off, follow up on implementation of water resource classification process	NWA	• Meetings held; correspondence written • Water resource classified • Baseflow is protected, implemented, monitored and reported on at EAF meetings	HIGH	BGCMA, RMA
c.	Incorporate the results of the Assessment of the impacts of a reverse osmosis desalination plant on the Piesang River estuary and nearshore marine habitats	NWA, Integrated Coastal Management Act (ICMA)	• Results reviewed once document released • Meetings/workshops held and recommendations considered • Conditions included in decisions made implemented and monitored	HIGH	Bitou Local Municipality (LM), Western Cape Department of Environmental Affairs and Development

					Planning (DEA&DP), BGCMA
d.	Investigate and assess the feasibility of alternatives for water abstraction to replace current estuarine abstraction	NWA, ICMA	• Feasibility study undertaken • Alternatives identified and assessed • Meetings/workshops held; correspondence written	HIGH	DWS, Department of Environmental, Forestry and Fisheries (DFFE), DEA&DP, BGCMA
e.	Develop and implement a water resource utilisation plan for surface and groundwater resources (including registration and licensing)	NWA	• Utilisation plan developed • Number of licensed users • Regulated water use/abstraction	HIGH	BGCMA
f.	Identify abstraction and discharge points – both legal and illegal – and implement compliance action against illegal operations	NWA	• Register of abstraction and discharge points compiled • Legal status determined • Illegal operations prosecuted	HIGH	DWS, BGCMA
g.	Continuous monitoring of inflow at gauging weir in the catchment	NWA	• Ongoing monitoring and generation of data • Annual report submitted to RMA and EAF • Data incorporated into EMP 5-year review • Annual report submitted to RMA and EAF	HIGH	DWS, BGCMA
h.	Continue with Catchment Management Strategy (CMS) implementation monitoring at strategic sites	NWA, ICMA, National Environmental management Act (NEMA)	• Ongoing monitoring and generation of data • Data incorporated into EMP 5-year review • Annual report submitted to RMA and EAF	MEDIUM	BGCMA, DWS
i.	Enforce agricultural/environmental best practice for farms and golf course, specifically to reduce nutrient enriched return flow and sediment erosion	Conservation of Agricultural Resources Act (CARA), NWA	• Engagement with famers/land owners in catchment initiated • Best practice methods promoted and implemented • Management guidelines for golf course developed	MEDIUM	Department of Agriculture, land Reform and Rural Development (DALRRD), BGCMA

j.	Catchment water quantity and quality to be summarised and reported on	NWA	• Annual report submitted to RMA and EAF	MEDIUM	DWS, BGCMA, Bitou LM
k.	Monitor water level and natural mouth dynamics (in partnership with neighbouring land owners and other interested and Affected Parties (I&APs))	NWA (RDM)	• Mouth state documented • Photographic database generated	HIGH	RMA with support from Plettenberg Bay Environment Forum
l.	Investigate methods for effective mouth management according to specific conditions/thresholds	ICMA, NEMA	• Conditions/thresholds for mouth manipulation determined • Mouth Management Plan (MMP) to be developed	MEDIUM	RMA
m.	Development and approval of Maintenance Management Plan (MaintMP) (should artificial breaching be supported in the Mouth Management Plan)	ICMA	• Stakeholder meetings undertaken • Stakeholder input received and minuted • Minutes of meetings • MaintMP developed and submitted for authorisation • Implementation of MaintMP recorded	MEDIUM	RMA
n.	Monitor and report on the status of the estuary annually (inclusive of estuarine pressures and impacts) and implement appropriate mitigation measures	NWA	• Status determined and interrogated • Estuary impacts identified • Mitigation measures established and proposed • Priority mitigation measures implemented • Annual report submitted to DFFE and EAF • Data incorporated into EMP 5-year review	MEDIUM	RMA (supported by e.g. CapeNature, Department of Science and Technology (DST), Council for Scientific and Industrial Research (CSIR)

o.	Undertake seasonal (summer/winter) monitoring of fish and bird populations (including indicators species), taking RQOs into account	NWA (RDM), National Environmental Management: Biodiversity Act (NEM:BA), Marine Living Resources Act (MLRA)	• Indicators species identified, and population trends analysed • Species list and abundance data produced • Databases developed • Monitoring reports compiled and submitted • Data incorporated into EMP 5-year review	HIGH	RMA (supported by e.g. CapeNature, DST, CSIR)
p.	Undertake full Resource Direct Measures (RDM) monitoring of all estuary components every 3 years according to RDM methodology	ICMA, NWA	• Required monitoring undertaken • Data produced and reported on • Data incorporated into EMP 5-year review	LOW	DWS, BGCMA, RMA
Management Objective 1.2: Ensure estuary requirements are integrated into catchment processes to ensure healthy water quality					
a.	EMP included in catchment management strategy, and catchment classification systems and processes	NWA	• EMP integrated into BGCMS • Estuary acknowledged as sensitive end-points • Catchment impacts identified, and mitigation strategies investigated	HIGH	BGCMA
b.	Catchment land use map developed and updated annually	NWA, CARA	• Updated land use map produced every year • Potential sources of pollution identified	HIGH	DALRRD (Land Care)
c.	Land use and effluent management included in the CMS	NWA	• CMS reduces nutrient pollution from agricultural practices and identifies additional sources of pollution (land use and effluent) to the estuary and provides mitigation strategies	HIGH	BGCMA
d.	Water use plan updated on an annual basis	NWA	• Updated water use plan produced every year	HIGH	DWS (Resource protection)

Management Objective 1.3: Minimise pollution by addressing activities that lead to poor water quality					
a.	Implement and document DFFE and DWS policy to not allow effluent discharge directly to the estuary (including Waste Water Treatment Works (WWTW), septic tanks, conservancy tanks, industrial & livestock effluent etc.)	NWA	• Discharge of effluent strictly prohibited • Upstream discharges monitored	HIGH	RMA, Bitou LM
b.	DWS to review discharge permits and revise discharge standards where necessary	NWA	• Inventory of legal and illegal discharges compiled • Review of discharge permits • Standards revised • Meetings with water users • Written notifications issued to water users		DWS
c.	Undertake basic Water Quality (WQ) monitoring on a quarterly basis, taking Resource Quality Objectives (RQOs) into account	NWA	• Estuary WQ database maintained to facilitate long term database • Report compiled and provided to EAF • EMP informed by monitoring results going forward	HIGH	Bitou LM
d.	Enforce best practice guidelines in reference to sustainable urban drainage systems (SUDS)	MSA, NWA, ICMA	• 1-day training for officials convened and attended • SUDS applied by building control and technical services	MEDIUM	Bitou LM
e.	Implement waste management plan, with a focus on peak visitor periods	National Environmental Management: Waste Management Act (NEM: WA), MSA	• Appropriate preparation for peak periods • Clean-up operations undertaken after peak visitor periods	LOW	Bitou LM, RMA, DFFE: Working for the Coast (DFFE: WftC)

Management Objective 1.4: Control the spread and densification of invasive alien plant species					
a.	Identify and prioritise infested areas	CARA, NWA	• Detailed maps produced • Priority areas identified • Appropriate methods of control determined	HIGH	Bitou LM, RMA, DFFE, DFFE: Working for Water (WfW), Garden Route Biosphere Reserve (GRBR)
b.	Develop and implement invasive alien species eradication programme	CARA, NWA	• Invasive Alien Plants (IAPs) eradication programme implemented • Increased area of IAPs removed	HIGH	RMA, DFFE, DFFE: Working for Water (DFFE: WfW), GRBR
Management Objective 1.5: Regulate the use of living resources through the establishment of a no-take zone enforced by effective compliance management					
a.	Determine status of fish and bait stocks in Piesang River estuary, including regular monitoring to determine recruitment patterns	MLRA	• Research undertaken • Data generated, and results reported on • Data incorporated into EMP 5-year review	MEDIUM	DFFE
b.	Establish and demarcate a no-take zone against fishing and bait harvesting	MLRA	• EFZ controls enforced and offenders prosecuted • Sustained fish populations • Reduced habitat loss/degradation and disturbance, and inappropriate behaviour	HIGH	RMA, DFFE
c.	Determine carrying capacity for fishing and bait harvesting	MLRA	• Carrying capacity determined	MEDIUM	DFFE
d.	Assess, quantify and regulate extractive resource use activities on the estuary according to carrying capacity through relevant monitoring programmes (e.g. roving creel surveys, compliance patrols)	MLRA	• Monitoring programme developed and implemented • Monthly counts of number of harvesters • Increased patrols and monitoring conducted	LOW	CapeNature, DFFE

e.	Deploy human resources for ad hoc compliance and enforcement in reference to MLRA	MLRA	• Incidents of poaching reduced • Transgressors prosecuted • Improved fish and invertebrate populations • Creel survey undertaken • Research undertaken • Reports submitted to DFFE	LOW	CapeNature, DFFE
f.	Initiate and enforce ban on night fishing	MLRA		When adopted	DFFE
g.	Combined compliance monitoring and enforcement operations need to be planned to address illegal activities	MLRA, ICMA		MEDIUM	South African police Service (SAPS), DFFE, DEA&DP, SANParks, DFFE, CapeNature
h.	Investigate and implement options for the effective control of alien fishes in the Piesang River and estuary (e.g. fishing competitions, no return of caught invasive fish)	MLRA, NEM:BA	• Methods implemented • Reduction in invasive species and abundance	MEDIUM	DFFE, CapeNature (support from SANParks[3])
i.	Informative signage, indicating zonation and allowable activities, to be placed at strategic points for all users/visitors	ICMA	• Key public spaces / access points identified • Signage created and erected	MEDIUM	RMA

[3] Kyle Smith from SANParks working with local communities to reduce invasive fish species in other systems

5.2 Biodiversity Conservation

<u>Strategic Objective 2</u>: The biodiversity of the Piesang River estuary is conserved.

Table 5: Management Objectives and Actions for Biodiversity Conservation

	Proposed Activity/Action	Relevant Legislation	Performance Indicator	Priority	Responsibility
Management Objective 2.1: Ensure the conservation of estuarine habitats and indigenous species					
a.	Include estuary as a Conservation Priority in CMS, Western Cape Protected Area Expansion Strategy (WC PAES), DFFE management processes, and municipal environmental overlay[4]	ICMA, NWA, NEM: PAA, MSA, Land Use Planning Act (LUPA)	• Piesang River estuary included in key strategic and planning documents • Piesang River estuary protected area status requirements resolved	HIGH	RMA, Bitou LM, BGCMA, DFFE, CapeNature
b.	Investigate protection opportunities and mechanisms with CapeNature (e.g. nature reserve, conservation servitude, Memorandum of Understanding (MOUs), stewardship agreements, etc.)	NEM: PAA, MSA, LUPA	• Meeting convene with principle authorities • Conservation methods identified and investigated	HIGH	RMA, CapeNature
c.	Identify all state-, municipality- and privately-owned land parcels that are suitable for inclusion into a conservation area network	NEM:PAA, ICMA	• Land parcels identified • Methods for inclusion investigated • Agreements entered into	HIGH	CapeNature
d.	Enter into environmental custodianship/ stewardship agreements with adjacent properties	NEM: PAA; NEMA (Duty of Care)	• Meeting with adjacent land owners convened (river and estuarine) • Signed agreements with land owners • Degraded areas rehabilitated	HIGH	RMA, Bitou LM

[4] The Piesang River estuary was identified as part of the set of national priority estuaries where partial protection should be achieved, and 50% of the estuary margin that should remain undeveloped (Turpie *et al,* 2012).

			• Integrity of estuary improved and maintained		
e.	Implement conservation status (e.g. formal PA status, conservation servitude in Spatial Development Framework (SDF), Special Management Act (SMA), etc.) for the protection of various estuarine habitats	NEM: PAA, ICMA, MSA, LUPA, WC BRA	• Estuary receives formal protection status • Management authority assigned	HIGH	RMA, Bitou LM, CapeNature, GRBR
f.	Identify species and habitats of concern and generate specific management guidelines	NEM:BA, ICMA, MLRA	• Critical species identified • Species/habitat management guidelines developed	HIGH	RMA (supported by e.g. CapeNature, DST, CSIR)
g.	Incorporate Piesang EMP into GRBR Management Plan	ICMA, NEM: PAA, WC BRA	• EMP and spatial zonation included in management plan for GRBR	MEDIUM	RMA, CapeNature, GRBR
h.	Lobby GRBR to establish an estuarine division to ensure commitment to estuarine matters in the region	WC BRA	• Estuarine division established, and estuarine co-ordinator appointed	MEDIUM	RMA, GRBR, CapeNature
i.	Adopt, implement and enforce spatial zonation plan, which establishes the no-take and no-go areas (as detailed in the EMP zonation plan)	ICMA, LUPA	• EFZ controls enforced and offenders prosecuted • Reduced illegal activities • Reduced habitat loss/degradation and disturbance, and inappropriate behaviour • Improved fish and invertebrate populations	MEDIUM	RMA, Bitou LM
j.	Include the "no-go" zone in the municipal planning and zoning schemes and ensure physical demarcation	ICMA, LUPA	• Saltmarsh protection area included in planning documents • No-go area respected and protected from urban impacts • Channel markers erected	MEDIUM	Bitou LM

k.	Instate educational signage to indicate conservation	WC BRA, NEM: PAA, NEM: BA	• Signage created and erected in key public spaces	MEDIUM	GRBR, DFFE, Bitou LM
l.	Consider managing access to birding areas via bird hides, formal boardwalks etc.	NEM: BA	• Appropriate sites identified • Bird hides and board walks erected where feasible • Ongoing maintenance of structures	LOW	RMA, Plettenberg Bay Environment Forum

5.3 Land-use and Infrastructure Planning and Development

<u>Strategic Objective 3</u>: Impacts associated with developments and proposed changes in land-use, including infrastructure and agriculture, are minimised.

Table 6: Management Objectives and Actions for Land-use and Infrastructure Planning and Development

	Action	Relevant Legislation	Performance Indicator	Priority	Responsibility
Management Objective 3.1: Ensure appropriate and sustainable coastal development in and around the Piesang River estuary					
a.	Incorporate Piesang EMP into GRBR Management Plan and District/local CMPs	ICMA, NEM: PAA, WC BRA	• EMP and spatial zonation included in management plan for GRBR	HIGH	RMA, CapeNature, GRBR
b.	RMA to adopt and incorporate EMP and spatial zonation plan into all municipal and relevant government department planning documents and processes (e.g. municipal IDP, SDF, zoning scheme & overlay, Water Use Licence (WUL) Applications, Environmental Impact Assessment (EIA) Applications)	MSA, LUPA, NEMA, NWA, ICMA, WC BRA	• EMP included in all relevant planning documents • EFZ respected as a limited development area	HIGH	Bitou LM, All authorities
c.	Municipal SDF and environmental overlay updated	Municipal Systems Act (MSA)	• Updated SDF and overlays produced annually	HIGH	Bitou LM
d.	Develop and publish estuarine bylaws or regulations to support spatial zonation and permissible activities	MSA, ICMA	• Bylaws developed and gazetted	HIGH	Bitou LM

e.	Ensure that all proposed developments adhere to the full suite of relevant environmental legislation, specifically implementation of the coastal management line, coastal protection zone, and associated development controls	NEMA, LUPA, NWA ICMA, etc	• All developments comply with environmental legislation and environmental best practice / risk aversion approach • No new development, further infilling or transformation of the EFZ and natural habitat • Transgressors prosecuted • Corrective action undertaken • Reduced risk of degradation, transformation and disturbance to the estuary	HIGH	DEA&DP, Bitou LM
f.	Implemented recommended degree of undeveloped margin (as per National Biodiversity Act (NBA))	ICMA, NEM:BA	• No further permanent development, expansions, infilling or transformation of EFZ and remaining natural habitat • Undeveloped margins preserved • Impacts on the estuary are mitigated/prevented	HIGH	Bitou LM, DEA&DP
g.	Use EAF as source of I&APs for EIAs	MSA, LUPA, ICMA, NEMA	• EAF partakes in development planning affecting the estuary • Impacts on the estuary are mitigated/prevented	MEDIUM	RMA, Bitou LM, Garden Route DM, DEA&DP

5.4 Institutional and Management Structures

<u>Strategic Objective 4</u>: The Piesang River estuary is well managed through effective co-operative governance.

Table 7: Management Objectives and Actions for Institutional and Management Structures

	Action	Relevant Legislation	Performance Indicator	Priority	Responsibility
Management Objective 4.1: Ensure effective co-ordination of estuarine management responsibilities					
a.	RMA to adopt and facilitate implementation of the EMP by incorporating the EMP and the spatial zonation plan into planning documents	MSA, LUPA, NEMA, ICMA	• EMP and zonation plan adopted by RMA • EMP included in all relevant planning documents • Spatial zonation included in SDF	HIGH	RMA
b.	Undertake needs analysis and identify skills for estuarine management	ICMA, WC BRA	• Needs and skills identified • Motivation for acquisition drafted and approved • Equipment purchased and maintained	HIGH	RMA, GRBR
c.	Implement skills development, ongoing training or co-opt additional members / secondment for estuarine management to ensure capacity	ICMA, WC BRA	• Motivation for training drafted and approved • Staff attend relevant accredited training courses • MOU to be developed for secondments	HIGH	RMA, GRBR
d.	Request/set up mentoring of the RMA for additional support	ICMA	• Meetings convened and minuted • Mentorship agreement signed • Ad hoc staff assigned		RMA, DEA&DP, DFFE
e.	Develop good communication protocols and processes with implementing agents (The RMA to develop working relationships with mandated department & agreements	ICMA	• Project champions identified • Networks established, and contacts database compiled • Regular email correspondence	HIGH	RMA

	need to be developed to address each management action)		• Regular meetings • Meetings minuted		
f.	Ensure that EMP is maintained, enforced and activities budgeted for annually	ICMA, MSA, LUPA, NWA, WC BRA	• An action plan for securing future funding drafted and approved • Additional funding and support sourced • Funding secured for 5-year cycle	HIGH	All authorities
g.	Constitute and maintain a fully functional, regional EAF (or utilise other applicable forum) to facilitate co-operative governance	ICMA, MSA, LUPA, NWA	• EAF constituted (Membership includes representatives of government and stakeholders/civil society) • Regional EAF meets on a quarterly basis • Meetings are minuted	HIGH	RMA
h.	EMC present on critical forums to ensure that estuarine issues are tabled, e.g. Catchment Management Agencies (CMA), Water Users Association (WUA), Agriculture groups, Municipal Coastal Committee and Provincial Coastal Committee (where relevant) etc.	ICMA	• EMC attendance at critical forum meetings • Meetings are minuted	HIGH	DEA&DP
i.	Monitor, review and report on the progress of EMP actions and achievements on annual basis	ICMA	• Feedback received from participating agencies • Annual reporting to DFFE, DEA&DP, MCC and EAF by EMC • Action plans updated as and when required	MEDIUM	RMA, DEA&DP
j.	Undertake formal 5-year review as prescribed by the NEMP, with involvement of EAF	ICMA	• Motivation for updated drafted and approved • Funding confirmed • Terms of reference drafted • Consultants appointed • Plan updated	LOW	RMA

k.	Provincial or National authority to intervene and assume management responsibilities if RMA incapacitated and ineffectual	ICMA	• Needs and shortages identified • Motivation for hand over • Meeting with EAF • MOU signed	When required	DEA&DP, DFFE
Management Objective 4.2: Define co-operative governance arrangements					
a.	Identify and implement procedures to ensure cooperative governance between all gov. depts. with a mandate to act	ICMA, Inter-governmental relations Act (Act 13 of 2005)	• Roles and responsibilities defined and accepted via implementation protocols between RMA and implementing entity/agent • Regional EAF meets on a quarterly basis • Meetings are minuted • Active collaboration of various implementing agents	HIGH	All authorities
b.	EAF to monitor performance of RMA in reference to implementation of EMP	ICMA	• Authorities to provide formal feedback on mandated activities • Regional EAF meets on a quarterly basis	MEDIUM	All authorities, All stake-holders
c.	Individual agencies to identify and address training needs, with possible secondment to address training and capacity shortfalls	ICMA	• Motivation for training drafted and approved • Staff attend relevant accredited training courses • MOU to be developed for secondments	MEDIUM	All authorities
d.	Individual agencies to allocate resources, create and fill posts (including project champions), and acquire necessary infrastructure, resources and equipment of fulfil their mandates	MSA, NWA, ICMA, NEMA, WC BRA	• Need and Desirability investigation undertaken • Motivation for acquisition drafted and approved • Equipment purchased and maintained • Project champion(s) for allocated management actions • Staff appraisals in terms of management actions and projects	MEDIUM	All authorities

			(performance management system implemented)		
e.	Mandated authorities and participating agencies to confirm budget allocations for mandated activities/actions	MSA, NWA, ICMA, NEMA, WC BRA	• Formal feedback from authorities on mandated activities • Motivation for budget drafted and approved • Funding secured for 5-year cycle	MEDIUM	All authorities

5.5 Socio-economic Considerations

Strategic Objective 5: Socio-economic benefits are enhanced and regulated to ensure sustainable use of the Piesang River estuary and its resources.

Table 8: Management Objectives and Actions for Socio-economic Considerations

	Action	Relevant Legislation	Performance Indicator	Priority	Responsibility
Management Objective 5.1: Regulate recreational use of the estuary					
a.	Undertake annual assessment of recreational activities and determine whether any additiional zonation or controls are required to manage new/conflictual recreational activities	ICMA, WC BRA	• Assessment undertaken and zonation/controls amended if required • Reduced habitat loss/degradation and disturbance, and inappropriate behaviour	LOW	RMA, GRBR, CapeNature
b.	Informative signage, indicating zonation and allowable activities, to be placed at strategic points	ICMA, WC BRA	• Signage created and erected in key public spaces	LOW	RMA, GRBR
c.	Determine and implement carrying capacities for each water-based activity in consultation with relevant organs of state	Recreational Water Use Manual (DWA, RW GP2.2) MLRA,	• Carrying capacities established and implemented • Revised boating bylaws • Notification gazetted	MEDIUM	RMA
d.	Develop clear regulations/ management guidelines to manage each use, and monitor users and impacts	ICMA	• Regulations/guidelines developed and gazetted • Carrying capacity and regulations enforced • Counts of users recorded • Impacts recorded • Annual report submitted to EAF	MEDIUM	RMA

e.	Develop and implement an effective communication strategy for users	ICMA, MLRA	• Strategy developed • Effective network established • Cell phone link set up • Peaks season patrols undertaken • Investigative surveys/ questionnaires undertaken	MEDIUM	RMA, Plettenberg Bay Environment Forum
f.	Develop and maintain appropriate infrastructure (ablutions, parking, bird hides, walking paths, decks)	ICMA	• Need and desirability assessment undertaken • Key points identified • Appropriate infrastructure installed/ constructed	LOW	Bitou LM, land owners
Management Objective 5.2: Improve local livelihoods by promoting involvement of historically disadvantaged communities and individuals in the provision of tourism & recreation services					
a.	Investigate livelihood opportunities for previously disadvantaged communities	ICMA, MLRA	• Livelihood study completed • Opportunities identified, and feasibility determined • Viable options implemented – projects initiated • Initiatives compliant with all forms of legislation and planning frameworks	LOW	RMA
b.	Implement Environmental Protection and Infrastructure Programmes (EPIP) such as DFFE: WfW and DFFE: WftC	ICMA,	• EPIP programmes adopted and implemented • Signed agreements • Increased employment opportunities	MEDIUM	RMA/ SANParks

5.6 Education & Awareness

<u>Strategic Objective 6</u>: Members of society are sensitive to, and aware of, the value and importance of the Piesang River estuary.

Table 9: Management Objectives and Actions for Education & Awareness

	Action	Relevant Legislation	Performance Indicator	Priority	Responsibility
Management Objective 6.1: Promote high levels of public awareness and appreciation of the value of estuaries					
a.	Develop and effective education and awareness programme for residents, visitors and farmers in the catchment	ICMA, WC BRA	• Education & awareness programme developed and implemented at schools and through interest groups • Increased educational opportunities at group gatherings, community meetings, conferences etc.	MEDIUM	RMA, GRBR
b.	Source and/or commission educational and informative material including signage, posters, pamphlets and webpage design	ICMA	• Signage created, and erected Posters and pamphlets erected/ disseminated • Bitou estuaries webpage operational	MEDIUM	RMA, Bitou LM
c.	Engage and educate all estuary users	ICMA	• Reduction in illegal activities • Reduced habitat loss/degradation and disturbance, and inappropriate behaviour • Informative surveys/talks undertaken	LOW	RMA, Plettenberg Bay Environment Forum

5.7 Disaster Risk Management

<u>Strategic Objective 7</u>: Potential risks that could impact the Piesang River estuary are reduced (inclusive of climate change impacts).

Table 10: Management Objectives Actions for Disaster Risk Management

	Action	Relevant Legislation	Performance Indicator	Priority	Responsibility
Management Objective 7.1.1: Disaster prevention and preparedness					
a.	Conduct and maintain a risk assessment portfolio and identify areas and infrastructure of potential concern (catchment/marine pollution, flooding, erosion, etc.)	Disaster Management Act (DMA) (Act 57 of 2002), WMA (Act 59 of 2008) NEMA, ICMA, NWA	• Risk assessment portfolio compiled • specific sources of pollution (in addition to agricultural run-off) identified • High risk areas identified and included in relevant plans	MEDIUM	RMA, Bitou LM
b.	Develop an integrated disaster management plan (flooding, marine storm surge), including estuary early warning and monitoring system, and evacuation protocols, etc.		• Integrated disaster management plan developed • Estuary risks and early warning system compiled • Emergency response networks established	MEDIUM	RMA, Bitou LM, Garden Route DM, WC Dept of Local Gov: Disaster Management
Management Objective 7.1.2: Mitigate areas of high risk					
a.	Identify, estimate costs, prioritise and rehabilitate areas of bank erosion, trampling, disturbed riparian vegetation (priority areas and hot spots).	ICMA, NEMA, NWA	• Degradation profiles compiled • Rehabilitation programme developed & implemented • Re-establishment of indigenous vegetation • Priority degraded areas restored • Increase in area of natural estuarine habitat & vegetation	MEDIUM	Bitou LM

b.	Install informative and educational signage informing public of rehabilitation process	ICMA, NEMA, NWA	• Signage erected • Public compliance - Reduced disturbance, and inappropriate behaviour • Successful rehabilitation	LOW	RMA
c.	Identify areas and infrastructure at risk of flooding and erosion, and develop contingency plans	DMA, MSA	• High risk areas identified • No further development in high risk areas (below the 1:100-year floodline) • Risk areas included in regional disaster management plan • Relevant plans updated with early warning and monitoring systems and evacuation protocols, and contingency plans for high erosion and flood risk areas	HIGH	RMA, Bitou LM
d.	Install and maintain appropriate defence for critical infrastructure against flooding and erosion	ICMA, NEMA,	• Appropriate defence methods identified • Infrastructure protected	HIGH	Bitou LM
e.	Investigate and develop a plan of systematic retreat for risk-prone infrastructure and development in the EFZ	ICMA	• Meetings of relevant stakeholders • Strategies developed • Retreat strategies initiated • Withdrawal of development from EFZ and high-risk areas	HIGH	RMA, Bitou LM, DEA&DP, WC Dept of Local Gov: Disaster Management

6 PROPOSED SPATIAL ZONATION

6.1 Introduction

Spatial zonation of activities on an estuary is necessary to avoid user conflict and to guide sustainable utilization without degradation of the estuarine environment. The spatial zonation plan provides a means of geographically transposing the aims of the management objectives, where applicable, and is typically informed by the following (DEA, 2015):

- The geographical boundary of the estuary also indicating important habitats (e.g. floodplain, open water, reed beds, sandflats, etc.);
- The surrounding land uses and existing infrastructure;
- Areas designated for the conservation and protection of biodiversity;
- Appropriate buffers in which land use and development are strictly controlled and monitored; and
- Zones where certain types of activities (recreational, commercial, industrial, harvesting etc.) are permissible and others not permissible.

6.2 Habitat zones

A habitat sensitivity analysis is the baseline which guides the differentiation of the various zones, specifically identifying:

- threatened, ecologically important habitats as no-go or minimal disturbance zones;
- those areas which can support controlled, sustainable exploitation of marine living resources; and
- those where various forms and levels of appropriate water-based recreation are acceptable.

The habitat map shown in Figure 6 is used as the baseline for the identification of sensitive estuarine habitats.

Given that approximately 75% of the EFZ is developed (with additional open areas considered disturbed) (Van Niekerk et al., 2015), all remaining natural vegetation should be protected from any further transformation or degradation, specifically the salt marsh habitat near the mouth (which is the only area of saltmarsh in the system) and the indigenous forest of the Klein Piesang River. Protection of the former, will also protect a portion of the shallow water sandbank habitat that supports bait organisms (i.e. sandprawns).

Areas of existing riparian vegetation (including degraded/disturbed areas), including *Phragmites* reed beds, must also be preserved as they provide valuable habitat but also a level of protection against erosion related to flooding.

The open channel provides an opportunity for boat-based recreation (i.e. kayaking/ canoeing), however, motorised boating must be strictly prohibited to prevent wake erosion, and disturbance to bottom and marginal habitats.

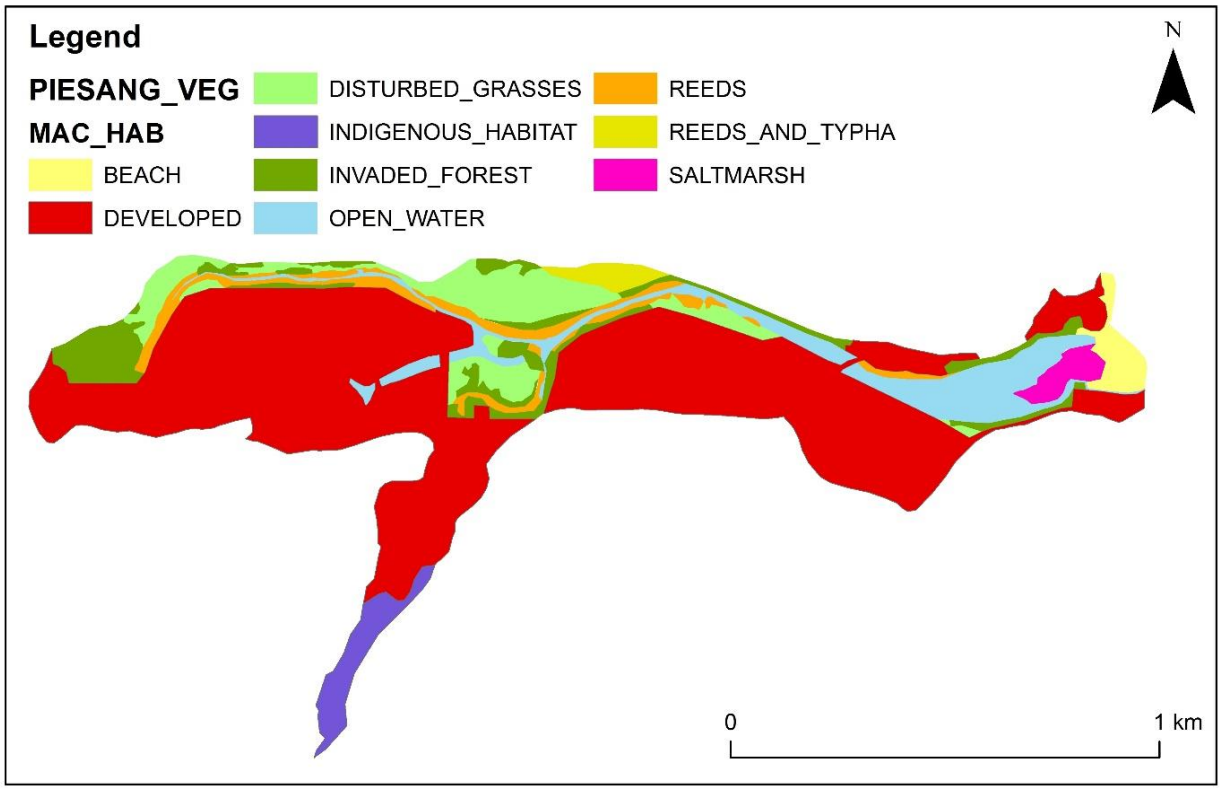

Figure 6: Habitats identified in the Piesang River estuary

6.3 Legislated Coastal Boundaries and Buffer Zones

6.3.1 Estuarine Functional Zone

The ICMA defines an estuary as "*a body of surface water -*

a) that is permanently or periodically open to the sea;
b) in which a rise and fall of the water level as a result of the tides is measurable at spring tides when the body of surface water is open to the sea; or
c) in respect of which the salinity is higher than fresh water as a result of the influence of the sea, and where there is a salinity gradient between the tidal reach and the mouth of the body of surface water".

Similarly, the National Water Act (NWA) defines an estuary as "*a partially or fully enclosed water body that is open to the sea permanently or periodically, and within which the seawater can be diluted, to an extent that is measurable, with freshwater drained from land*".

However, the 2018 National Biodiversity Assessment provides a more detailed definition of an estuary, that is: "a partially enclosed permanent water body, either continuously or periodically open to the sea on decadal time scales, extending as far as the upper

limit of tidal action, salinity penetration or back-flooding under closed mouth conditions. During floods an estuary can become a river mouth with no seawater entering the formerly estuarine area or, when there is little or no fluvial input, an estuary can be isolated from the sea by a sandbar and become fresh or even hypersaline" (SANBI 2019).

The EFZ is defined by the 2014 Environmental Impact Assessment (EIA) Regulations (as amended in 2017) (GN 324) as "*the area in and around an estuary which includes the open water area, estuarine habitat (such as sand and mudflats, rock and plant communities) and the surrounding floodplain area, as defined by the 5 m topographical contour (referenced from the indicative mean sea level)*". The NEMP acknowledges the EFZ as the geographical boundary of estuaries in South Africa. In practice, it is found that the 5 m topographic contour approximates the EFZ for most estuaries in South Africa. It is consequently commonly used to delineate the EFZ in the absence of specific biophysical assessments. Where biophysical information is available, the EFZ can be delineated according to the presence of estuarine vegetation or features such as wetlands that are directly supportive of the estuary. This approach informed the EFZ used in the 2018 NBA (SANBI, 2019) (refer to Figure 3).

6.3.2 Coastal Protection Zone and proposed Coastal Management Line

The Integrated Coastal Management (ICM) Act defines a default **Coastal Protection Zone (CPZ)** which, in essence, consists of a continuous strip of land, starting from the High Water Mark (HWM) and extending 100 m inland in developed urban areas zoned as residential, commercial, or public open space, or 1 000 m inland in areas that remain undeveloped or that are commonly referred to as rural areas. It also includes certain sensitive or at-risk land such as estuaries, littoral active zones and protected areas.

The Provincial Member of the Executive Council (MEC), in consultation with the Local Municipalities, is required to refine and formally adopt the CPZ. A process is currently underway to formally establish a CPZ for the Western Cape Coastline. In accordance with provisional delineation of the CPZ for estuaries in the Garden Route DM, as per draft delineations recommended in the Coastal Set-back / Management Lines for the Eden District project (WCG, 2015), the CPZ is informed by a coastal risks zone approximated by the **10 m Above Mean Sea Level (amsl) contour or 1:100-year floodline** around an estuary, whichever is wider.

The ICMA also provides for the establishment of a **Coastal Management Line (CML)**, designed to limit development in ecologically sensitive or vulnerable areas, or an area where dynamic natural processes pose a hazard or risk to humans. A CML, as envisaged by the amended ICM Act, is informed by the projections of risk emanating from dynamic coastal processes such as sea level rise or erosion, information on ecological or other sensitivities adjacent to the coast, as well as the location and extent of existing development and existing executable development rights. The CML is a continuous line, seawards of which lies:

- Areas of biophysical or social sensitivities such as sensitive coastal vegetation identified as priority conservation areas and formal protected areas,

- those areas that should be left undeveloped, or only be granted appropriately restricted development rights, due to a high risk from dynamic coastal processes, or
- coastal public property.

In estuaries, the CML is delineated by the 5 m amsl contour or 1:100-year floodline, whichever is wider, to differentiate a zone where formal development should be discouraged. The coastal boundaries for the Piesang River estuary are illustrated in Figure 7.

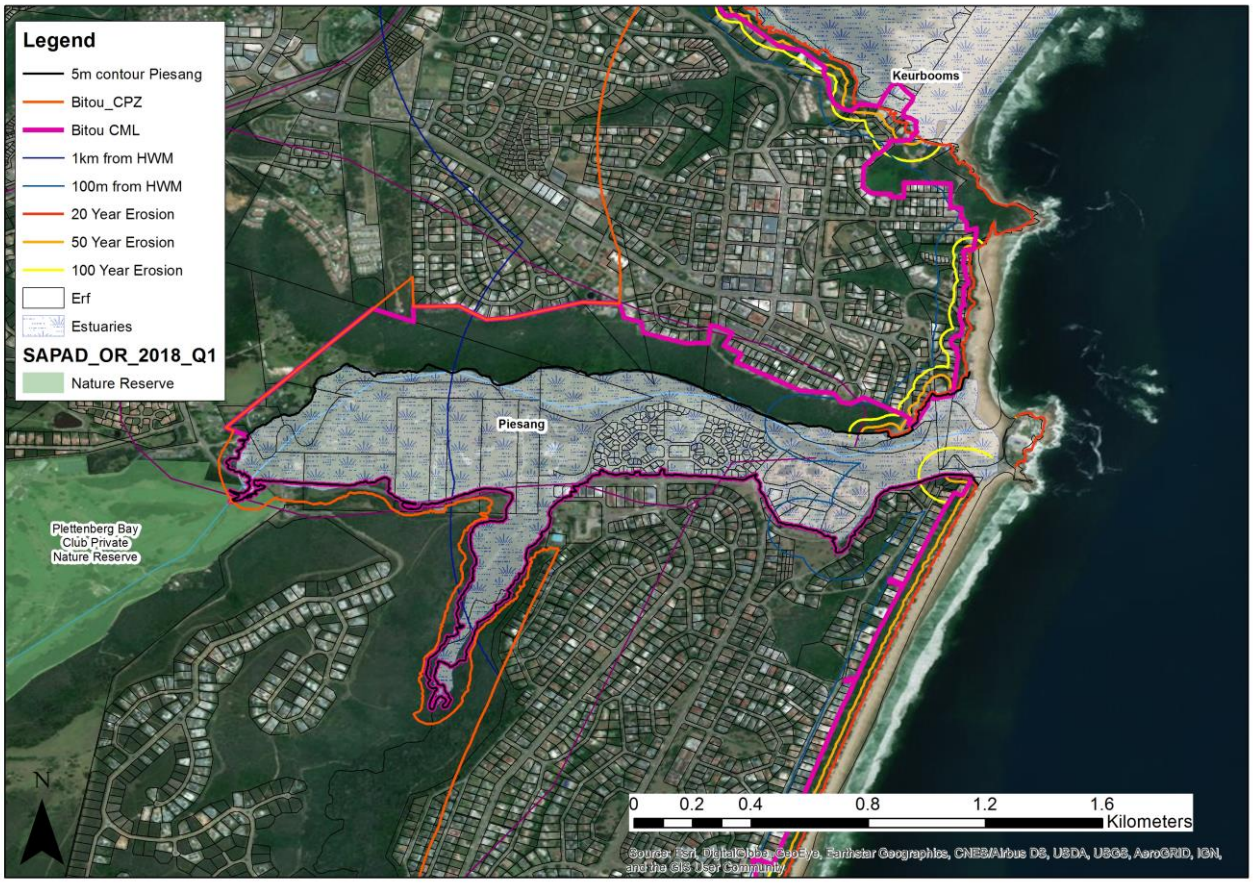

Figure 7: Coastal boundaries of the Piesang River estuary and risk projections (WCG, 2015)

6.3.3 Environmental Impact Assessment regulatory line

In respect of the EIA regulatory scheme, an additional line called the Development Set-Back Line (DSL) needs to be differentiated as it relates to the 'development set-back' referred to in the EIA regulations[5] rather than the coastal management lines described in the ICM Act. However, as part of the on-going process of defining coastal

[5] The Environmental Impact Assessment Regulations, 2014 (as amended in 2017), published under Government Notice No. 326 in Gazette No. 40772 of 4 April 2017, in terms of sections 24(5) and 44 of the National Environmental Management Act, 1998 (Act No. 107 of 1998)

management lines for the Western Cape, it is currently **proposed that the CML, as defined under ICMA, also be used as the DSL**.

Reference to development set-backs is found in the EIA Listing Notices that list a range of activities that require different levels of environmental impact assessment and the issuing of an environmental authorisation prior to being undertaken.

Typically, an activity would be listed in the form of a range of thresholds which, if exceeded, trigger the need for an environmental impact assessment in the form of a Basic Assessment or an EIA. In some cases, however, a development set-back line is used as spatial reference to include or exclude activities. The EIA regulations indicate that: "*development setback" means a setback line defined or adopted by the competent authority*". This implies that if such a setback is defined, the setback delineation replaces the default parameters for an activity, as read within the context of that activity. The competent authority in the Western Cape is DEA&DP or the National DFFE.

The EIA regulations also refer to whether a development is in front or behind the line – for a coastal development set-back this equates to any development seaward of the line being 'in front of', whilst landward of the line being 'behind'.

An important further point to note is that the development set-backs are usually linked to the presence of urban built-up areas. The regulations indicate that ""*urban areas" means areas situated within the urban edge (as defined or adopted by the competent authority), or in instances where no urban edge or boundary has been defined or adopted, it refers to areas situated within the edge of built-up areas*". These exclusion areas create *de facto* islands in the area below the DSL, within which the specifically excluded EIA triggers don't apply.

The Western Cape Government, as designated competent authority, considers the area below/seaward of existing development as falling outside of the 'built-up area'. Therefore, any exclusions based on a listed activity taking place within the built-up area would not apply to this strip of coastal land, and the prescriptions for environmental assessments related to the particular activity will apply. For example, the beach in front of seafront houses is not considered 'built-up' and environmental authorisations will be required to execute any listed activities on that beach.

6.4 Zonation of Activities

6.4.1 Current zonations and uses

Figure 8 and Table 11 indicate the surrounding land use types as per the interim[6] Bitou Municipal Town Planning Scheme (TPS) and activities occurring in and/or adjacent to the Piesang River estuary.

[6] The Bitou LM Town Planning Department is currently revising and updating the Bitou Town Planning Scheme. The interim zonation provided is therefore subject to change in the near future. Zone colours are adapted from the Cape Farm Mapper to match the TPS colours as close as practically possible

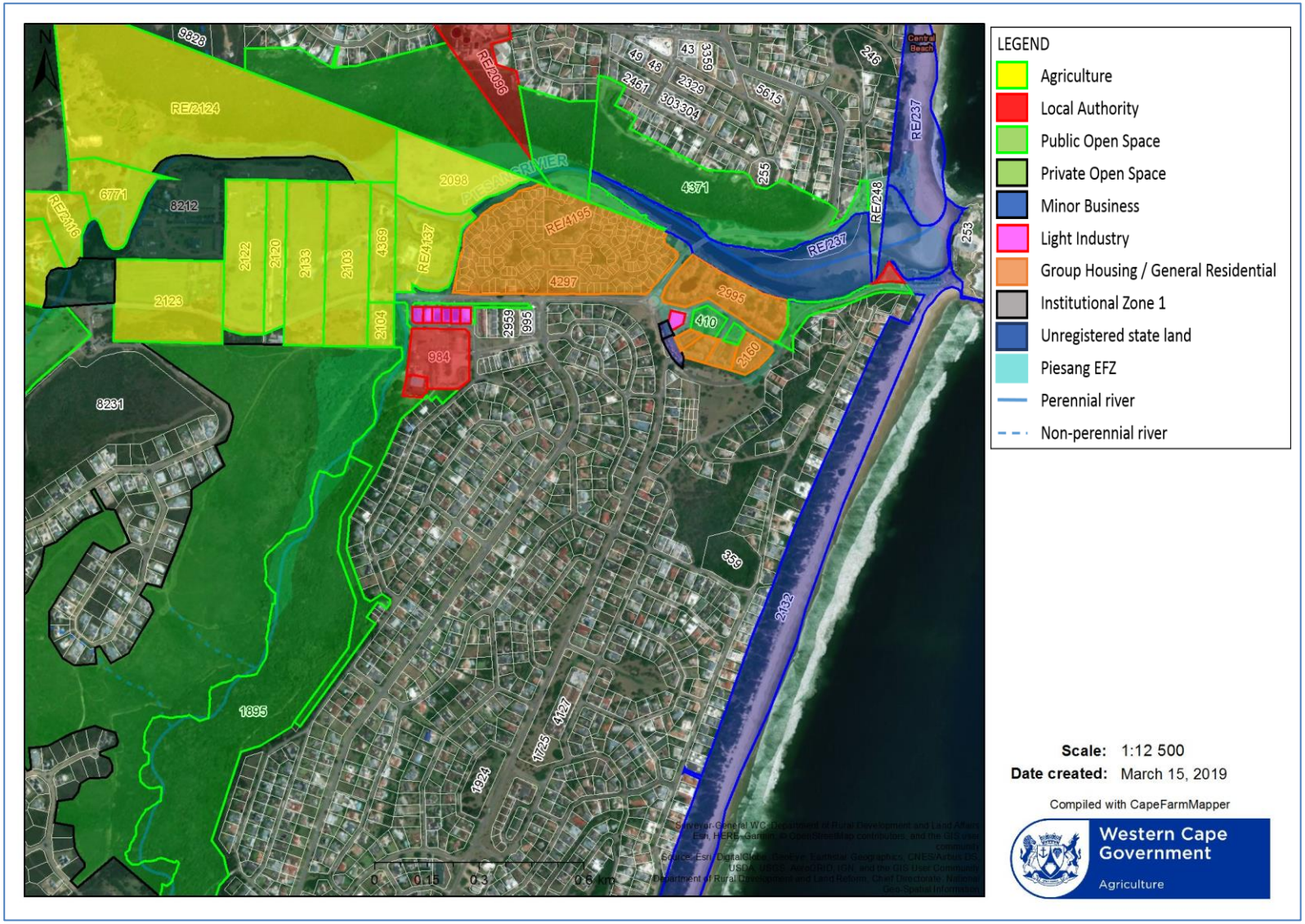

Figure 8: Interim Bitou Municipal Town Planning Scheme: zonation of land intercepting the Piesang estuarine functional zone (WC DoA, 2018 compiled using data provided by the Bitou LA)

Table 11: Current zonations and activities occurring in and/or adjacent to the Piesang River estuary *

LAND USE	DESCRIPTION*
Agriculture Zones	Zoned for Agricultural uses. Consent uses: Additional dwelling units, farm store, farmstalls, intensive-feed farming, riding school, nursery, service trade, tourist facility. Tourist facilities, farm store. Specific land use restrictions and additional provisions apply.
Local Authority	Authority/Government/Municipal uses. Potential uses: buildings/office space, water treatment facilities, desalination plant, electrical substations etc. Specific land use restrictions and additional provisions apply as per type of building.
Open Space Zone I and III	Land earmarked for public use and conservation usage (e.g. nature reserve). Consent uses: none. Additional provisions apply - all structures must be compatible with this land use type.
Open Space Zone II: Private	Any land set aside as a private site for sports, play, rest or recreational facilities or garden and includes public land which is or will be leased on a long-term basis. Consent uses: none. Additional provisions apply - all structures must be compatible with this land use type.
Business Zones I and II	Zoned for Minor Business, namely business premises, shops, offices. Consent use include: town house, flats, residential building, place of assembly, place of entertainment, place of instruction, institution, bottle-store, supermarket, service trade, restaurant. Specific land use restrictions and additional provisions apply.
Industrial Zone I	Zone for Light Industry. Consent uses: warehouse, public garage, transport usage, scrap yard. Specific land use restrictions and additional provisions apply.
Residential Zones	Zoned for a dwelling house/town house. Consent uses: additional dwelling units / dwelling house, group house, retirement village. Specific land use restrictions and additional provisions apply.
Residential Zone II	Zoned for Group Housing: a group of separate and/or linked dwelling units designed as a harmonious architectural entity. Consent uses: dwelling house, retirement village. Specific land use restrictions and additional provisions apply.
Institutional Zone I	Zone for Place of Instruction (Education). Consent uses: Place of assembly. Specific land use restrictions apply.
Transport	Zonation includes roads, public parking areas and other transport usage. Consent uses: none.
Unregistered state land	Land surveyed but not registered at the Deeds office. (could have any use but in this instance considering its location in the 5 m contour, any potential future development will be limited/low impact). Consent uses: none.

ACTIVITIES	DESCRIPTION
Fishing	Throughout the system.
Bait harvesting	Heavy utilisation of prawn banks, mostly during summer peak holiday season.
Boating (non-motorised)	Only non-motorised boating is permitted (kayaking/ canoeing).
Swimming & beach-based recreation	The sand bar of the estuary forms part of the Plettenberg Bay main beach. The sand bar also provides access from the Beacon Island resort to the beach and carpark.

*Zone descriptions adapted from Land Use Planning Ordinance 1985: Section 8 Zoning Scheme Regulations according to the interim Bitou Town Planning Scheme

6.4.1.1 Development planning provisions

According to the Bitou LM SDF (CNdV, 2017), emphasis is placed on growing the tourism market, specifically capitalising on the economic growth potential of Plettenberg Bay and promoting it as a tourism destination. Plettenberg Bay has been identified as a Specialised Centre (exclusive holiday resort focusing on tourism and recreation) and development and densification of the current urban settlements is the main development objective for the Piesang Estuary area (CNdV, 2017).

A parcel of undeveloped land within the Piesang EFZ has been flagged for GAP housing development (CNdV, 2017) (Figure 9). This would mean irreversible transformation of nearly the entire EFZ and a concomitant decline in estuarine health and function. Evidently, there is conflict between municipal development planning and the conservation requirements for the estuary described below.

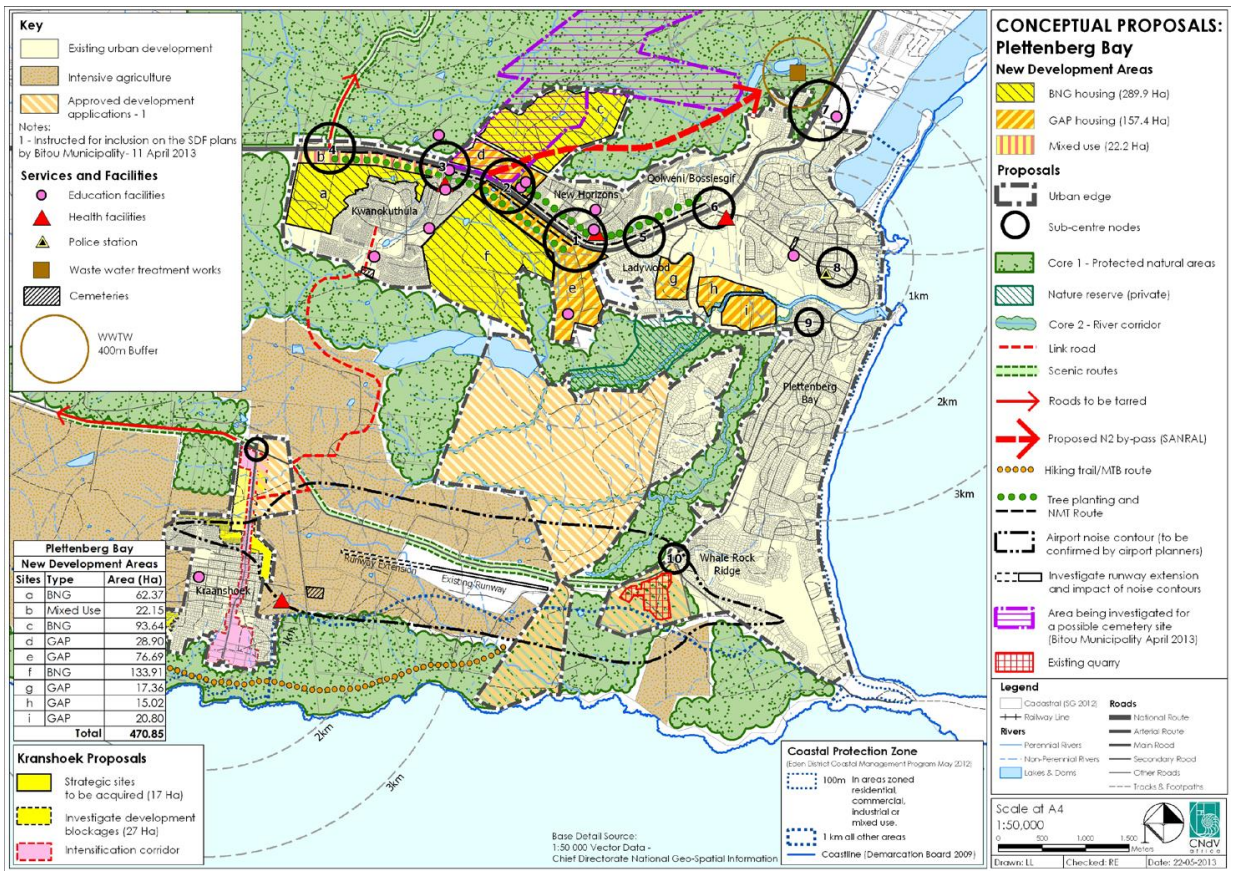

Figure 9: Extract from Bitou LM SDF: conceptual proposals (source: CNdV, 2017)

6.4.2 Proposed spatial zonation

As priority estuary in terms of the National Estuary Biodiversity Plan (Turpie et al., 2012), the Piesang River estuary is to be considered a partial no-take system (i.e. a portion of the estuary is to be set aside as a no-take in terms of marine living resources) and 50% of the margin is to remain undeveloped (or behind an appropriate development setback line). Currently nearly 75% of the EFZ is developed with future development opportunities identified, thus significant rehabilitation and conservation is required to reach this target.

Conservation of the natural environment is critical for the Bitou area, as it is one of the major attractions from a tourism perspective (CNdV, 2017). Numerous studies and assessments have indicated the status of the Piesang River estuary and its river course as a critical biodiversity area requiring conservation, which attains elevated importance due to the highly urbanised surrounding environment. Biodiversity conservation is competing with urban expansion and densification, and tourism development as indicated above.

The following zonation is proposed, as illustrated in Figure 10, to preserve the integrity of the estuary whilst providing for limited eco-tourism development associated with the estuary.

6.4.2.1 *Conservation Zones*

i) Conservation Servitude

It is apparent from the municipal TPS that the Piesang River (and estuary) is not zoned as a conservation servitude, or similar equivalent, irrespective of the designated land zonation, where special consideration is given by the municipality and adjacent landowners in respect to the impacts on the riparian margin, through the development or transforming land-use practices, and maintaining the health of the water course itself.

It is therefore recommended that Piesang River and estuary be designated a Conservation Servitude / Special Zone within the TPS, such that there is no further development or habitat transformation within 32 m of the water course (as per the recommendations of the 2017 Bitou SDF – see below). Specific land use restrictions and provisions with the aim of reducing impacts, reducing disturbance to the riparian edge (e.g. formalising access paths and points, designating canoe launching/landing points), reducing pollution (e.g. mitigating contaminated stormwater discharges) and rehabilitating where necessary, should be implemented.

ii) Fish Conservation Zone (No-take):

The estuary basin, channel and riparian edge up to the Beacon Island road bridge is designated a Conservation Zone. The purpose of this zone is the provision and conservation of habitat with healthy water quality, maintained through periodic flushing of the mouth, for commercially important and estuarine-dependent fish species utilising the estuary.

This zone allows for low-impact human interaction and activities, such as walking/hiking, bird watching, non-motorised boating (canoeing/paddling) and bait harvesting (see Sanctuary Zone below).

Fishing in any or form is strictly prohibited (no-take) whether the mouth is open or closed. This area will need to be published as a no-take zone within the municipal bylaws according to the MLRA, and law enforcement will vest with DFFE.

a. Saltmarsh Sanctuary Zone (No-go, No-take)

A Sanctuary Zone is proposed within the estuary basin, specifically for the protection of the salt marsh habitat, a portion of heavily exploited sandprawn population, and shallow water fish nursery area. This zone extends from the point of the desalination plant on the southern bank to lower property boundary of the Beau Rivage estate, and to the centre of the Piesang River estuary bed.

This area should be designated a no-go area, where no access is permitted except for research (research for an affiliated research institute or university), rehabilitation purposes (clearing of litter/debris) and rescue

operations. The capture of any organisms (fishing, bait collection) except for research purposes must be prohibited.

This zonation will prevail during high and low water conditions, and channel markers must be erected.

This area will need to be proclaimed as a protected environment in terms of the NEM: PAA or a special management area in terms of the ICMA, and will need to be managed by a suitable agency (e.g. CapeNature) according to the applicable legislation.

iii) Blackwood Forest:

The Blackwood Forest and associated grasslands within the Klein Piesang River drainage line represents a noteworthy patch of indigenous vegetation, which despite invasive alien plant infestation, remains mostly intact and unimpacted by urban development. The grassland provides critical habitat for several owl species.

This area should be designated a conservation area (e.g. municipal nature reserve/conservancy) and expanded beyond the EFZ to encapsulate as much natural habitat as possible. The purpose of this zone is to preserve various indigenous vegetation types and protect naturally occurring wildlife species and their habitat.

6.4.2.2 *Development Zones*

The Development zones were demarcated taking irreversible development and habitat transformation into account.

i) Development – High Intensity

The high intensity development zone is indicative of the existing Group Housing as per the TPS.

It extends along the southern shoreline from Beacon Island upstream to the confluence with the Klein Piesang River, and on the northern shoreline incorporating the beach parking area. This zonation reflects areas of dense urban and tourism development (e.g. Beau Rivage estate and River Club Villas) and accompanying infrastructure (roads, parking areas and desalination plant). This zone generally reflects the areas of greatest transformation and negative environmental impact. No further development is recommended.

Management guidelines in these areas relate specifically to:

- Implementation of the coastal management line and related development controls/restrictions;
- Mitigating the environmental impacts of the high number of visitors (e.g. litter, fishing, etc.);

- Prevent or rehabilitate disturbed, eroded or trampled areas; and
- Re-establishing natural vegetation and utilising indigenous urban planting schemes wherever possible.

ii) Development – Low Intensity

The low intensity development zone is indicative of land zoned as agriculture and public open space as per the TPS. It includes the remaining land parcels on the northern and southern banks and part of the Klein Piesang River. This zone reflects the current nature of development but also a specific purpose, which is to regulate the type of future development and activities that may take place within these private land parcels.

The following points are extracted from the Plettenberg Bay Spatial Development Framework, relevant to the Piesang River estuary (CNdV, 2017) that must be implemented:

- The Piesang River Valley should be developed as a series of private nature reserves which are designed in such a way that sufficient security and privacy is afforded to future residents but that public and environmental benefits are maximized;
- As it is unlikely that public funding can be secured in this context this will have to be leveraged from private interests;
- However, it is essential that private development impacts as little as possible on the environmental integrity of this area;
- As much land as possible should be incorporated in conservation reserves;
- Limited residential accommodation should be considered. This would be considered outside of the Urban Edge and be built according to green principles using off grid to the low densities proposed in the Provincial Manuals on development in this context;
- The visual impact of such development should be as limited as possible;
- River corridors should be designated as Core 1 spatial planning categories with no ploughing or urban development permitted with 32 metres of the banks unless set-back lines have been determined by an aquatic ecologist; and
- Development should be focused at the nodes in order to increase the economic opportunities for the local community.

Based on the above, it is recommended that these areas be reserved for either no development or very low-density development, tailored towards agriculture, conservation and eco-tourism. All developments, existing and proposed, and associated activities should focus on reducing environmental impacts, rehabilitation and retreat from the littoral active zone.

Formal development or construction activities in either development zone is to be regulated according to the EIA Regulations and any future controls emanating from the Provincial determination of and Municipal adoption of coastal management lines.

6.4.2.3 Recreational Activities

Recreational activities including canoeing, birdwatching, swimming, and beach-based activities (picnicking, etc.) are permissible throughout the estuary. The latter two are generally concentrated closer to the Plettenberg Bay main beach. Motorised boats and the use of jetskis are currently prohibited. This is to be strictly maintained. The beaching of canoes should be permitted at designated points only (e.g. only at the mouth, or existing boardwalks/jetties) to prevent habitat disturbance and trampling. Fishing is permitted in accordance with MLRA regulations, except in the designated conservation/no-take areas. Capture of all invasive species, particularly *Oreochromis mossambicus*, is encouraged.

Zonation prescriptions are provided in Table 12 below.

6.4.3 Areas requiring rehabilitation

The low intensity development zone provides the greatest opportunity for the reversal of habitat transformation and rehabilitation. Consideration should be given to rehabilitating open and undeveloped areas of land (areas previously used for recreation or grazing) e.g. river frontage at the River Club Villas. This will require buy-in from private land owners and stewardship agreements between owners and the municipality.

The manipulation and canalisation of tributaries and wetland must be prohibited and reversed. Consideration must be given to the redesign of impounding/impeding access roads, replacing hard canalisation with soft vegetated edges, and retaining and reinstating riparian vegetation.

Although not incorporated within the EFZ, the Plettenberg Bay Country Club (golf course) should seek to reinstate riparian habitat along the river channel (with the assistance of a freshwater ecologist and rehabilitation specialist) and remove/redesign impounding structures within the river bed (e.g. weirs, drifts, foot bridges).

Table 12: Zonation prescriptions for the Piesang River estuary

ZONE/USE	CONDITIONS OF USE	RELEVANT LEGISLATION	RESPONSIBLE AUTHORITY	ENFORCEMENT
Municipal Conservation Servitude	No further development or habitat transformation within 32 m of the water course No earthworks or any form of development is permitted within the area except for rehabilitation in terms of an approved management plan No construction of additional jetties, decks/ viewing platforms or slip ways No landscaping or planting except for rehabilitation in terms of an approved management plan. No planting of alien lawn No collection or damaging of fauna, flora, soil and water resources No vehicles of any type are permitted Other applicable regulations as per the Land-Use Planning bylaw and River by-law	Municipal TPS/ LUMS Bylaws	Bitou LM	Bitou LM
Conservation: Saltmarsh Sanctuary	All access prohibited, including pedestrian and boat-based access (canoeing) Only research permitted, with an approved permit No motorised boating No construction of jetties or boardwalks No harvesting or fishing Focussed capture of Mozambique Tilapia *Oreochromis mossambicus*	ICMA, Bylaws Seashore Act MLRA MLRA, NEM:BA	Bitou LM CapeNature DFFE DFFE	CapeNature (to be confirmed)
Conservation: Blackwood Forest	Pedestrian access permitted, along formal designated paths/trails/boardwalks Consolidated access points No construction of additional jetties or slip ways No harvesting or fishing No motorised boating No clearing of indigenous vegetation Removal of invasive alien vegetation	ICMA, Bylaws Seashore Act MLRA Bylaws NEMA CARA	Bitou LM DFFE Bitou LM Bitou LM DFFE Bitou LM	Bitou LM or CapeNature
Conservation: Fish Sanctuary	Pedestrian access, along formal designated paths/boardwalks and boat-based access, permitted	ICMA, Bylaws	Bitou LM	CapeNature

	Consolidated access points and boat landing areas No construction of additional jetties or slip ways No harvesting or fishing No motorised boating Compliance with water quality guidelines for recreational use No clearing of indigenous vegetation Removal of invasive alien vegetation Focussed capture of Mozambique Tilapia *O. mossambicus*	 Seashore Act MLRA Bylaws Health Act NEMA CARA MLRA, NEM:BA	 CapeNature DFFE Bitou LM Bitou LM Bitou LM DFFE DFFE	
Development - High Intensity	Nodal development of housing and commercial facilities Implementation of the CML development controls Highly effective stormwater management system / SUDS Highly effective pollution control system No further development and/or expansion within the EFZ No further infilling of the EFZ Preferential planting with locally indigenous species Removal of invasive alien vegetation No motorised boating Compliance with water quality guidelines for recreational use No construction of additional jetties or slip ways	LUPA, ICMA ICMA LUPA LUPA NBA NEMA, CARA Bylaws Health Act Seashore Act	Bitou LM Bitou LM Bitou LM Bitou LM Bitou LM Bitou LM Bitou LM Bitou LM Bitou LM DWS CapeNature	Bitou LM / DEA&DP
Development - Low Intensity	Limited eco-tourism development - low numbers - low density - low impact Limited consolidated access roads Limited supporting light commercial development No industrial, noxious or hazardous development No WWTW development, no waste dumps or waste transfer stations Implementation of the CML development controls No large-scale commercial agriculture or livestock New developments to be set back at least 32 m, preferably 100 m, from estuary channel Mandatory SUDs Pedestrian access, along formal designated paths/boardwalks and boat-based access, permitted Consolidated access points and boat landing areas	LUPA, ICMA ICMA NEMA NEMA DWS ICMA NBA LUPA NWA LUPA Bylaws	Bitou LM Bitou LM Bitou LM Bitou LM Bitou LM DALRRD DEA&DP DWS Bitou LM Bitou LM	Bitou LM / DEA&DP

	Compliance with water quality guidelines for recreational use Network of MTB and hiking routes Preferential planting with locally indigenous species No clearing of indigenous vegetation Removal of invasive alien vegetation No construction of additional jetties or slip ways No motorised boating No modification to wetlands unless for rehabilitation purposes (must be approved)	Health Act NBA NEMA, CARA CARA Seashore Act Bylaws NWA	Bitou LM Bitou LM DFFE CapeNature DFFE DEA&DP	
Recreation Activities (general)	Pedestrian access from roads and carparks and boat-based access, permitted Consolidated access points and boat landing areas No construction of additional jetties or slip ways Fishing and harvesting permitted according to the MLRA regulations (except in designated conservation/no take areas) Focussed capture of Mozambique Tilapia *O. mossambicus* Compliance with water quality guidelines for recreational use No clearing of indigenous vegetation Removal of invasive alien vegetation	ICMA, Bylaws ICMA Seashore Act MLRA MLRA, NEM:BA Health Act NEMA CARA	Bitou LM Bitou LM CapeNature DFFE DFFE Bitou LM Bitou LM DFFE	Bitou LM / DEA&DP

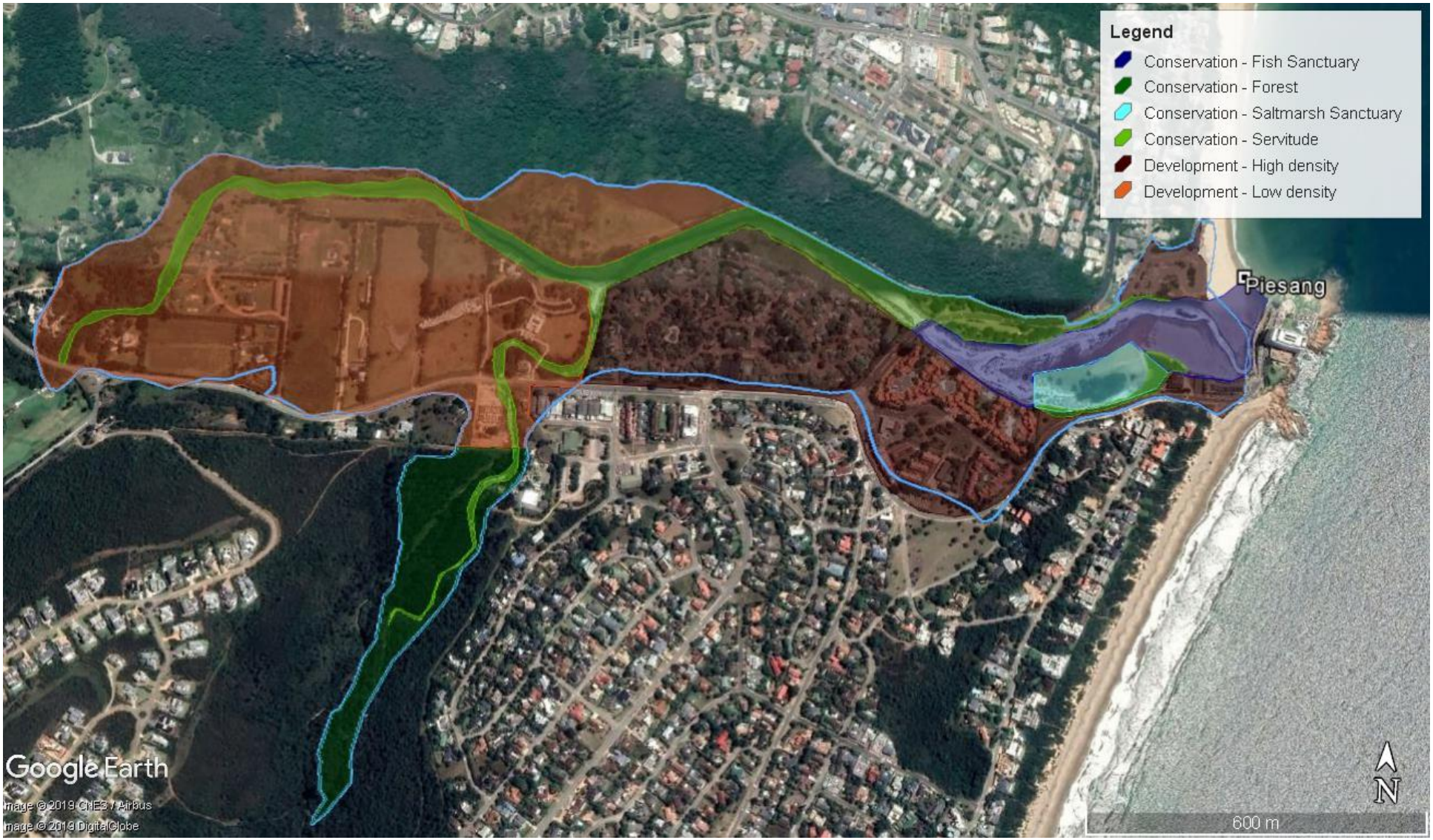

Figure 10: Proposed zonation of the Piesang River estuary

7 INTEGRATED MONITORING PLAN

According to the standards for estuarine management, management actions should be based on sound scientific evidence. Thus, monitoring is a crucial aspect of the adaptive estuarine management planning process as the generated data will be used to inform and update management decisions. However, the collection, processing and interpretation of such data, particularly ecological data, are generally costly and time-consuming and often require considerable scientific expertise.

In the context of estuarine management, there are three broad categories of monitoring which should be incorporated into an integrated monitoring plan, namely resource monitoring, compliance monitoring and performance monitoring (DEA, 2015). These components are discussed in the following sections.

7.1 Resource Monitoring

7.1.1 Current Resource Monitoring

- DWS flow recorder: The DWS has a permanent water flow recorder (K6H003) in the Piesang River below the Roodefontein Dam, approximately 2.4 km above the estuary, which monitors water flow continuously. It is of the utmost importance that this monitoring continues.
- Water quality: A basic water quality monitoring programme funded by the Breede-Gouritz Catchment Management Agency is currently in place for the Piesang River. The sampling point is located at the head of the estuary at the Piesang Valley Road bridge and samples are collected bi-monthly. Variables measured include pH, suspended solids, electrical conductivity, chemical oxygen demand, ammonia, PO_4, *E. coli* and faecal coliforms. It is imperative that this monitoring programme is maintained and the data stored and utilised to inform the future management of the Piesang River estuary.
- Municipal water quality testing: Bitou Municipality take water samples on a monthly basis at specific points within the system (It was reported that this was initiated in response to polluted water emanating from the municipal dump site in the Klein Piesang catchment entering the estuary through this stream, becoming a hazard to swimmers and other users (e.g. canoers) (H. Nieuwoudt, *pers. comm.*, 2018)[7]). As with the above monitoring, is imperative that this monitoring programme is maintained and the data stored and utilised to inform the future management of the Piesang River estuary.

There are limited ecological monitoring programmes for specific species e.g. Owls within the Klein Piesang River catchment by CapeNature[8]

[7] Mr H. Nieuwoudt, Conservation Manager, Keurbooms River Nature Reserve, 20/08/2018

[8] Minutes of the stakeholder meeting for the Piesang River estuary, 15 November 2017, at Piesang River Community Hall, Plettenberg Bay

7.1.2 Recommended Resource Monitoring Programmes

The recommended baseline monitoring requirements to improve the confidence of the preliminary reserve determination as developed through Gouritz Water Classification Study (DWS, 2015), are provided Table 14 in Appendix 1. The recommended long-term monitoring requirements to ascertain impacts of changes in freshwater flow, and current and future impacts on the estuary and/or any improvement or reductions therein are listed in Table 15. The purpose of recommended long-term monitoring programme is also to test for compliance with Ecological Specifications (Ecospecs) and Thresholds of potential concern (TPCs) and to continuously improve understanding of ecosystem function.

7.1.3 Resource Quality Objectives / Ecological Specifications

Resource Quality Objectives (RQOs) or Ecological Specifications (EcoSpecs) are clear and measurable specifications of ecological attributes (in the case of estuaries - hydrodynamics, sediment dynamics, water quality and different biotic components) that define a specific ecological category, in the case of the Piesang River estuary, a Category B/C (DWS, 2015). However, it is noted that the 2018 NBA (SANBI, 2019) suggests a Category D.

Thresholds of potential concern (TPCs) are defined as measurable end points related to specific abiotic or biotic indicators that if reached (or when modelling predicts that such points will be reached) prompts management action. In essence, TPCs should provide early warning signals of potential non-compliance to ecological specification (i.e. not the point of 'no return'). The EcoSpecs, and the TPCs, representative of a Category B/C for the Piesang River estuary, are presented in Table 16 (Appendix 2) (DWS, 2015).

7.2 Compliance Monitoring

Compliance monitoring refers to the monitoring of the type and intensity of uses/activities and developments within an estuary/EFZ. Such monitoring is usually prescribed in relevant legislation, regulations, policies, standards, guidelines and or permits and license agreements (DEA, 2015). The purpose of this form of monitoring is to test whether activities are compliant with the established limits and objectives as well as to detect growing pressures on resources.

7.2.1 Current Compliance Monitoring

There is little to no compliance and enforcement monitoring occurring in the Piesang River estuary in terms of the use of marine living resources, due to the lack of the capacity within the DFFE and with CapeNature's mandate being on protected areas[9].

[9] Minutes of the stakeholder meeting for the Piesang River estuary, 15 November 2017, at Piesang River Community Hall, Plettenberg Bay

7.2.2 Recommended Compliance Monitoring

In respect to the implementation of this EMP, compliance monitoring is the responsibility of the DFFE (or devolved to CapeNature) in terms of the MLRA in order to establish the estuarine basin as a no-take/closed fishing zone. This will be undertaken according to legislation and policies applicable and by means of law enforcement and compliance monitoring protocols.

It is recommended that a scheduled compliance/law enforcement programme be developed, beginning with frequent patrols to ascertain degree and timing of estuary use (e.g. holiday periods), and then modified based on the findings (Table 13). For example, patrols should be conducted daily during peak holiday seasons and weekly (during weekends) during off-peak periods.

Table 13: Recommended compliance monitoring requirements

INDICATOR	FREQUENCY	TARGET/LIMIT	LEGISLATION	RESPONSIBILITY
USE/ ACTIVITY: FISHING AND BAIT HARVESTING				
• Number of fishers • Number of harvesters • Species targeted • Confiscated catch volume • Gear utilised • Number of offences/ transgressions	Monthly, increased to weekly during peak season	Target species and limits as per MLRA regulations	MLRA	DFFE / CapeNature

7.3 Performance Monitoring (Review & Evaluation)

A performance monitoring plan is used by the RMA, and/or identified implementing agents, to assess the effectiveness with which planned management activities contained in the EMP are being performed and ultimately to gauge progress in achieving the vision and objectives. This component utilises the performance indicators included for the various actions, specifically the management priorities, and includes a temporal scale or the frequency of the collection of the performance data and the targets that should be achieved.

Ultimately the EMP must be holistically reviewed every 5 years from the date it was adopted, ideally in line with the review cycles of the applicable IDP, SDF and/or CMP. This review is the responsibility of the RMA. According to the NEMP, this review should include an assessment of:

- The effectiveness of the EMP and success with meeting the objectives (i.e. the performance monitoring plan);
- Environmental changes at a local or a wider scale that could affect the estuarine resources or the implementation of the EMP; and

- Changes (if any) to legislation, land-use planning, goals or policies that may require the EMP to be amended.

This review may involve revisiting the SAR to determine the progress or changes that have come about because of the EMP in terms of the objectives that were originally set. It may also require the EMP to be amended, including a revision of the objectives, amendments to the management actions, and/or monitoring protocols. Ideally, representatives and experts in the major sectors (e.g. water quantity and quality, land-use and infrastructure planning and development), should evaluate the efficiency of the EMP in the context of their mandate or area of expertise. Public participation will be required before the amended EMP can be approved.

Table 17 in Appendix 3 below provides the performance monitoring plan relative to the proposed management priorities.

8 INSTITUTIONAL CAPACITY & ARRANGEMENTS

It is essential that this EMP is regarded as a strategic plan that can guide the detailing of management actions and identification of implementing agents. Therefore, it does not specify the required resources (human and financial) required for effective management of the estuary. It does, however, offer a schedule or phased planning approach that incorporates capacity building and implementation at the local level over a five-year period. It is crucial that champions/project leaders/teams are identified who will be responsible for the formulation of detailed project plans and the implementation thereof.

8.1 Key Role Players

Co-management and effective governance have been identified as vital aspects to the efficient and effective management of the Piesang estuarine system. Figure 11 displays the key role players that should be included in its management.

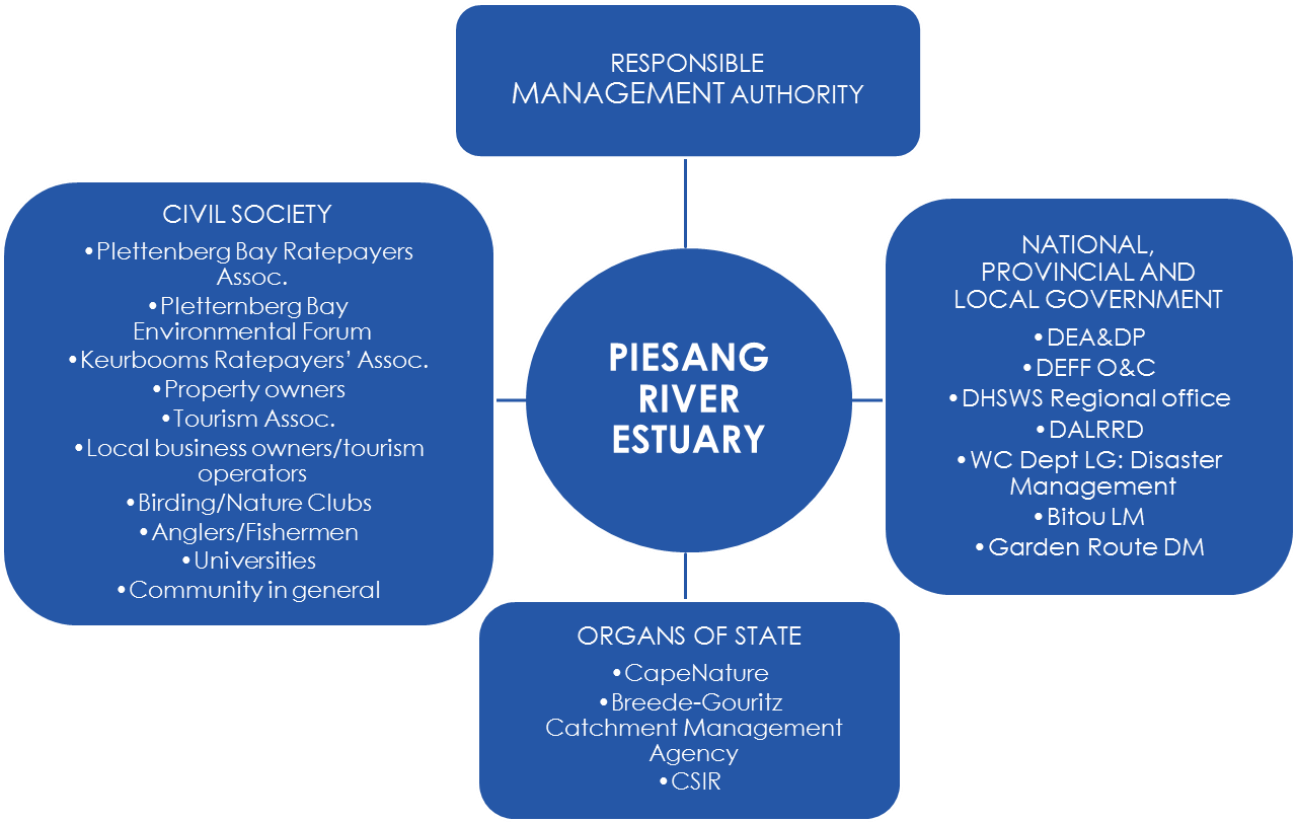

Figure 11: Key role players for the management of the Piesang river estuarine system

8.2 Responsible Management Authority

The 2021 NEMP identifies the **Department of Environmental Affairs & Development Planning (DEA&DP)** (**provincial environmental department)**, or its assigned representative, as the RMA responsible for the co-ordination of the implementation of the Piesang River Estuary EMP. **It is noted that the NEMP allocates such responsibilities to the DEA&DP (provincial**

environmental department) unless agreement / or until agreement is reached with the respective body to undertake the coordination of the implementation process. Ultimately, the role of the RMA must be designated through formal signed agreement. Specific implementation actions identified in this EMP remain the responsibility of mandated government agencies as well as respective departments within the RMA. As an example, the DWS will monitor water quality, while the DFFE will ensure compliance with matters related to fisheries (unless devolved to CapeNature). It is crucial that champions/project leaders/teams are identified who will be responsible for the formulation of detailed project plans and the implementation thereof.

Effective implementation of this EMP requires the augmentation of capacity for the Bitou LM, with the recommended appointment of a regional coastal and estuarine management co-ordinator (EMC) within DEA&DP. This individual will play a critical co-ordinating role for all other implementing agencies and municipal departments.

Progress towards achieving the objectives set out in this EMP should be reviewed on an annual basis by the RMA and communicated to stakeholders as well as to DEA&DP and DFFE via an annual report. This EMP will need to be revisited and updated after five years to reflect goals that have been achieved and to accommodate changing priorities.

8.3 Estuary Advisory Forum

While the establishment of an EAF for each estuary is no longer a requirement in the 2013 NEMP, the Western Cape Government still support their establishment and recommend that private entities and non-government organisations continue to play a supporting role in the implementation of this EMP. While the establishment of a regional EAF is generally preferred over numerous individual EAFs, the number of issues and potentially affected citizens/stakeholders warrants an individual EAF for the Piesang River estuary, which should be chaired by a suitably appointed, independent stakeholder.

Government departments should be represented on this regional EAF by delegates mandated by the respective department to do so. Each government representative on the EAF will be tasked to convey recommendations to his/her department and report back to the EAF on behalf of the department. Moreover, representatives from the authority/ies who have executive powers within the specific sector should also be present. This ensures that recommendations are executed, and resources are made available for priority tasks or activities. This also streamlines the flow of information and decreases the turnaround time of required interventions.

The various local members of the EAF will play an invaluable role in providing on the ground, local insight and support to the various authorities as well as to the RMA.

8.4 Government Departments and Organs of State

The key to successful implementation of this EMP is the commitment and contribution of all spheres of government to the process, including:

- The Bitou Local Municipality (with support from CapeNature): responsible for providing key municipal services, as well as the provision of management, technical and legislative support;
- The Garden Route DM: Responsible for health and safety issues relating to water and sanitation, disaster management as well as the provision of management and technical support;
- Western Cape Government departments: Responsible for legislatively mandated responsibilities as well as support, including compliance, funding, research and monitoring;
- Relevant National government departments, especially DFFE, DWS (via the regional office), and Department of Science and Technology (DST); and
- Organs of State: CapeNature, currently managing parts of the neighbouring Keurbooms River estuary and the Robberg Marine Protected Area, to assist with enforcement and monitoring, BGCMA, CSIR.

A crucial element towards achieving the vision and objectives of this plan, now and in future, is to ensure that the responsible authorities and their constituent departments, fulfil their roles and responsibilities as identified within the EMP. In terms of practical implementation of the EMP, each responsible government department is required to produce internal project plans linked the identified management actions, and in line with their legislative mandates. Funding and staff resources will need to be sourced within each respective sector department and/or institute. Alternatively, departments may fund other entities to undertake their necessary functions on their behalf.

The DFFE is generally responsible for national standardisation of estuarine management and approval of provincially-compiled estuarine management plans. Direct involvement in individual estuaries will occur via existing forums for intergovernmental coordination. These forums will have the estuarine management on their agendas, and include:

- The Garden Route Municipal Coastal Committee: Responsible for facilitating co-management, effective governance and district level co-ordination of coastal and estuarine management issues;
- Western Cape Provincial Coastal Committee: Responsible for facilitating co-management and effective governance and provincial co-ordination of estuarine management; and
- Western Cape Estuaries Task Team: Responsible for facilitating provincial co-ordination of estuarine management.

8.4.1 Project Plans for Implementation

Effective implementation of this EMP requires the conversion of the priority actions into detailed project plans, which must be prepared and adopted into the respective departmental implementation strategies. A template for such project plans is provided in

the EMP Development Guideline (DEA, 2015) and is attached as Appendix 4 for ease of reference. This template can also be utilised to facilitate the implementation of other projects proposed in the EMP.

9 RECOMMENDATIONS AND CONCLUSION

The following items/issues are considered critical towards the ultimate achievement of the vision and should be immediately addressed and/or receive greatest effort in respect to human/financial resources:

- An effective resolution must be sought in response to the impact of the desalination plant on the system;
- The mouth of the system must be effectively managed and a maintenance management plan drafted and approved should the mouth management plan indicate that artificial breaching is required to improve ecological functioning;
- No further development in the EFZ/ floodplain/ in high risk areas / below the Coastal Management Line should be supported;
- Both a fish sanctuary/no-take zone and saltmarsh sanctuary no-go/no-take zone must be established as part of the zoning scheme and incorporated into the SDF;
- The ecological health of the system must be improved by reducing pollution, appropriately dealing with urban runoff (recycle water and SUDS); responding to the continued run-off and contamination from the closed municipal dump; and upgrading pump station 5 located within the EFZ;
- In response to the requirement to partially protect the system, the remaining forest; northern bank plus the Klein Piesang must be protected and the estuary integrated into the Bitou 'Coming together' corridor;
- Every effort made to eradicate invasive alien plant and fish species; and
- The DEA&DP to consider the appointment of a Regional estuarine management co-ordinator/champion within either DEA&DP or CapeNature, to support the RMA.

In conclusion, this plan adopts the principle of adaptive management and presents an integrated and holistic approach to addressing not just the impacts but also the social and economic drivers that affect estuarine health. The actions proposed in this EMP reflect an ongoing process of implementation and should accommodate potential amendment due to changing circumstances. They are the first steps of a long-term process designed to secure ongoing and sustainable improvements to the current situation.

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APPENDIX 1: RECOMMENDED MONITORING PROGRAMMES

Table 14: Generic baseline surveys to improve confidence in the preliminary reserve determination of estuaries (Priority components are highlighted) (DWS, 2015b)

Monitoring action	Temporal Scale (frequency and timing)	Spatial Scale (Number of stations)
Hydrology		
For larger systems record river inflow at head of estuary (smaller systems hydrology to be simulated every 10 years).	Continuous.	Install recorder near head of estuaries.
Hydrodynamics		
Record water levels Large system (permanent recorder DWS levelled to mean sea level). Smaller systems (small in situ probe).	Continuous.	Near mouth.
Aerial photography (or using high resolution satellite imagery i.e. 5x5 m pixel size, e.g. Google Pro or BirdEye).	Once-off.	Entire estuary.
Sediment dynamics		
Monitoring berm height using appropriate technologies.	Quarterly.	Mouth.
Bathymetric surveys: Series of cross section profiles and a longitudinal profile collected at fixed 500 m intervals, but in more detail in the mouth including the berm (every 100 m). Vertical accuracy at least 5 cm.	Once-off.	Entire estuary.
Collect sediment grab samples (at cross section profiles) for analysis of particle size distribution and organic content (and ideally origin, i.e. microscopic observations).	Once-off.	Entire estuary.
Water quality		
Electrical conductivity, pH, inorganic nutrients and organic content (e.g. Total P and Kjeldahl N) in river inflow (preferably also suspended solids and temperature).	Monthly (as in DWS monitoring programme).	Include monitoring station near head of estuary.
Salinity and temperature profiles (and any other in situ measurements possible e.g. pH, DO, and turbidity).	Quarterly, preferably for two years.	Along entire length of estuary (at least three stations covering all zones).
Inorganic nutrient concentrations (together with above).	Quarterly, preferably for two years.	Along entire length of estuary (at least three stations covering all zones).
Measure pesticides/herbicides and metal accumulation in sediments (for metals investigate establishment of distribution	Once-off.	Entire estuary, including depositional areas (i.e. muddy areas).

Monitoring action	Temporal Scale (frequency and timing)	Spatial Scale (Number of stations)
models – refer to Newman and Watling, 2007)		
Microalgae		
Record relative abundance of dominant phytoplankton groups, i.e. flagellates, dinoflagellates, diatoms, chlorophytes and blue-green algae. Chlorophyll-a measurements taken at the surface, 0.5 m and 1 m depths, under typically high and low flow conditions using a recognised technique, e.g. spectrophotometer, HPLC or fluoroprobe. Intertidal and subtidal benthic chlorophyll-a measurements (four replicates each) using a recognised technique, e.g. sediment corer or fluoroprobe.	Quarterly preferably for two years.	Along length of estuary minimum five stations.
Macrophytes		
Map area covered by different macrophyte habitats using recent imagery. Conduct field survey to record total number of macrophytes habitats, identification and total number of macrophytes species, number of rare or endangered species, or those with limited populations. Assess extent of invasive species in EFZ. Where there are salt marsh areas greater than 1 ha measure % plant cover along elevation gradient. Sediment samples collected along the transect and analysed in the laboratory for sediment moisture, organic content, EC, pH and redox potential. In the field measure depth to water table and ground water salinity	Once-off, in summer.	Entire estuary (mapping). Where there is salt marsh (minimum three transect sites).
Invertebrates		
Collect duplicate zooplankton samples at night from mid-water levels using WP2 nets (190 µm mesh) along estuary Collect sled samples (day) at same zooplankton sites for hyper benthos (190 µm) Collect grab samples (five replicates) (day) from the bottom substrate in mid-channel areas at same sites as zooplankton (each sample to be sieved through 500 µm). Intertidal invertebrate hole counts using 0.25 m2 grid (five replicates per site). Establish the species concerned *(C. kraussi* or *U. africana*) using a prawn pump.	Quarterly, preferably for two years.	Minimum of three sites along length of entire estuary. For hole counts –three sites in each of muddy or sandy areas.

Monitoring action	Temporal Scale (frequency and timing)	Spatial Scale (Number of stations)
Collect sediment samples using the grab for particle size analysis and organic content (at same sites as zooplankton) (preferably link with sediment dynamics).		
Fish		
Record species and abundance of fish, based on seine net and gill net sampling. Sampling with a small beam trawl for channel fish should also be considered. Seine net specifications: 30 m x 2m, 15 mm bar mesh seine with a 5 mm bar mesh with a 5 mm bar mesh 5 m either side and including the cod-end. Gill nets specifications: Set of gill nets each panel 30 m long by 2 m deep with mesh sizes of 44 mm, 48 mm, 51 mm, 54 mm, 75 mm, 100 mm and 145 mm. Gill net sampling can be replaced by a large mesh seine (44 mm stretch mesh, 100 m x 2 m). Trawl specification: 2 m wide by 3 m long, 10 mm bar nylon mesh in the main net body and a 5 mm bar in the cod-end.	Once-off, in spring/ summer and autumn/ winter.	Larger system (> 5 km): 10 - 15 stations along length of estuary) (~ length/10). Small systems (< 5 km): 3 - 5 stations (mouth, mid, top).
Birds		
Undertake count of all water birds.	Once-off.	Entire estuary.

Table 15: Recommended long-term monitoring programme for the Piesang River estuary (priority components are highlighted) (DWS, 2015b)

ECOLOGICAL COMPONENT	MONITORING ACTION	TEMPORAL SCALE	SPATIAL SCALE
Hydrology	Record river inflow at head of estuary	Continuous	Head of estuary
Hydrodynamics	Record water levels using small in situ probe	Continuous	Near mouth
	Aerial photography (or using high resolution satellite imagery i.e. 5x5 m pixel size, e.g. Google Pro or BirdEye)	Every 3 years	Entire estuary
Sediment dynamics	Monitoring Berm height using appropriate technologies	Quarterly	Mouth
	Bathymetric surveys: Series of cross section profiles and a longitudinal profile collected at fixed (e.g. 300-500m intervals) but in more detail in mouth including berm (every 100 m). Vertical accuracy at least 5 cm	Every 3 years (and after large resetting event)	Entire estuary
	Set sediment grab samples (at cross section profiles) for analysis of particle size distribution (and ideally origin, i.e. microscopic observations)	Every 3 years	Entire estuary
Water quality	Electrical conductivity, pH, inorganic nutrients and organic content (e.g. TP and Kjeldahl N) in river inflow *(preferably also suspended solids and temperature)*	Monthly continuous (as in DWS monitoring programme)	Just above head of estuary
	Salinity and temperature profiles (and any other in situ measurements possible e.g. pH, DO, turbidity)	Seasonally, annually	Along entire length of estuary (at least 3 stations covering all zones)
	Inorganic nutrient concentrations (together with above)	High flow/low flow surveys, every 3 years or when significant change in WQ expected	Along entire length of estuary (at least 3 station covering all zones)
	Measure pesticides/herbicides and metal accumulation in sediments (for metals investigate establishment of distribution models – see Watling and Newman, 2007)	Once off, then every 3 – 6 years, if results show contamination	Entire estuary, including depositional areas (i.e. muddy areas)

ECOLOGICAL COMPONENT	MONITORING ACTION	TEMPORAL SCALE	SPATIAL SCALE
Microalgae	Record relative abundance of dominant phytoplankton groups, i.e. flagellates, dinoflagellates, diatoms, chlorophytes and blue-green algae. Chlorophyll-a measurements taken at the surface, 0.5 m and 1 m depths, under typically high and low flow conditions using a recognised technique, e.g. spectrophotometer, HPLC, fluoroprobe. Intertidal and subtidal benthic chlorophyll-a measurements (4 replicates each) using a recognised technique, e.g. sediment corer or fluoroprobe.	Quarterly for 1st two years and then low flow surveys every 3 years	Along length of estuary minimum 5 stations
Macrophytes	Map area covered by different macrophyte habitats using recent imagery. Conduct field survey to record total number of macrophytes habitats, identification and total number of macrophytes species, number of rare or endangered species, or those with limited populations. Assess extent of invasive species in EFZ. Where there are salt marsh areas greater than 1 ha measure % plant cover along elevation gradient. Sediment samples collected along the transect and analysed in the laboratory for sediment moisture, organic content, EC, pH and redox potential. In the field measure depth to water table and ground water salinity	Every 3 years in summer	Entire estuary (mapping)

ECOLOGICAL COMPONENT	MONITORING ACTION	TEMPORAL SCALE	SPATIAL SCALE
Invertebrates	Collect duplicate zooplankton samples at night from mid-water levels using WP2 nets (190 um mesh) along estuary Collect sled samples (day) at same zooplankton sites for hyper benthos (190 um) Collect grab samples (5 replicates) (day) from the bottom substrate in mid-channel areas at same sites as zooplankton (each samples to be sieved through 500 um). Intertidal invertebrate hole counts using 0.25 m^2 grid (5 replicates per site). Establish the species concerned (*Callichirus kraussi* or *Upogebia Africana*) using a prawn pump. Collect sediment samples using the grab for particle size analysis and organic content (at same sites as zooplankton) (*preferably link with sediment dynamics*)	Quarterly for 1st two years and then Every 2 years mid-summer	Minimum of 5 sites along length of entire estuary For hole counts – three sites in each of muddy or sandy areas,
Fish	Record species and abundance of fish, based on seine net and gill net sampling. Sampling with a small beam trawl for channel fish should also be considered. Seine net specifications: 30 m x 2 m, 15 mm bar mesh seine with a 5 mm bar mesh with a 5 mm bar mesh 5 m either side and including the cod-end Gill nets specifications: Set of gill nets each panel 30 m long by 2 m deep with mesh sizes of 44 mm, 48 mm, 51 mm, 54 mm, 75 mm, 100 mm and 145 mm Gill net sampling can be replaced by a large mesh seine (44 mm stretch mesh, 100 m x 2 m) Trawl specification: 2 m wide by 3 m long, 10 mm bar nylon mesh in the main net body and a 5 mm bar in the cod-end	Twice annually Spring/ summer and autumn/ winter	5 stns (mouth, mid, top)
Birds	Undertake count of all water birds	Every 2 years mid-summer	Entire estuary

APPENDIX 2: ECOLOGICAL SPECIFICATIONS

Table 16: EcoSpecs and Thresholds of Potential Concern for the Piesang River estuary (Category B/C) (DWS, 2015; 2018)

ECOLOGICAL COMPONENT	RECOMMENDED RQO	THRESHOLD OF POTENTIAL CONCERN
Hydrology	• Maintain at least present-day base flows	• MAR do not vary by more than 10 % • Floods (indicated by 1:10 year event) do not reduce by more than 5 % from present. • Base flows do not increase by more than 50 % from present

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
MMR/MAR (%Nat)	71.4	77.2	69.5	68.8	63.6	69.2	70.9	81.5	68.1	66.8	74.7	86.1	73.8

Hydro-dynamics	• Maintain connectivity with marine environment to create the required habitat for birds, fish, macrophytes, microalgae and water quality	• Closed mouth state increase by 10 % from present • Average water level in system > 10 % from present • Tidal amplitude (when open) < 20 %
Water Quality	• Salinity distribution not to cause exceedance of TPCs for fish, invertebrates, macrophytes and microalgae • Turbidity and Dissolved oxygen not to cause exceedance of TPCs for biota • DIN/DIP concentrations not to cause in exceedance of TPCs for macrophytes and microalgae • Concentrations of waterborne pathogens should be maintained in an Acceptable category for full contact recreation • Toxic substances not to cause exceedance of TPCs for biota	• Salinity > 20 (expected range 10-20) • Salinity < 5 (expected range 10-20) • DO < 5 mg/ℓ in estuary • Turbidity > 10 NTU in low flow • Secchi: to bottom • DIN >100 µg/ℓ once off • DIP > 20 µg/ℓ once off • ≥185 Enterococci/100 ml • ≥500 E. coli/100 ml • Concentrations in water column exceed target values as per SA Water Quality Guidelines for coastal marine waters (DWAF, 1995) • Concentrations in sediment exceed target values as per WIO Region guidelines (UNEP/Nairobi Convention Secretariat and CSIR, 2009)
Sediment dynamics	• Flood regime to maintain the sediment distribution patterns and aquatic habitat (instream physical habitat) so as not to exceed TPCs for biota • Changes in sediment grain size distribution patterns not to cause exceedance of TPCs in benthic invertebrates • Change in average sediment composition and characteristics • Change in average bathymetry	• Average sediment composition (% fractions) along estuary change from baseline (to be measured) by 30 % (per survey) • Average depth along main channel change from 30 % of baseline (to be determine) (system expected to significant fluctuation in bathymetry between flood and extended closed periods)

ECOLOGICAL COMPONENT	RECOMMENDED RQO	THRESHOLD OF POTENTIAL CONCERN
Microalgae	• Maintain median phytoplankton/benthic microalgae biomass • Prevent formation of phytoplankton blooms	• Phytoplankton >3.5 µg/ℓ (median) • Benthic microalgae >11 mg/m^2 (median) • Phytoplankton >20 µg/ℓ and/or cell density >10 000 cells/ml (once-off)
Macrophytes	• Maintain distribution of macrophyte habitats. • Prevent an increase in nutrient input leading to macroalgal blooms. • Control the spread of invasive plants in the riparian zone.	• Greater than 20 % change in the area covered by macrophytes (reeds and sedges currently cover 3.14 ha, submerged macrophytes and salt marsh present). • Macroalgal blooms cover > 50 % of the open water area during closed mouth conditions. • Invasive plants cover >5 % of total habitat.
Invertebrates	• Maintain presence of sand prawn *Callichirus kraussi* on sand banks in lower estuary • Maintain presence of the copepod *Pseudodiaptomus hessei* or estuarine congeneric in the zooplankton of the estuary	• Populations deviate from average baselines (as determined in first 3 visits) by more 30 %
Fish	Fish assemblage should comprise the 5 estuarine association categories in similar proportions (diversity and abundance) to that under the reference. Numerically assemblage should comprise: • Ia estuarine residents (50-80% of total abundance) • Ib marine and estuarine breeders (5-20%) • IIa obligate estuarine-dependent (10-20%) • IIb estuarine associated species (5-15%), • IIc marine opportunists (20-80%) • III marine vagrants (not more than 5%) • IV indigenous fish (1-5%) • V catadromous species (1-5%) Category Ia species should contain viable populations of at least 2 species (*G.aestuaria, & Hyporamphus capensis,* Category IIa obligate dependents should be well represented by at least 2 large exploited species (*L. lithognathus, Lichia amia*). REI species dominated by both *Myxus capensis* and *G. aestuaria*.	• Ia estuarine residents <50 % • Ib marine and estuarine breeders <10% • IIa obligate estuarine-dependent <10% • IIb estuarine associated species <5 % • IIc marine opportunists < 20 % • III marine vagrants > 5 % • IV indigenous fish <1% • V catadromous species <1 %

ECOLOGICAL COMPONENT	RECOMMENDED RQO	THRESHOLD OF POTENTIAL CONCERN
Birds	• Maintain population of original groups of birds present on the estuary	• Number of birds in any group, other than species that are increasing regionally such as Egyptian geese, drops below the baseline median (determined by past data and or initial surveys) number of species and/or birds counted for 3 consecutive summer or winter counts.

APPENDIX 3: PERFORMANCE MONITORING PLAN

Table 17: Recommended Performance Monitoring Plan for the management of Piesang River estuary

MANAGEMENT OUTPUT	PERFORMANCE INDICATOR	TEMPORAL SCALE (frequency)	RELEVANT LEGISLATION	RESPONSIBLE AUTHORITY
1. ESTUARINE HEALTH AND FUNCTION				
1.1 Secure adequate quantity and quality of freshwater input to improve and maintain ecosystem health and functioning	• Recommended reserve(s) signed off and implemented • Sustained base flow to estuary • Water resource utilisation plan developed • Effective regulation of water use • Agricultural/environmental best practice adopted • Monitoring on the state of the catchment and estuary • Monitoring of mouth dynamics & sustainable mouth management • Ecological monitoring programmes (fish and birds) developed and in place • Ecological condition improved from a D to a B/C	• Twice a year for DWS • Twice a year	NWA	DWS, BGCMA, RMA, Bitou LM, DFFE
1.2 Ensure estuary requirements are integrated into catchment processes to ensure healthy water quality	• Critical catchment maps updated • Effective catchment management • Good catchment water quality preserved • Water use plan cognisant of estuarine water requirements	• Twice a year	NWA, NWA, MSA, CARA, NEM:BA, NEM;PAA	DWS, BGCMA, DFFE, Bitou LM
1.3 Minimise pollution by addressing activities that lead to poor water quality	• Water quality (WQ) monitoring programme implemented • Control of all polluting discharges, conservancy/ septic tanks seepage, brine or sludge • Revised discharge standards • Environmental best practice irt effluent reduction, and urban drainage is implemented and enforced • Waste management plan in place for peak visitor periods	• Quarterly for WQ monitoring programme • Twice a year	NWA, CARA	RMA, Bitou LM, DFFE, GRBR

MANAGEMENT OUTPUT	PERFORMANCE INDICATOR	TEMPORAL SCALE (frequency)	RELEVANT LEGISLATION	RESPONSIBLE AUTHORITY
1.4 Control the spread and densification of invasive alien plant species (IAPs)	• Detailed maps of invasive vegetation produced and priority areas identified • IAPS eradication programme implemented • Increased area / tonnes of IAPs removed	• Annually	CARA, NWA	DFFE, RMA, DFFE: WfW, GRBR
1.5 Regulate the use of living resources through the establishment of a no-take zone enforced by effective compliance management	• No-take area established and demarcated • Status of fish and bait stocks determined • Extractive use quantified, enforcement of carrying capacity • Increased patrols and monitoring conducted • Compliance network established, reduction in illegal activities • Signage created and erected in key public spaces • Reduced habitat degradation and inappropriate behaviour/activities • Invasive alien fish species eradicated • Improved fish and invertebrate populations	• Twice a year	ICMA, MLRA	RMA, DFFE, CapeNature, GRBR,
2. BIODIVERSITY CONSERVATION				
2.1 Ensure the conservation of estuarine habitats and indigenous species	• Formal protection status obtained • Spatial zonation plan adopted, implemented and enforced • Participation of land owners and stakeholders • EMP and zonation plan included in GRBR Management Plan, Municipal CMP and other strategic documents • Educational signage erected; areas demarcated • Reduced habitat degradation and inappropriate behaviour/activities	• Twice a year	ICMA, NEMA, MLRA, LUPA, NEM: PAA, NEM:BA, WC BRA	RMA, CapeNature, GRBR, Bitou LM, DWS,
3. LAND USE AND INFRASTRUCTURE DEVELOPMENT PLANNING				
3.1 Ensure appropriate and sustainable coastal development in and around the Piesang River estuary, considering the importance of ecosystem services	• EMP included in management plan for GRBR • Piesang EMP included in all relevant planning documents • Bylaws developed and gazetted	• Annually	ICMA, LUPA, WC BRA, MSA, NEMA	GRBR, Bitou LM, DEA&DP and applicable authorities

MANAGEMENT OUTPUT	PERFORMANCE INDICATOR	TEMPORAL SCALE (frequency)	RELEVANT LEGISLATION	RESPONSIBLE AUTHORITY
	• No new development, infilling or land transformation in the EFZ, undeveloped margins of EFZ preserved • Inspections undertaken, transgressors prosecuted, and remedial actions implemented • Regional EAF partakes in development planning affecting the estuary			
4. INSTITUTIONAL AND MANAGEMENT STRUCTURES				
4.1 Ensure effective co-ordination of estuarine management responsibilities	• Piesang EMP adopted by RMA • Regional Estuarine management function established and EMC • Piesang EMP incorporated into GRBR management plan and Municipal CMP • Bylaws developed and gazetted to support zonation and protect EFZ • RMA official(s) are well-trained and knowledgeable • Regional EAF constituted • Good communication and working relationship established with implementing agencies, including DEA&DP for ad hoc support • Regional EAF supported and meets on quarterly basis • RMA presence at critical forum meetings • Effective system of monitoring, report and review in place • Annual reporting undertaken by RMA • Funding secured for 5-year cycle	• Quarterly	ICMA, MSA, NEMA, LUPA, NWA, WC BRA	RMA, Bitou LM, Garden Route DM, DEA&DP, applicable authorities
4.2 Define and enable co-operative governance	• Implementation Protocols signed between RMA and spheres of government and participating agencies • Monitoring of EMP implementation by EAF • Active collaboration of various institutions, private and civil stakeholders • Individual agencies knowledgeable and with capacity and resources to carry out mandated actions	• Annually	MSA, NWA, ICMA, NEMA, WC BRA, CARA	RMA supported by all applicable authorities

MANAGEMENT OUTPUT	PERFORMANCE INDICATOR	TEMPORAL SCALE (frequency)	RELEVANT LEGISLATION	RESPONSIBLE AUTHORITY
	• Formal review of EMP every 5 years			
5. SOCIO-ECONOMIC CONSIDERATIONS				
5.1 Regulate recreational use of the estuary	• Informative signage and markers erected and maintained • Carrying capacities determined for each use and regulations gazetted • EFZ controls enforced and offenders prosecuted • Communication strategy developed for estuary users/landowners	• Annually	ICMA, WC BRA, MLRA, MSA	RMA, DFFE, Bitou LM
5.2 Promote involvement of historically disadvantaged communities and individuals in the provision of tourism & recreation services	• Livelihood opportunities identified for communities in close proximity to Piesang River estuary • Education and capacitation of personnel • EPIP programmes adopted and implemented • Employment of local communities	• Annually	ICMA	RMA, Bitou LM, Garden Route DM, SANParlks
6. EDUCATION AND AWARENESS				
6.1 Promote high levels of public awareness and appreciation of the value of estuaries	• Education & awareness programme developed and implemented • Educational signage erected, and information disseminated • Bitou estuaries webpage operational • Reduced habitat loss/degradation and disturbance, and inappropriate behaviour • Reduced illegal fishing activities	• Every 3 years	ICMA, MLRA	RMA, GRBR, Bitou LM,
7. DISASTER RISK MANAGEMENT				
7.1 Disaster prevention and preparedness	• Risk assessment portfolio compiled, and key areas identified • Health incident evacuation plan developed • Emergency response networks established • Integrated flood disaster management plan developed • All developments and activities are legally compliant	• Annually	DMA, MSA, NEM: WA, NEMA, ICMA, NWA	RMA, Bitou LM, Garden Route DM, DWS, WC Dept of Local Gov: Disaster Management

MANAGEMENT OUTPUT	PERFORMANCE INDICATOR	TEMPORAL SCALE (frequency)	RELEVANT LEGISLATION	RESPONSIBLE AUTHORITY
7.2 Mitigate areas of high risk	• Rehabilitation programme developed & implemented • Risk areas included in regional disaster management plan and contingency plans developed • Critical infrastructure defended • Development and initiation of retreat strategies • Reduced incidence of pollution, and timeous implementation of mitigation	• Annually	DMA, MSA, NEM: WA, NEMA, ICMA, NWA,	RMA, Bitou LM, Garden Route DM, DWS, WC Dept of Local Gov: Disaster Management

APPENDIX 4: PROJECT PLAN TEMPLATE

<table>
<tr><td>ACTION</td><td>Describe the action to be undertaken</td></tr>
<tr><td>COMPLETION DATE</td><td>Provide date of expected completion</td></tr>
<tr><td>PERFORMANCE INDICATOR</td><td></td></tr>
<tr><td>Requirements stipulated in policy and legislation</td><td></td></tr>
<tr><td>Available methods, protocols and best practice-guides</td><td></td></tr>
<tr><td>Spatial zonation consideration (e.g. limits/targets)</td><td></td></tr>
<tr><td>Detailed work plan</td><td>Task 1:
Task 2:
Task 3:
Task 4:</td></tr>
<tr><td>Scheduling</td><td>
<table>
<tr><th rowspan="2">TASK</th><th colspan="9">TIME (months)</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th></tr>
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<tr><td>4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Milestone/interim performance indicator</td><td>
<table>
<tr><th>MILESTONE</th><th>INTERIM PERFORMANCE INDICATOR</th><th>DUE DATE</th></tr>
<tr><td>1</td><td></td><td></td></tr>
<tr><td>2</td><td></td><td></td></tr>
<tr><td>3</td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Responsibilities for different tasks</td><td>E.g. Identify specific departments, personnel and/or service providers responsible for execution of this action</td></tr>
<tr><td>Monitoring and reporting plan</td><td>E.g.
• Define data and information to measure in order to monitor performance indicator/s
• Specify frequency at which data/information should be collected/monitored
• Where and when to report on progress</td></tr>
<tr><td>Human resource plan</td><td>
<table>
<tr><th rowspan="2">HUMAN RESOURCE</th><th colspan="4">WEEKS PER TASK</th></tr>
<tr><th>1</th><th>2</th><th>4</th><th>4</th></tr>
<tr><td>Staff member 1</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Staff Member 2</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Service provider</td><td></td><td></td><td></td><td></td></tr>
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</td></tr>
<tr><td>Financial resource plan</td><td>
<table>
<tr><th>TASK</th><th>COST (ZAR)</th></tr>
<tr><td>1</td><td></td></tr>
<tr><td>2</td><td></td></tr>
<tr><td>3</td><td></td></tr>
<tr><td>4</td><td></td></tr>
<tr><td>TOTAL</td><td></td></tr>
</table>
</td></tr>
</table>

Source: DEA (2015)

APPENDIX 5: DRAFT MOUTH MANAGEMENT PLAN

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Department of Environmental Affairs and Development Planning

Chief Directorate: Environmental Sustainability

Directorate: Biodiversity and Coastal Management

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