C.A.P.E. Estuaries
Management Programme

BERG ESTUARY DRAFT MANAGEMENT PLAN

November 2008

ANCHOR ENVIRONMENTAL

University of Cape Town,
PO Box 34035, Rhodes Gift 7707
www.uct.ac.za/depts/zoology/anchor
Tel/Fax +27 21 685 3400
barry.clark@uct.ac.za

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Background

The Berg Estuary is one of 279 functional estuaries in South Africa (Turpie 2004) and one of 4 permanently open estuaries on the west coast (Whitfield 2000). It is the one of the largest estuaries in the country, with a total area of 61 km^2. The estuary is one of the most important in the country in terms of its conservation value. The extensive floodplain that surrounds the middle and upper reaches of the system make it unique in the south-western Cape. It has been identified as an Important Bird Area (Barnes 1998) and a desired protected area in the conservation planning assessment conducted for C.A.P.E. (Turpie & Clark 2007) as well as in other studies (e.g. Turpie *et al.* 2002, Turpie 2004). However, mounting pressures could reduce this value, as water abstraction and pollution degrade estuary condition, fish stocks are affected by small-scale fishing, and demand for development increases on the West Coast.

This document is a Management Plan for the Berg estuary. It was developed under the auspices of the Cape Action Plan for the Environment (C.A.P.E.) Estuaries Management Programme. The main aim of the overall programme was to develop a conservation plan for the estuaries of the Cape Floristic Region (CFR), and to prepare strategic management plans for each estuary.

1.2 Purpose and scope of the Berg Estuary Management Plan

Drawing on the **Situation Assessment** prepared for the Berg Estuary (Anchor Environmental 2008a), inputs from key stakeholders (Anchor Environmental 2008b – Berg Estuary Management Plan Stakeholder Consultation Report), and other supporting documents prepared for the C.A.P.E. Estuaries Programme (e.g. Turpie & Clark 2007 – Cape Estuaries Classification, Prioritisation, Protection and Rehabilitation report), the Berg Estuary Management Plan sets out the **Vision** and **Management Objectives** for the Berg estuary. It also identifies **Strategies** needed to meet these objectives, and indicates the main **Actions** required in the next five years in order to achieve the overall vision. The **Berg Estuary Management Plan (EMP)** focuses on strategic priorities only. While planning for some emergencies, e.g. floods, is part of this plan, it remains possible that unforeseen disasters could disrupt the prioritisation set out here.

A set of **Key Result Areas** have been identified for the estuary for the next five years. A Key Result Area is a priority area of action for the estuary and addresses one or more of the strategies required to meet the objectives. Each strategy will be implemented through a set of actions and will result in a number of deliverables. A plan of implementation is provided for each Key Result Area.

The implementation of the strategies by the management agency for the estuary (to be determined) and its strategic partners (Berg River Local Municipality, Cape Nature, Marine & Coastal Management, West Coast District Municipality, Western Cape Provincial Government, Department of Water Affairs), will be monitored by a **Berg Estuary Management Forum (BEMF)** comprising all key stakeholders on the estuary, using indicators within a set time-frame. The **Management Agency** for the Berg Estuary and the appointed **Estuary Manager** will ultimately be responsible for overall management of the estuary, and will play a co-ordinating role for all other implementing agencies.

It is important to recognize that this document is designed to focus management attention at a strategic level and does not provide guidance on the day-to-day management actions required for management of the estuary. Annual Business Plans will have to be developed by the Estuary Management Agency and Estuary Manager in consultation with the Estuary Management Forum, and should be guided by this EMP in that major effort should be directed towards priority activities that support its strategic objectives.

Progress towards achieving the objectives set out in this EMP should be reviewed on an annual basis by the Estuary Management Agency and BEMF and focal efforts adjusted to ensure targets are met within specified time frames. This Berg EMP will have to be revisited and updated within the next five years to reflect goals that have been achieved and to accommodate changing priorities.

2 VISION FOR THE BERG ESTUARY

A vision is a high level statement which defines the strategic intent of a management intervention. The following draft vision was developed and agreed upon at successive stakeholders meeting held in Veldrif in October and November 2008:

"The Berg estuary
is a wetland of global conservation significance
that provides recreational, social and economic benefits
through a balance between
sustainable use, conservation and development."

3 MANAGEMENT OBJECTIVES

Key management objectives for the Berg estuary were identified and agreed upon at a successive stakeholder workshops held in Veldrif in October and November 2008. These are all set out in the form of a circular diagram as all objectives are seen to reinforce all other objectives and none are seen as being of greater importance than any other.

3.1 Maximise long-term economic benefits

The estuary must be managed to maximize the value of ecosystem goods and services delivered in the long term, ensuring an equitable balance between local, regional and national benefits

3.2 Conserve biodiversity

Adequate protection must be provided for estuarine biota to ensure persistence of populations, species, habitats and ecosystem processes, living resources must be protected from overexploitation and excessive disturbance.

3.3 Ensure harmony among users

Appropriate zonation of the estuary and effective control over recreational, subsistence and commercial users of the estuary will minimise the potential for conflicts between user groups and will ensure all groups are adequately catered for.

3.4 Improve ecosystem health

The estuary should be maintained in a condition which is largely natural. This will require that it is improved from its current status as a moderately modified to a largely natural system through improvements in water quality, restoration of freshwater supply and other measures.

3.5 Retain sense of place

Development around the estuary should be planned to maximize aesthetic and tourism value without compromising the existing sense of place, cultural or archaeological heritage or conservation objectives.

3.6 Increase awareness

Residents and visitors should be aware of the importance and economic value of the estuary, know the regulations, and understand the rationale for management measures and interventions.

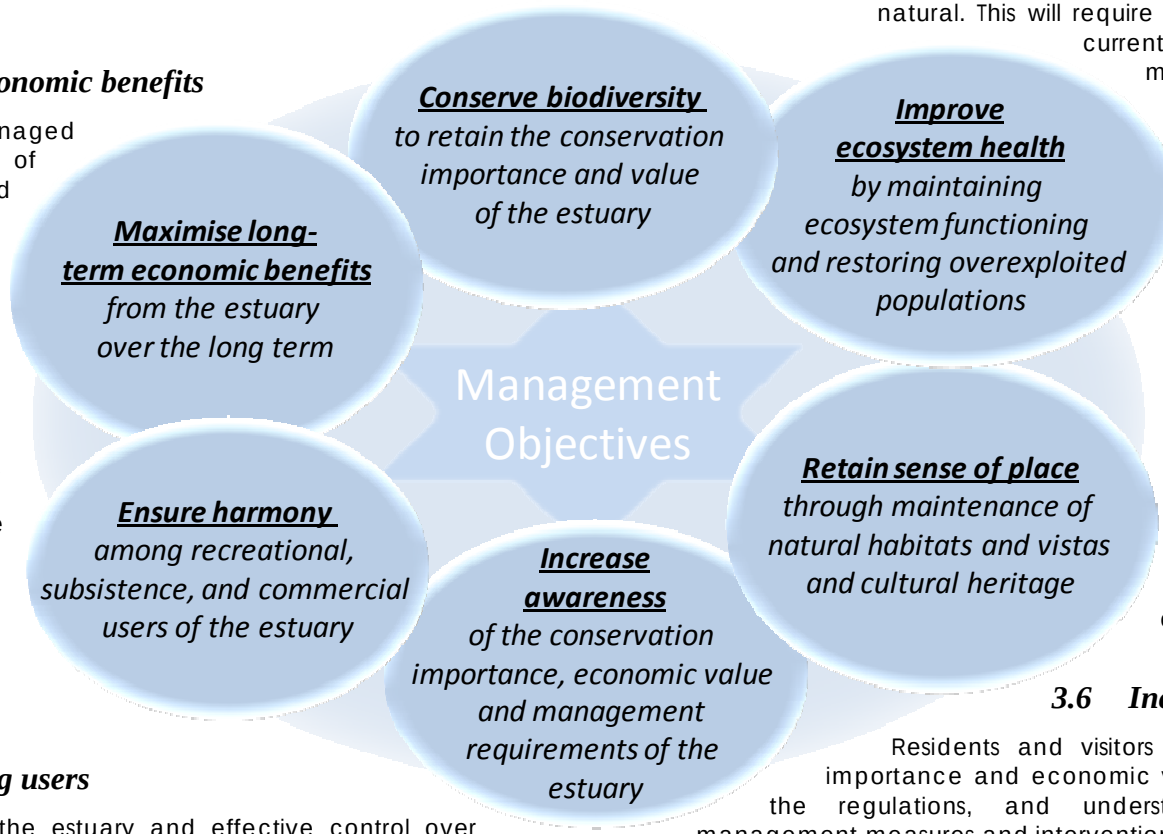

Figure 1. Management objectives for the Berg estuary

4 STRATEGIES TO MEET KEY MANAGEMENT OBJECTIVES

Strategies required to achieve the management objectives are summarized in Figure 2. Each management objective requires a number of strategies. Note that some of the management objectives form part of the strategy for other management objectives.

Maximising economic benefits and improving local livelihoods will require the conservation of biodiversity and maintaining the sense of place as well as development and marketing initiatives. Conservation of biodiversity requires the establishment of a **protected area** that provides a sanctuary for at least **50% of all biota** in the estuary. It also requires that use of the remaining stocks is **sustainable**. **Zonation** of the estuary will support **biodiversity conservation** objectives as well as assisting in maintaining **harmony amongst users**.

Economic objectives require development and opportunities for **ecotourism** growth, but this will have to be subject to **setback lines** and development guidelines that safeguard the **sense of place** of the estuary. These features will need to be integrated into **regional and local development plans**. Ecotourism growth will require **marketing** and attractive **visitor facilities** that draw people to the area and will also depend on future developments being **sensitive** to biodiversity and the sense of place.

Conservation of biodiversity will also require restoration and maintenance of ecosystem health through the provision of **environmental flows**, as well as **rehabilitation** of habitats that have been damaged, e.g. by mining activities. Biodiversity conservation will also be facilitated if public awareness is improved, which in turn will require the provision of **educational material** and **signage**. The management and monitoring of the estuary area, the freshwater inflows and development in the surrounding area will require **cooperative governance** among the estuary management agency, catchment management agency, conservation agencies, and local and national government. This in turn will require an **estuary management forum** that has r**epresentation amongst all relevant organisations**.

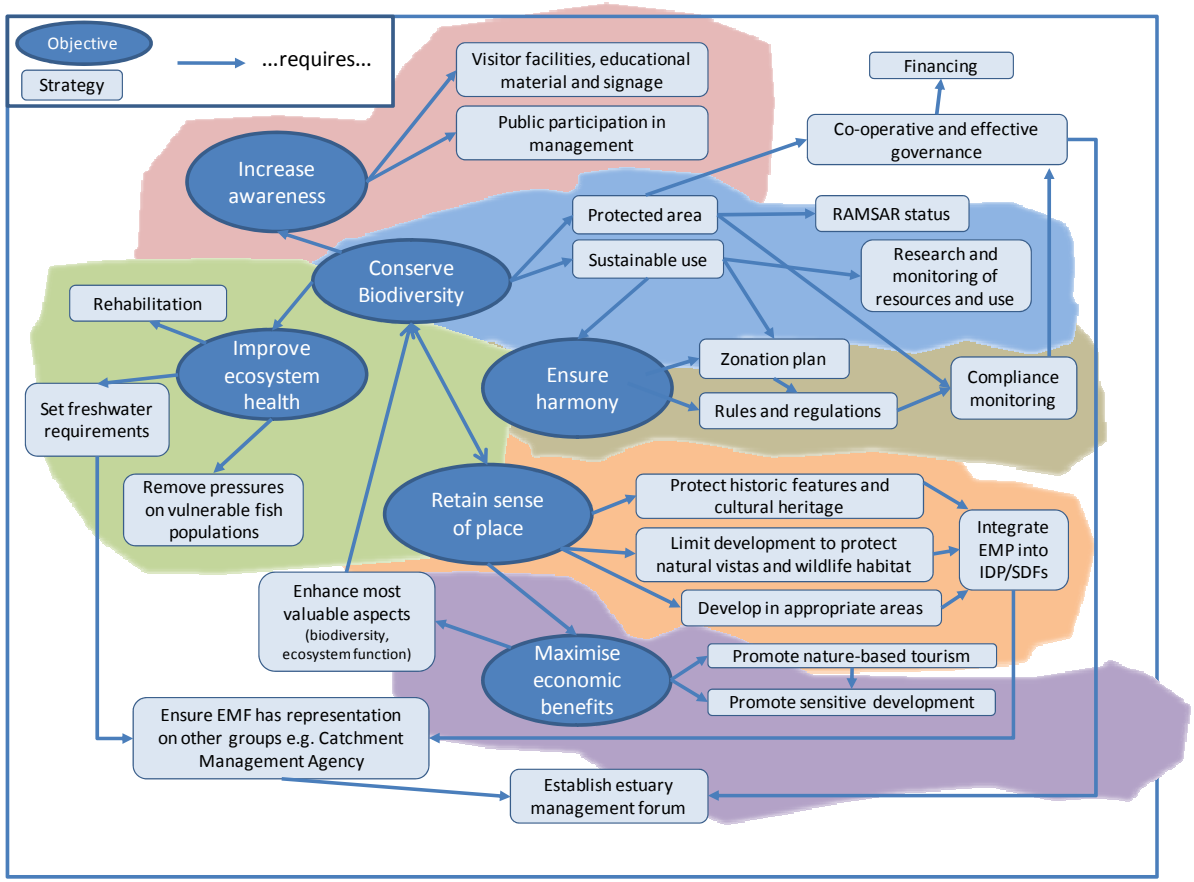

Figure 2. Strategies to meet management objectives for the Berg estuary

5 PROPOSED BERG ESTUARY MPA AND ZONATION PLAN

5.1 Introduction

The Berg estuary is among the top five estuaries in the country in terms of conservation importance, and is under consideration for being assigned Ramsar status as a wetland of international importance. Establishment of a protected area on the Berg estuary is fundamental to meeting biodiversity conservation targets (Turpie & Clark 2007) as well as meeting policy decisions enshrined in the White Paper on the Conservation and Sustainable Use of South Africa's Biological Diversity (1998) and commitments made at the World Summit on Sustainable Development (WSSD), to increase the area under formal protection.

Conservation of living resources below the high water mark (including control over exploitation) can only be achieved through the *Marine Living Resources Act* (1998). This act provides for establishment of Marine Protected Areas which can be zoned and hence provide varying levels of protection for living resources within their bounds.

5.2 Zonation plan and marine protected area on the Berg Estuary

A **zonation plan** for the Berg Estuary has been prepared based on discussions with and submissions received from stakeholders engaged in the development of the Berg EMP (Figure 3). There is strong support for improved control over recreational activities (particularly boating) on the estuary and also for proclamation of formal conservation areas. The zonation plan represents the best possible means of satisfying the many conflicting requirements of the different user groups and stakeholders who wish to enjoy the benefits provided by the Berg Estuary. Zonation will allow for partitioning of activities within the estuary thus permitting their co-existence without one activity precluding or conflicting with another. It will also reduce management costs as it will focus activities in particular geographic areas and hence eliminate the need to deploy all types of management staff across the whole estuary at all times. Requirements, for which the greatest scope for conflict exists, most likely include exploitative resource use, high intensity recreation and biodiversity conservation.

The zonation plan makes provision for **three different use zones:** Commercial, Recreational and Conservation Use Zones, with the latter two categories each incorporating **three intensity levels** (high, medium and low). Management regulations applicable to each of the zones are summarised in Table 1.

- The **Commercial Use Zone** incorporates only the lower reaches of the estuary from the mouth up to the upper Port Owen entrance and is designed to safeguard and facilitate movement of large fishing boats and other vessels in and out of the estuary. A speed limit of 10 km/h applies to all vessels in this zone.

- Four **Recreational Use Areas** have been designated on the estuary. Two of these are multipurpose recreation zones (Upper Port Owen Entrance to Carinus Bridge and Kliphoek Oxbow) that cater for high intensity recreation. Waterskiing is permissible in these zones. The third recreational use area extends from the powerlines that cross the estuary opposite the farm Langrietvlei upstream to the Kersefontein Bridge. This is a medium-intensity recreational use area in which a speed limit of 10 km/h applies. The forth recreational use area extends from the Kersefontein Bridge up to the top of the estuary at Steenboksfontein, and is designated as a low-intensity recreational use area for non-motorised vessels only.

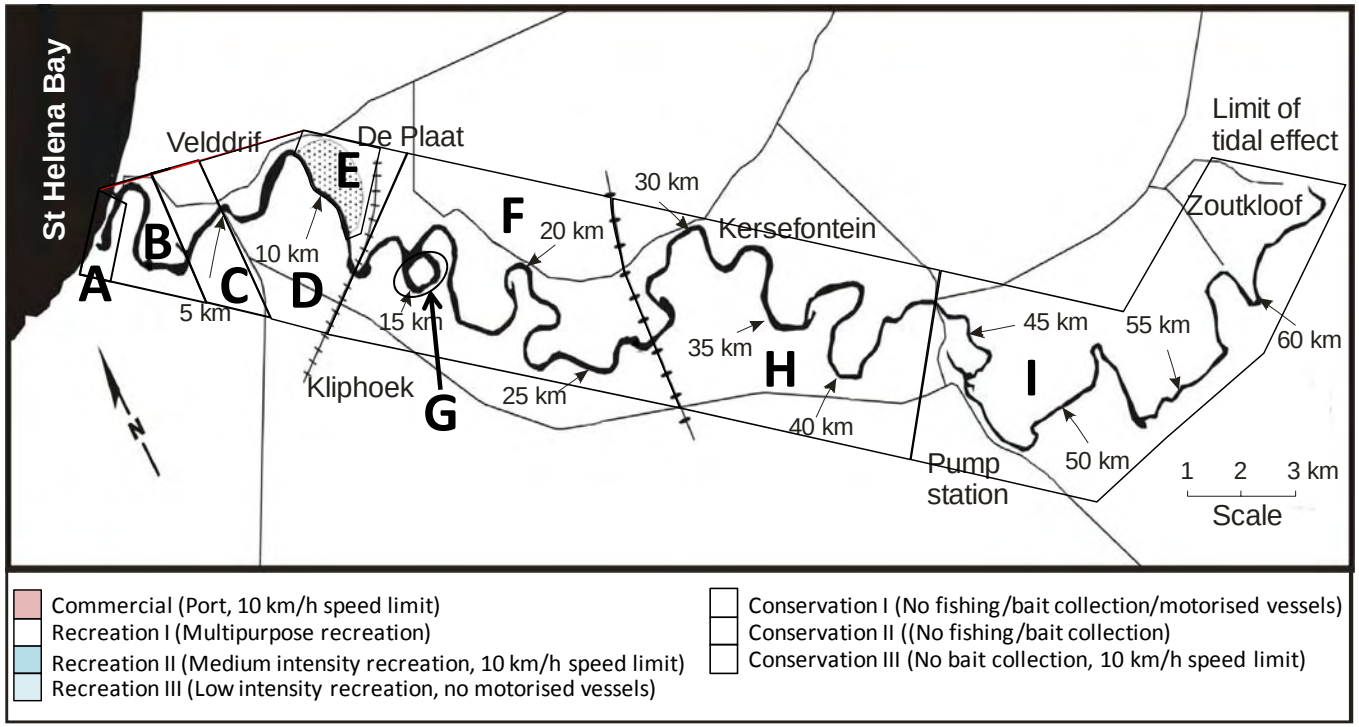

Figure 3. Draft zonation plan for the Berg estuary. Note that the lateral extent of all zones is up to the high tide mark only and the sizes of boxes shown here are exacerbated for clarity.

- Four **Conservation Areas** have been designated. These have the dual purpose of catering for conservation and low-intensity recreational use requirements of the estuary. The proposed conservation areas have been designated as follows:
  - **Old Mouth Lagoon:** a **no-take zone** in which all forms of exploitation are banned and entry to motorised vessels is prohibited;
  - **Carinus Bridge to the Railway Bridge:** a **bird and bait sanctuary** where collection of invertebrates is banned and a speed limit of 10 km/h shall apply to all vessels;
  - **De Plaat:** a **no-take zone** within the Carinus to Railway Bridge Conservation area in which all forms of exploitation are banned and entry is restricted to non-motorised vessels only; and
  - **Railway Bridge to the overhead powerlines (Langrietvlei)**: a a **no-take zone** in which all forms of exploitation are banned but all other forms of recreation are permitted (including waterskiing). This area corresponds with the core nursery area for estuarine dependant marine fish species in the estuary described in the Situation Assessment (Anchor Environmental 2008a).

Table 1. Management regulations applicable to each of the Berg Estuary management zones.

	No fishing	No bait collecting	Speed limit (10 km/h)	No power boats	Description	Boundaries
A	■	■	■	■	Old Mouth Lagoon	New mouth to top of old mouth lagoon
B			■		Fishing harbour	New mouth to upper Port Owen entrance channel
C					Carinus multipurpose recreation zone	Upper Port Owen entrance to Carinus Bridge
D		■	■		Swartjiesbaai Bird Sanctuary	Carinus Bridge to Railway Bridge
E	■	■	■	■	De Plaat Bird Sanctuary and MPA	De Plaat
F	■	■			Kruispad MPA	Railway Bridge to Powerlines
G					Kliphoek multipurpose recreation zone	Kliphoek Oxbow
H			■		Kersefontein/Langrietvlei area	Powerlines to Kersefontein Bridge
I			■	■	Upper Berg estuary	Kersefontein Bridge to Steenboksfontein

The purpose of banning the collection of invertebrates in the areas designated as bird and bait sanctuary is to minimise disturbance to the birds on their main feeding grounds and to protect their food supplies. The rationale for introducing maximum speed limits for vessels on the estuary and for limiting use of motorised vessels in certain areas is to minimise disturbance of wildlife (particularly birds), for human safety (where boat traffic is likely to be high, where the waterways are restricted due to depth, sand bars or other obstacles, or where contact recreation is popular), and/or to protect the sense of place on the less developed portions of the estuary.

Boundaries between zones are indicated in Figure 3 and will be clearly demarcated on the ground with beacons and signage indicating what restrictions are in force in each zone of the estuary. Coordinates for the boundaries between each of the zones are provided in Appendix 1.

5.3 Coastal protection zone and development setback line

The Provincial MEC in consultation with the Local Municipalities is required to define a **coastal protection zone** of at least 1km from the coastal and estuarine high tide mark under the ***Integrated Coastal Management Bill*** for all areas zoned agricultural or undetermined use and that are not part of a lawfully-established township, urban area or other human settlement, and a corresponding zone of 100 m for all other land. The Integrated Coastal Management Bill also provides for the establishment of a **coastal setback line**, designed to protect the coastal protection zone. No new development (construction) is permitted within the coastal setback line.

Given the fact that the Berg Estuary and floodplain are recognised as a highly important conservation area with high recreational value, it is recommended that coastal setback zone surrounding the estuary be designated in such a way as to encompass most or all of the coastal protection zone in this area. However, where relevant, it is recommended that the coastal setback lines surrounding the Berg estuary be adjusted either inwards or outwards to correspond with features that are clearly visible or demarcated on the ground (e.g roads, railway lines, farm boundaries) for ease of interpretation and enforcement.

The coastal protection zone and proposed development setback line for the Berg estuary are demarcated in Figure 4.

The development setback zone will serve to protect ecological functioning and integrity of the estuary, limit disturbance to estuarine flora and fauna, and will assist in retaining the wilderness character of the estuary and enhance its ecotourism appeal.

The development setback area should be incorporated in its entirety within a newly designated **core area of the Cape West Coast Biosphere Reserve (CWCBR)**.

The establishment of a formall **conservancy** should also be considered for all privately owned riparian lands adjoining the Berg Estuary.

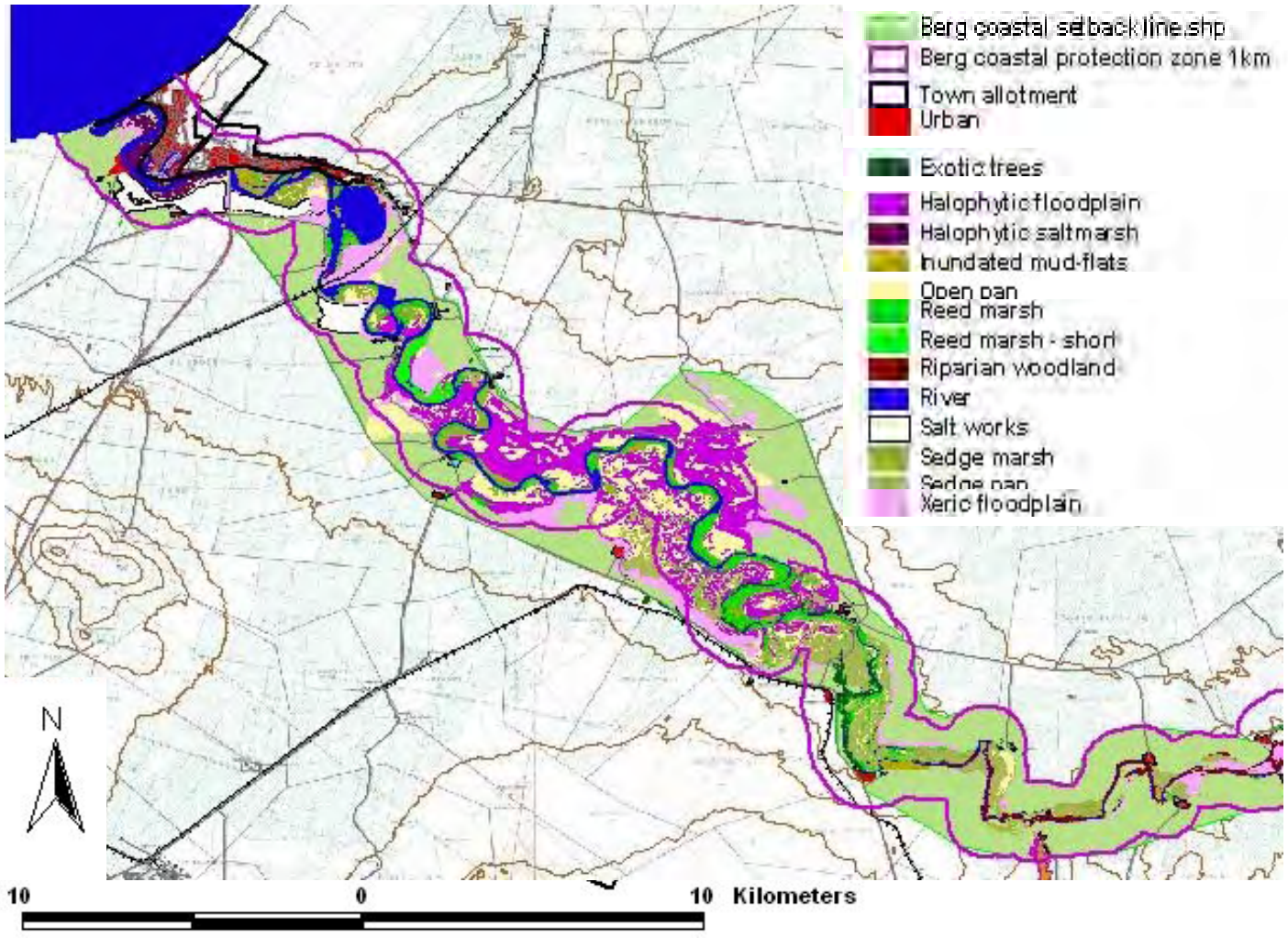

Figure 4. Coastal protection area and proposed development setback line for the Berg Estuary

6 KEY RESULT AREAS AND ACTION PLANS

6.1 Protection of biodiversity and wilderness character

The Berg estuary is widely acknowledged as being one of the most important estuaries in South Africa from a conservation perspective. It provides habitat and food resources for the largest population of resident and migrants water birds on the East Atlantic seaboard. It is also the most important nursery habitat for juvenile fish species on the South African West Coast. The expansive floodplain marshes surrounding the estuary are unique in the south-western Cape. For these reasons alone, it is strongly recommended that a significant portion of the estuary be set aside for biodiversity conservation through the enactment of appropriate legislation. The Berg Estuary is identified as a core estuary in the CAPE estuary conservation plan (Turpie & Clark 2007), which recommends that 50% of its biota is protected. It is also recommended that necessary steps be taken to ensure that the estuary in its entirety receive the international recognition it warrants by being awarded RAMSAR status and being incorporated as a core area within the Cape West Coast Biosphere Reserve. It is also important that these ideals and others contained in the vision and management objectives of this EMP be embraced by national, provincial and municipal authorities responsible for management of the Berg estuary, though the incorporation of these ideals and objectives into relevant planning documents (SDFs and IDPs). Positive steps in this respect would be the inclusion of the proposed setback line in planning documents and ensuring that the style and density of development around the estuary does not compromise biodiversity conservation, existing natural vistas, and the wilderness feel or sense of place of the estuary.

KRA	Strategies	Actions	Deliverables / Indicators	Timing	Implementation	Indicative budget
1. Protection of biodiversity and wilderness character	a. Establish a Marine Protected Area (MPA) that incorporates the tidal portion for the Berg estuary between the Carinus Bridge and overhead powerlines crossing the estuary between the farms Langrietvlei and Kruispad as well as the Old Mouth Lagoon and have this zoned in accordance with the Zonation plan in this EMP and and gazetted in terms of the Marine Living Resources Act, 1998. [Marine Living Resources Act, 1998]	i. Berg Estuary Management Forum (BEMF), C.A.P.E. and MCM to draft and submit request to the Minister, DEAT, to establish an MPA on the Berg estuary that includes sanctuary and control use zones as per the zonation plan prepared for the estuary (Figure 3)	• Joint memorandum from BEMF, C.A.P.E. and MCM to Minister DEAT requesting proclamation of a new MPA on the Berg estuary	2009-10	BEMF, C.A.P.E. and MCM	C.A.P.E R4 000
		ii. With endorsement from DEAT, enlist legal support to prepare notice of intent to proclaim the MPA to be published in the government gazette	• Notice of intent in government gazette		DEAT (MCM)	
		iii. DEAT MPA Working Group to consider comments on gazette notice and to and prepare responses to I&APs and Minister	• Response letters			
		iv. Preparation of final gazette notice	• Proclamation notice in government gazette			
	b. Integrate Berg estuary management plan into development planning [Coastal Management Bill, Municipal Systems Act, 2000]	i. Ensure that setback lines and other developmental needs and restrictions are integrated into IDPs and SDFs	• SDFs reflect requirements of Estuary Management Plan • Setback line gazetted	2009	Berg River Local Municipality	
		ii. Apply for legal status of the setback line under the Integrated Coastal Management Act (when gazetted)				

KRA	Strategies	Actions	Deliverables / Indicators	Timing	Implementation	Indicative budget
	c. Regulate boat traffic on the estuary to minimise impacts on biodiversity and sense of place [Coastal Management Bill, Sea Shore Act 1935]	i. Berg River Local Municipality or West Coast District Municipality to publish regulations requiring permits for using motorised vessels on the Berg estuary and restriction their use to specified zones as per the Zonation plan in this EMP	• Regulations/Bylaws	2009	West Coast District or Berg River Municipality	
	d. Seek RAMSAR status for the Berg estuary	i. BEMF with assistance from C.A.P.E. and other stakeholders to renew application for RAMSAR status on the Berg estuary	• Ramsar Status	2009	BEMF, C.A.P.E.	
	e. Redefine the Berg Estuary as a core area within the Cape West Coast Biosphere Reserve (CWCBR)	i. BEMF to lobby CWCBR for change in status of Berg estuary to a core area within the Biosphere Reserve	• Berg estuary redefined as core area within CWCBR	2009	BEMF, C.A.P.E., CWCBR	

6.2 Co-management and effective governance

Owing to their position on the boundary between freshwater, terrestrial and marine environments, management of estuaries requires cooperation from a large number of separate national, provincial and local government agencies each acting under a different legislative mandate. As a minimum the following national government agencies are implicated in management of the Berg Estuary: Department of Environmental Affairs and Tourism (DEAT), Marine and Coastal Management (MCM), Department of Water Affairs & Forestry (DWAF), Department of Public Works (DPW), Department of Transport (DOT). Provincial and local government agencies implicated in management of the estuary include the Department of Environmental Affairs & Development Planning (DEADP), Cape Nature, West Coast District Municipality (WCDM), Berg River Local Municipality (BRLM). The difficulties of ensuring a sufficiently high level of integration and cooperation amongst all of these different agencies is likely to extend beyond the mandate and capacity of a single local authority or agency. It has thus been recommended that a Berg Estuary Management Forum (BEMF) be established, that will include representatives from all of the principal national, provincial and local government agencies as well as key stakeholder groupings. The purpose of the Forum will be to provide a body for stakeholders with an interest in the future of the Berg Estuary to exchange information and ideas, and to reach agreement on action for the effective management of the estuary. One of the first tasks for the BEMF will be to identify and agree on a lead agency for the management of the proposed Berg Estuary Protected Area. Candidate management agencies include the Berg River Local Municipality (BRLM), the West Coastal District Municipality (WCDM) Cape Nature, Marine & Coastal Management (MCM), and the Department of Water Affairs (DWAF). Capacity (human, infrastructure and financial resources) available within each of these agencies for management of the Berg estuary is currently limited, however, and will need to be bolstered. Irrespective of which agency takes on the role of lead management agency, it is essential that all these agencies work cooperatively to ensure the vision and defined management objectives can be realised.

KRA	Strategies	Actions	Deliverables / Indicators	Timing	Implementation	Indicative budget
2. Co-operative and effective governance	a. Appoint the Berg Estuary Management Forum (BEMF) [Coastal Management Bill]	ii. Invite representative members of stakeholders and government to be members of the Berg Estuary Management Forum (BEMF)	• A list of members of the forum and their contact details	2009	C.A.P.E.	
	b. Define co-operative governance arrangements for management of the proposed Berg Estuary [Coastal Management Bill ; Protected Areas Act 2003]	i. Estuary Management Forum to meet to identify the preferred lead agency (CapeNature, Berg River Municipality, WCDM or MCM) and to define clear roles and responsibility for the lead agency and the other participating agencies.	• Proceedings	2009	BEMF, C.A.P.E.; CapeNature, Berg River Municipality, MCM and DWAF	C.A.P.E R56 000
		ii. Estuary management Forum to obtain agreement from the proposed lead agency and other participating agencies in respect of their roles and responsibilities.	• Signed letters from all agencies to be involved with the management of the Berg Estuary Protected Area and the BEMF clearly outlining respective roles and responsibilities	2009		C.A.P.E R16 000
	c. Secure financing	i. Secure start-up financing for estuary management, capacity building and research and monitoring programmes	• Funds secured for 5 years • An action plan for securing future funding	2009-10	Estuary management agency and key partners	
		ii. Lobby respective agencies to allocate resources, create and fill posts, and acquire necessary infrastructure and resources				
		iii. Develop a long-term financing plan				C.A.P.E R56 000
	d. Adequate resources and capacity	i. Establish an office at the estuary, preferably at Veldrif	• Office building	20010	Estuary management agency and key partners	EMA R350 000
		ii. Acquire necessary equipment (office equip, water quality meter, boat, vehicle)	• Office is adequately equipped			EMA R340 000
		iii. Recruit estuary manager and two field rangers as permanent staff.	• Staff & resources deployed for management of Berg Estuary Protected Area			EMA R1 960 000
		iv. Identify and address training needs among management staff and staff (involved in estuary) of CapeNature, Berg River Municipality and MCM (e.g. for monitoring, visitor regulation and assistance)	• Training records			
		v. Evaluate performance of staff, contractors and volunteers	• Performance evaluations	2011 +		

6.3 Restoring estuary health

Four focal areas have been identified for restoration or rehabilitation on the Berg estuary:

1. Restoration of water quality;
2. Restoration of the quantity of freshwater inflows; and
3. Removing significant obstructions to flow
4. Elimination of illegal fishing activity (gill netting);

The Berg Estuary currently receives some 65% of the natural mean annual runoff (MAR). While this does not affect mouth condition, since the mouth of the estuary has been stabilised between concrete promontories, reduction in flow has had a considerable impact on water quality, both due to reduced ability to dilute pollution and due to the increase in polluted return flows as a result of use of the water in irrigation. The reduced flows have probably also altered the physical habitat of the estuary in that the depth and profile may have changed, and may also have affected the extent of flooding on the floodplain areas surrounding the estuary. The reduction in flows will also most likely have resulted in considerable changes to the biota of the estuary. Primary productivity by microalgae has, for example, increased considerably over the last few decades owing to increased nutrient inputs and a reduction in flushing of the estuary. Plants have also most likely been significantly affected. The distribution of brackish reeds and sedges has probably diminished as a result of increased salinity. The biomass of zooplankton and bottom-living invertebrates such as amphipods and prawns is also likely to have increased as a result of the increase in salinity. Abundance and composition of fish and bird communities on the estuary are also likely to have changed as a result of changes in freshwater flow, salinity, habitat and food supplies. A reserve determination study designed to assess freshwater requirements of the estuary (as required in terms of the National Water Act, 2003) has not yet been completed for the estuary in spite of the fact that a new dam has recently been constructed within the Berg catchment. DWAF have however, indicated that this is a priority and hopefully this will be commissioned soon and will provided clarity on many of these issues.

A policy decision was recently taken by DEAT: MCM to phase out estuarine gill net fisheries throughout the country, with the result that all gill net permits on the Berg estuary were withdrawn in 2003. While a measurable recovery in the abundance of certain fish species (principally harders elf) in the Berg estuary has been observed subsequent to the ban it is likely that continued illegal gill net activity is hampering further recovery. It is thus imperative that this illegal activity is eliminated given the importance of the Berg estuary as a nursery area for juvenile fish and the severe impact this form of fishing has on juvenile linefish species in particular.

KRA	Strategies	Actions	Deliverables / Indicators	Timing	Implementation	Indicative budget
3. Restoring estuary health	a. Secure adequate quantity and quality of freshwater input to restore and maintain ecosystem health and functioning [National Water Act 1998]	i. Lobby minister DWAF for commissioning of a Reserve Determination Study for the Berg Estuary to ascertain impacts of existing reductions in freshwater flow to the estuary and for identification of a minimum recommended flow requirements for the system. ii. Lobby minister DWAF to sign off the recommended freshwater reserve for the estuary once this has been ascertained.	• Improvements in ecological health indices	2009	BEMF C.A.P.E. Estuary management agency DWAF	DWAF: R800 000
	b. Remove obstruction to flow in the estuary channel	i. Promote alien clearing activities in and around the upper estuary focussing particularly on removing debris from the estuary channel	• Improvements in ecological health and aesthetic indices	2009	BEMF, C.A.P.E. Estuary management agency	DWAF/WFW R500 000

	c. Eliminate illegal fishing activities on the Berg estuary	i. Lobby MCM to appoint additional staff and to undertake additional patrols on the Berg estuary with a view to eliminating illegal gill net activity	• Improvements in fish abundance and nursery value of the estuary	2009-	BEMF, C.A.P.E. Estuary management agency	MCM R500 000

6.4 Research and Monitoring

This management plan has been devised based on current understanding of the functioning of the estuary and its economic value. There are gaps in this understanding, and there will be an ongoing need to improve understanding through research.

Increasing use by visitors, surrounding development, changes in freshwater supply from the catchment, and climate and sea-level change can impact on the health and ecological functioning of the estuary, as well as its value at different spatial scales.

Monitoring and research are essential to enable the respective agencies responsible for management of the Berg Estuary to adapt management plans, operational plans and activities to changing circumstances. Three key focal areas for monitoring and research associated with the Berg estuary include visitor numbers and behaviour, water quantity and quality, physical characteristics, nutrients, biodiversity, and populations of exploited species.

A detailed baseline assessment of the abiotic and biotic characteristics of the estuary was undertaken prior to the construction of the Berg River dam. There are also detailed operating rules governing flow releases from the dam, designed to protect ecosystem health of the estuary and riverine biota downstream of the dam. Post implementation monitoring is critical however to ascertain whether the measures that have been put in place are adequate to ensure that there is no further deterioration in the health of the estuary from pre-implementation conditions. The responsibility for this monitoring resides with the Department of Water Affairs & Forestry (DWAF) but may be delegated to another agency.

Recommended protocols for monitoring the health of the Berg estuary are included in Appendix 2. These have been adapted from monitoring protocols designed for monitoring the freshwater reserve for the Olifants estuary prepared by Taljaard *et al*. (2006). These protocols serve to monitor the health of the estuary. Related to this, the "Ecological Specifications" and "Thresholds of Potential Concern" (TPC) for the Berg estuary are included as Appendix 2.

In addition to monitoring the biotic and abiotic health of the Berg estuary, it is also strongly recommended that visitor numbers, profiles, behaviour and opinions are monitored on a regular basis to gauge management effectiveness and user responses to management. Monitoring protocols for these aspects are also included in Appendix 2.

KRA	Strategies	Actions	Deliverables / Indicators	Timing	Implementation	Indicative budget
4. Research and monitoring	a. Promote scientific research	i. Identify information gaps and develop research programme(s) aimed at gathering/ consolidating data on biodiversity and exploited species ii. Engage local research institutes and universities to collaborate on priority research projects	• Research projects • Scientific reports, paper and publications	20010-13	Estuary management agency C.A.P.E. BEMF	

		iii. Solicit research funding support				
	b. Monitor biophysical indicators of estuary health [National Water Act 1998]	i. Carry out monitoring programme as outlined in Appendix 2 and assess results in terms of thresholds of potential concern (Appendix 2)	• Monitoring data and reports	2010-14	Estuary management agency, BEMF	DWAF R672 000
	c. Monitor human use of the estuary [National Water Act 1998]	i. Carry out monitoring programme as outlined in Appendix 2	• Monitoring data and reports	2010 - 14	Estuary management agency, BEMF	EMA R40 000

6.5 Increasing public awareness

Effective management of the Berg Estuary will be dependent on stakeholder buy-in (through adequate consultation and communication) and visitors' appreciation of the management regulations. Education is also considered to be among the most important functions provided by a protected area along with biodiversity conservation, maintenance of population of exploited species. Protected areas provide opportunities where the public are able to view species in their natural environments, and to experience ecosystems in a largely undisturbed state. Provision of interpretive and educational material at these sites can greatly enhance this experience as it focuses attention of visitors on goods and services provided by the environment of which they may not have been aware, highlights keys aspects of the environment that are special or unique to the area, and can be used to highlight the impact of human activities on the environment. Furthermore, the better people understand the issues surrounding the management of a protected area, the more they are likely to respect the management requirements and regulations. Thus the Management agencies for the Berg Estuary Protected Area will need to provide state of the art service in this field.

KRA	Strategies	Actions	Deliverables / Indicators	Timing	Implementation	Indicative budget
5. Increasing public awareness	a. Create effective mechanisms for on-going communication with stakeholders	Develop an effective communication strategy	• Communication strategy	2009-10	Estuary management agency BEMF	EMA R8 000
		Maintain stakeholder database	• Stakeholder database			
		Explore alternative communications mechanisms (workshops, signage, radio etc)	• Record of Communications			
	b. Develop an effective education and awareness programme for the protected area that enhances visitor experiences	Establish a visitor centre within the estuary protected area which acts as a focal point where visitors can go to learn more about the estuary, its conservation importance, the ecology of the system, the cultural and archaeological significance of the area, and the need for rationale behind existing management interventions	• Visitor centre open to public	2009-10	Estuary management agency BEMF	EMA R150 000
		Source and/ or commission educational and informative material including signage, posters, pamphlets, and relevant literature to be housed in the visitor centre and other appropriate localities that will enhance visitor experiences	• Posters, pamphlets, signage, literature	2010+		EMA R300 000
		Encourage field excursions to the estuary by local schools, community groups, and other stakeholder groupings		2010+		

6.6 Promoting ecotourism

The Berg estuary is one of the most scenic of the large permanently-open estuaries in South Africa. The primary challenge facing the future management agency of the estuary is to provide a quality experience for visitors to the estuary while at the same time managing visitors in a manner that ensures that they do not compromise the resource that attracted them in the first place.

KRA	Strategies	Actions	Deliverables / Indicators	Timing	Implementation	Indicative budget
6. Promoting ecotourism	a. Establish and manage visitor facilities	i. Develop appropriate nature friendly infrastructure for visitors to the estuary including accommodation (e.g. camping facilities, lodges, guest houses) as well as other facilities (roads, boat launching facilities, bird hides, walking paths, nature trails, mountain bike trails) in collaboration with local communities and independent contractors that does not detract from sense of place of the area or impact on the environment	Visitor infrastructure and facilities	2010-12	Estuary management agency, Berg River Municipality	EMA R500 000
		ii. Facilitate opportunities for commercial operators to develop visitor facilities and provide services on the estuary	Number of tourism businesses increases			
		iii Ensure that visitor facilities are maintained in good condition at all times to maximise visitor experiences	Facilities receive good reviews			
	b. Market the Berg Estuary as a wilderness and nature based ecotourism destination	i. Develop and distribute promotional material for the Berg Estuary Protected Area to key national, provincial and local tourism agencies and info centres	Brochures, pamphlets, magazine articles, website and road signage	2010-12	Estuary management agency, Berg River Municipality	EMA R50 000
		ii. Develop a website				EMA R5000
		iii. Lobby relevant agencies to ensure the estuary is featured in local, regional and national tourism marketing and included on tourism routes				
		iv. Petition national road agencies to erect appropriate road signage informing passing visitors and tourists of the existence of the estuary				

7 SUMMARY OF MANAGEMENT ACTIONS, GANTT CHART AND BUDGET

Table 7.1 provides a summary of the budget required to implement the Berg Estuary Management Plan over the next 4 years. C.A.P.E.'s main contribution is towards establishment of the protected area. DWAF is required to finance the monitoring of estuary health in terms of the recently-completed Resource Directed Measures study on the system. Most of this monitoring will be done only every three years. The contribution attributed to the estuary management agency includes capital and staffing costs, much of which will have to be sourced from government (e.g. DEAT, which is responsible for MPA management), non-government organisations (e.g. WWF) and the private sector. Costs associated with community development have been allocated to the Berg River Municipality.

Table 7.2 provides a summary of the tasks to be carried out over the next 4 years, and their timing.

Table 7.1. Summary of estimated budget and its distribution among key institutions

Institution	Indicative budget (excluding in-house)
C.A.P.E.	R116 000
DWAF	R672 1005
EMA	R3 695 000
Berg River Mun.	R200 000
TOTAL	**R4 683 100**

Table 7.2. Summary of actions and timing of actions pertaining to each of the key result areas over the period Jul 2008 – Jun 2012.

Key result area	Action	2009 Jan-Jun	2009 Jul-Dec	2010 Jan-Jun	2010 Jul-Dec	2011 Jan-Jun	2011 Jul-Dec	2012 Jan-Jun	2012 Jul-Dec
1. Protection of biodiversity and sense of place	a. Establish a Marine Protected Area (MPA)								
	b. Integrate into IDP/SDF								
	c. Zonation plan								
	d. RAMSAR Status								
	e. CWCBR Core area								
2. Co-operative and effective governance	a. Appoint Berg Estuary Management Forum								
	b. Define co-operative governance arrangements								
	c. Secure financing								
	d. Provide resources and capacity								
3. Restoration of estuary health	a. Secure freshwater input								
	b. Remove instructions to flow and clear alien veg								
	c. Eliminate illegal fishing								
4. Research and monitoring	a. Promote scientific research								
	b. Monitor estuary health								
	c. Monitor human use								
5. Increasing public awareness	a. Create mechanisms for communication with stakeholders								
	b. Develop education and awareness programme								
6. Promoting ecotourism	a. Establish and manage visitor facilities								
	b. Market the Berg Estuary								

7. Enhancing local livelihoods	a. Sustainable use of estuary resources								
	b. Provide alternative livelihoods								
	c. Empower local communities								
	d. Favour local communities								

8 REFERENCES

Anchor Environmental Consultants 2008. Berg estuary management plan Part 1: Situation assessment. Report to CapeNature and the CAPE estuary management programme. 85 pp.

Clark, B.M. (Ed.) 2007a. Berg River Baseline Monitoring Programme Final Report - Volume 3: Berg River Estuary. Anchor Environmental Consultants CC and Freshwater Consulting Group for the Department of Water Affairs. DWAF Report P WMA 19/G10/00/1907.

Turpie, J.K. & Clark, B.M. 2007. The health status, conservation importance, and economic value of temperate South African estuaries and development of a regional conservation plan. Report to CapeNature.

Turpie, J.K. 2004. South African Spatial Biodiversity Assessment, Technical Report Vol. 3: Estuary component. DEAT: SANBI.

Turpie, J.K., Clark, B., Knox, D., Martin, P., Pemberton, C. & Savy, C. 2004. Improving the biodiversity rating of South African estuaries. Vol. 1. Contributions to information requirements for the implementation of resource directed Measures for estuaries. WRC Report no. 1247/1/04. 121pp.

Turpie, JK., Adams, J.B., Joubert, A., Harrison, T.D., Colloty, B.M., Maree, R.C., Whitfield, A.K., Wooldridge, T.H., Lamberth, S.J., Taljaard, S. & van Niekerk, L. 2002 Assessment of the conservation priority status of South African estuaries for use in management and water allocation. Water SA. 28: 191-206.

Whitfield, A.K. 2000. *Available scientific information on individual estuarine systems*. WRC Report no. 577/3/00.

APPENDIX 1: COORDINATES (WGS84) FOR THE BERG ESTUARY MANAGEMENT ZONES

Zone A (Old Mouth Lagoon)

- Downstream (northern) boundary: a line drawn through the point (1) situated at 32°46'16.24"S, 18° 8'40.50"E and point (2) situated at 32°46'19.15"S, 18° 8'52.82"E on the south bank of the estuary respectively where the old mouth joins the main channel
- Lateral and upstream (southern) boundaries: A line that follows the Spring HWM between points 1 and 2

Zone B (Fishing Harbour)

- Downstream boundary: a line joining point (3) situated at latitude 32°46'5.06"S, longitude 18° 8'35.59"E on the southern bank of the estuary and point (4) situated at latitude 32°46'6.21"S, longitude 18° 8'39.05"E on the northern bank of the estuary.
- Upstream boundary a line joining point (5) situated at latitude 32°47'24.38"S, longitude 18° 9'15.83"E on the north bank of the estuary and point (6) situated at latitude 32°47'29.00"S longitude 18° 9'19.78"E on the south bank of the estuary opposite the mouth of the Port Owen Marina
- Lateral boundary (North): A line that follows the Spring HWM linking point (4) (as designated above) with point (7) situated at latitude 32°47'14.93"S longitude 18° 8'42.34"E, a straight line from here to point (8) situated at latitude 32°47'16.37"S longitude 18° 8'44.27"E (spanning the lower entrance to the Port Owen Marina), and from here on a line following the SHWM to point (9) situated at latitude 32°47'24.93"S longitude 18° 9'13.46"E, and from here on a straight line to point 5 (designated above).
- Lateral boundary (South): A line that follows the Spring HWM linking point linking point (3) (as designated above) with point 1 as designated above), a straight line from here to point 2 (as designated above), and following the Spring HWM from here to point 6 (as designated above).

Zone C (Carinus Multipurpose Recreation Zone)

- Downstream boundary: As for Zone B Upstream boundary.
- Upstream boundary: a straight line joining point (10) situated at latitude 32°47'14.12"S longitude 18°10'8.74"E and point (11) latitude 32°47'16.86"S longitude 18°10'8.65"E.
- Lateral boundary (N): A line that follows the Spring HWM linking point linking points (5) and (10) (as designated above).
- Lateral boundary (S): A line that follows the Spring HWM linking point linking points (6) and (11) (as designated above).

Zone D (Swartjiesbaai Bird Sanctuary)

- Downstream boundary: As for Zone C Upstream boundary.
- Upstream boundary: a straight line joining point (12) situated at latitude 32°49'4.05"S longitude 18°11'37.65"E and point (13) latitude 32°49'5.49"S longitude 18°11'34.34"E.
- Lateral boundary (N): A line that follows the Spring HWM linking point linking points (10) and (12) (as designated above).
- Lateral boundary (S): A line that follows the Spring HWM linking point linking points (11) and (13) (as designated above).

Zone E (De Plaat Bird Sanctuary and MPA)

- The area encircled by a line that follows the Spring HWM linking point linking point 14 situated at latitude 32°47'24.65"S and longitude 18°11'49.15"E, and point (15) situated at latitude 32°48'31.27"S longitude 18°11'57.68"E, and a straight line joining these two points.

Zone F (Kruispad MPA)

- Downstream boundary: As for Zone D Upstream boundary.
- Upstream boundary: a straight line joining point (16) situated at latitude 32°52'19.36"S longitude 18°15'29.07"E and point (17) latitude 32°52'23.98"S longitude 18°15'28.30"E.
- Lateral boundary (N): A line that follows the Spring HWM linking point linking point (12) (as designated above) with point 16 (as designated above).
- Lateral boundary (S): A line that follows the Spring HWM linking point linking point (13) (as designated above) with point (18) situated at latitude 32°49'19.72"S longitude 18°12'27.29"E, and a straight line from here to point (19) situated at latitude

32°49'21.67"S longitude 18°12'31.55"E, and a line following the Spring HWM from here to point 20 situated at latitude 32°49'26.44"Slongitude 18°12'40.95"E, and a straight line from here to point (21) situated at latitude 32°49'26.03"S longitude 18°12'45.00"E, and a line from here that follows the Spring HWM to point (17) (as designated above).

Zone G (Kliphoek multipurpose recreation zone)

- The area encircled by a line that follows the Spring HWM linking point linking points 18 and 21 (as designated above), a straight lines joining points 18 and 19 (as designated above), and points 20 and 21 (as designated above), and a that follows the Spring HWM linking point linking points 19 and 20 (as designated above).

Zone H (Kersefontein/Langrietvlei recreation area)

- Downstream boundary: As for Zone F Upstream boundary.
- Upstream boundary: a straight line joining point (22) situated at latitude 32°54'24.96"S longitude 18°20'4.39"E and point (23) latitude 32°54'25.76"S longitude 18°20'3.66"E.
- Lateral boundary (N): A line that follows the Spring HWM linking point linking points (16) and 22 (as designated above).
- Lateral boundary (S): A line that follows the Spring HWM linking point linking points (17) and 23 as designated above).

Zone I (Upper Berg estuary)

- Downstream boundary: As for Zone H Upstream boundary.
- Upstream boundary: a straight line joining point (24) situated at latitude 32°56'23.36"S longitude 18°26'36.96"E and point (25) latitude 32°56'23.49"S longitude 18°26'37.35"E.
- Lateral boundary (N): A line that follows the Spring HWM linking point linking points (22) and 24 (as designated above).
- Lateral boundary (S): A line that follows the Spring HWM linking point linking points (23) and 25 as designated above).

APPENDIX 2: RECOMMENDED MONITORING PROTOCOLS

The following table provides a list of recommended abiotic and biotic parameters to be monitored on the Berg estuary to assess changes in health of the system over time, particularly in relation to the construction of the Berg River Dam. Additional recommendations have been included for monitoring of visitor numbers, profiles and opinions, and angler catch and effort required in terms of the management plan.

ECOLOGICAL COMPONENT	MONITORING ACTION	RELATED TPC (see Appendix 2)	TEMPORAL SCALE (frequency and when)	SPATIAL SCALE (No. Stations)
1. BIRDS	Undertake counts of all water-associated birds. All birds should be identified to species level and total number of each counted.	1.1 – 1.2	Winter and summer survey, yearly	Entire estuary
2. FISH	Conduct fish surveys using both seine and gill nets as primary gear.	2.1 – 2.6	Winter and summer survey every 3 years starting 2009	Entire estuary (30 stns)
3. INVERTEBRATES	Zooplankton: Collect quantitative samples using a flow meter after dark, preferably during neap tides (mid to high tide). Sampling to be done at mid- water level, i.e. not surface. (Include chlorophyll a measurements on benthic microalgae and water column chlorophyll as to establish feeding links)	3.1	Same as for fish	Entire estuary (12 stns)
	Benthic invertebrates: Collect (subtidal) samples using a Zabalocki-type Eckman grab sampler with 5-9 randomly placed grabs (replicates) at each station. Collect intertidal samples at spring low tide using core sampling.	3.2	Same as for fish	Entire estuary (12 stns)
	Macrocrustaceans: Collected quantitative samples during neap tides (mid to high tide), at the same stations used for zooplankton, using a benthic sled with flow meter.	3.3	Same as for fish	Entire estuary (12 stns)
4. MACROPHYTES	Map main macrophyte communities using aerial photos or GPS	4.1 – 4.5	Every 3 years	Entire estuary
5. MICROALGAE	Phytoplankton: Conduct water column chlorophyll a measurements and counts of dominant phytoplankton group.	5.1 – 5.3, 5.5	Same as for fish	Entire estuary (12 stns)
	Benthic microalgae: Conduct benthic chlorophyll a measurements	5.4	Same as for fish	Entire estuary (12 stns)
6. WATER QUALITY	Collect data on conductivity, temperature, suspended matter/turbidity, dissolved oxygen, pH, inorganic nutrients and organic content in river inflow	6.6, 6.7 & 6.8	At least monthly	At Jantjiesfontein or Steenboksfontein
	Monitor inorganic nutrient inflow from agricultural return flow in upper reaches (e.g. bore hole sampling)	6.6, 6.7 & 6.8	At least monthly	4 stns along upper estuary
	Collected longitudinal salinity & temperature profiles (*in situ*)	6.1 – 6.5	To be measured when biotic surveys require information for interpretation	Entire estuary (22 stns)
	Water quality measurements taken along the length of the estuary (surface and bottom samples) for pH, dissolved oxygen, suspended solids/turbidity and inorganic nutrients.	6.7 – 6.9		Entire estuary (22 stns)
	Baseline data set for pesticides/herbicides accumulation in sediments	6.13	Every 3 years	Focus on depositional areas

ECOLOGICAL COMPONENT	MONITORING ACTION	RELATED TPC (see Appendix 2)	TEMPORAL SCALE (frequency and when)	SPATIAL SCALE (No. Stations)
7. HYDRODYNAMICS	Water level recordings	8.6	Continuous	3 stations
	Flow gauging	7.1 – 7.3 & 8.1	Continuous	Head of the estuary (Steenboksfontein)
	Aerial photographs of estuary (spring low tide)	4.1 – 4.4 & 8.5	Annually	Entire estuary
8. SEDIMENT DYNAMICS	Bathymetric survey: Series of cross-section profiles and a longitudinal profile collected at fixed 500 m intervals, but more detailed in the mouth (vertical accuracy better than 300 mm)	8.5	Every 3 years	Entire estuary
	Set sediment grab samples (at cross section profiles) for analysis of particle size distribution (PSD) and origin (i.e. using microscopic observations)	8.3 - 8.4		Entire estuary
	Daily sampling of suspended sediment (and organic matter)	8.2	Daily	Steenboksfontein
9. HUMAN USE	Collect statistics on the profile (origin, sex, age, income category) and activities of visitors to the Berg estuary using self-fill in questionnaires		Continuous	Visitor entry points and key sites of interest
	Conduct regular counts of users and boats, separated by type.		Twice per week	Entire estuary
	Survey visitor opinions on impacts of key management interventions.		Every two years	Entire estuary
	Creel surveys of Catch, Effort and C.P.U.E. for shore and boat-based anglers		Intensively (3x/week) every 5th year	Entire estuary

APPENDIX 3: ECOLOGICAL SPECIFICATIONS AND THRESHOLDS OF POTENTIAL CONCERN (TPC) FOR MONITORING PARAMETERS LISTED IN APPENDIX 1

The following table provides "Ecological Specifications/Resource Quality Objectives" and "Thresholds of Potential Concern" (TPC) for the Berg estuary adapted from those prepared for ecological freshwater requirements study completed for the Olifants estuary (Taljaard *et al*. 2006). In this context, "Ecological Specifications/Resource Quality Objectives" are defined as being 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 reserve category, in this case a Category B, while "Thresholds of Potential Concern" 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) should prompt management action. Note that thresholds of potential concern endpoints are generally defined such that they provide early warning signals of potential non-compliance to ecological specification (i.e. not the point of 'no return'). Thus, indicators (or monitoring activities) included here incorporate biotic and abiotic components that are considered particularly sensitive to ecological changes associated with changes in river inflow and should be interpreted as such.

COMPONENT	ECOLOGICAL SPECIFICATIONS/RESOURCE QUALITY OBJECTIVES	THRESHOLD OF POTENTIAL CONCERN	POTENTIAL CAUSES
1. Birds	Retain the species richness, abundance and diversity of the bird community, representative of resident and migrant waders, wading birds and water fowl as under the Present State as assessed during the Berg River Baseline Monitoring Programme (Clark 2007).	1.1 Community composition or bird numbers deviates by more than 50% of average seasonal baseline counts for two consecutive summer or winter seasons, focusing on waders, wading birds, terns & water fowl (summer and winter), and specifically red data species which are supported by the system (e.g. Pelican, Oyster catchers, Chestnut banded plover) 1.2 In the case of water fowl densities decline by 20% of average seasonal baseline counts for two consecutive summer or winter seasons	Changes in: Salinity Invertebrate biomass/abundance Fish biomass/abundance in smaller size classes Vegetation habitats (e.g. reed beds, submerged macrophytes, salt marsh) Mud flats Human disturbance (not at moment)
2. Fish	Retain the following fish assemblages in the estuary: estuarine species (25-75%), partially estuarine dependent species (40-80%), and obligate estuarine dependent (e.g. white steenbras) (>1%). Exotic freshwater species (<0.5%)	2.1 Level of estuarine species drop below 25% of total abundance 2.2 Levels of obligate estuarine dependent species drop below 0.5% of total abundance 2.3 Levels of partially estuarine dependent species drop below 40% or rise above 80% of total abundance 2.4 Levels of exotic freshwater species above 0.5% (e.g. Mozambique tilapia out-competing resident species) 2.5 Benthic dwellers species drop below 2% of total abundance in estuary above 18 km from the mouth	Changes in: Insufficient spawn biomass (national stock – marine) Spawning failure due to environmental conditions (marine) Recruitment failure (e.g. no cues reaching the sea from the estuary) Habitat (macrophytes) Water column (temperature, salinity, turbidity, dissolved oxygen) Toxic substances (?) Food availability (Invertebrate & fish) Exploitation Introduction in aliens

COMPONENT	ECOLOGICAL SPECIFICATIONS/RESOURCE QUALITY OBJECTIVES	THRESHOLD OF POTENTIAL CONCERN	POTENTIAL CAUSES
	Maintain recruitment of adult and juvenile fish at Reference Condition levels. This requires maintaining sufficient flow for freshwater plume (temperature, salinity and olfactory gradient) entering the sea. This implies that there should be a significant number of 0 -1 year old fish and no missing year classes.	2.6 There are a missing year classes within a species	Blockage of eel migrations due to sand bar at mouth, Bad catchment practises/destruction of habitat, Blockage of migration due to dams.
3. Invertebrates	Retain Present State species richness and mix (low species abundance, high dominance). However, under the present state one or two species are always present at high densities compared to others (e.g *Pseudodiaptomus hessei*). For a B Category the higher densities need to be more variable in abundance during the year.	3.1 Species richness is greater than 30 for zooplankton and macroinvertebrates respectively (50% increase)	Changes in: Variability in intra-annual flow, e.g. loss of high flow pulses (>20 m^3/s) in autumn/spring (salinity) Sediment grain size distribution and organic content
	Indicator species such as *Capitella capitata*, should not dominate benthic species at any site	3.2 *Capitella capitata* exceeds 50% abundance of benthic species at any site	Increase in pollution (low oxygen high organic loading)
	Calianassa and *Upogebia* distribution patterns as under Present State	3.3 Abundance levels or areas of distribution decreases by more than 50% (mainly lower sandy reaches)	Changes in sediment characteristics along the estuary
4. Macrophytes	Maintain the present distribution and abundance of the different plant community types	4.1 Greater than 20% change in the area covered by different plant community types	Increase in salinity and reduced flooding influencing depth to groundwater and groundwater salinity. Increase in turbidity would reduce submerged macrophyte cover.
	Reduce the areas covered by macroalage (*Enteromorpha* sp.) in the upper reaches by 50% compared to the Present State (summer 2004).	4.2 Lower 15 km of estuary with greater than 50% of estuary mudflats covered by *Enteromorpha* sp.	Low flow, lack of flushing and reduced current speeds. Reduced flooding that resets the estuary. High nutrient input from agricultural activities and return flow.
	Control the spread of invasive aliens in the riparian zone (e.g. *Sesbania punicea* and *Eucalyptus* spp.).	4.3 Greater than 20% increase in area covered by invasive plants.	Disturbance of riparian zone due to human impacts such as bulldozing and clearing of natural vegetation
	Maintain reed and sedge areas and brackish salt marsh as for the Present State (by preventing upstream encroachment of saline water).	4.4 Dieback of reeds and brackish salt marsh in middle and upper reaches of estuary.	Reduced flow and an increase in saline intrusion.
	Prevent an increase in bare ground in the floodplain salt marsh by maintaining groundwater salinity at <70 ppt and depth to the water table at < 1.5 m	4.5 Greater than 20% increase in bare ground in salt marsh.	Reduced flow and flooding, increase in groundwater salinity and depth to groundwater.

5. Microalgae	Maintain a low phytoplankton biomass with a small REI (i.e. 10 ppt to river +1 ppt) zone	5.1 Phytoplankton biomass exceeds 10 µg/l chlorophyll a in summer or winter 5.2 Blue-green algae exceeds 10% of phytoplankton cell counts	Water flow rates falling too low in winter or summer.
	Maintain microalgal group diversity as measured under Present State	5.3 Flagellates cease to be the dominant group and diatoms become less diverse (<10 taxa per site)	Reduced freshwater inflow rates and high salinity near the upper areas of the estuary.
	Maintain intertidal and subtidal microphytobenthic biomass as measured under Present State (2004).	5.4 Benthic microphytobenthic biomass exceed 40 mg/m^2 chlorophyll a	Elevated nutrient in the inflowing freshwater.
	Maintain a low frequency of dinoflagellates	5.5 The frequency of dinoflagellates exceeds 5% of the total phytoplankton counts	Eutrophication of inflowing river water.
6. Water quality	Salinity intrusion should not to cause exceedence of TPCs for fish, invertebrates, macrophytes and microalgae (see above)	6.1 Salinity greater than 20 ppt for long than 3 months at 7 km upstream from the mouth (brackish saltmarsh, reeds and sedges & invertebrates) 6.2 Salinity of groundwater increases to 50 ppt and depth to water table to 1 m. (flood plain salt marsh) 6.3 Total dissolved solids (measure of 'salinity') of river inflow exceeds 3500 mg/l (phytoplankton) 6.4 Salinity in estuary exceeds 35 ppt (prevent hyper- salinity) (phytoplankton) 6.5 Salinity greater than 10 ppt occurs above 16 km upstream of the mouth (fish)	Modification of volume of river inflow Quality of agricultural return flow
	System variables (Temperature, pH, turbidity, dissolved oxygen, suspended solids and turbidity) not to cause exceedence of TPCs for biota (see above)	6.6 River inflow: Summer temp < 20°C pH < 6.5 'Turbid' river inflow (to be determined) Dissolved oxygen < 4 mg/l	Changes in water quality of river inflow at head of estuary and as a result of agricultural return flow along the banks of the upper estuary. Excessive macroalgal/microalgal growth in the estuary
		6.7 Secchi disc reading above 8 km from the mouth is greater than 1 m (proxy for turbidity in estuary)	
		6.8 pH > 8.5 or < 6.5 in river inflow or in estuary	
		6.9 Water column DO drops below 4 mg/l (1 m above bottom except in deep holes) (need to investigate DO level at night in dense macrophyte beds)	

	Inorganic nutrient concentrations not to cause exceedance of TPCs for macrophytes and microalgae (see above).	6.10 When average river inflow is less than 5 m^3/s and average DIN concentrations exceed 100 µg/l in river inflow and DIN concentrations in the upper reaches of the estuary (above 16 km from mouth) exceed 100 µg/l 6.11 During high flow season (flows > 20 m^3/s) average DIN concentrations exceed 500 µg/l in river inflow and average DIN concentrations in the upper reaches of the estuary (above 16 km from mouth) exceed 500 µg/l 6.12 Average DRP concentration exceed 100 µg/l in river inflow and average DRP concentrations in the upper reaches of the estuary (above 16 km from mouth) exceed 100 µg/l	Changes in water quality of river inflow at head of estuary and as a result of agricultural return flow along the banks of the upper estuary.
	Presence of toxic substances not to cause exceedence of TPCs for biota (see above).	6.13 For pesticides/herbicides baseline studies still need to be undertaken before TPCs can be set (special concern in upper reaches with extensive agricultural activities along banks of estuary)	Inputs from agricultural activities in the catchment and along the banks of the estuary in upper reaches
7. Hydro-dynamics	Maintain a flow regime to create the required habitat for birds, fish, macrophytes, microalgae and water quality	7.1 River inflow distribution patterns differ by more than 5% from present 7.2 River inflow decreases to below 1.5 m^3/s at any time 7.3 River inflow below 2 m^3/s persist for longer than 4 months	Modification to inflow at head of estuary
8. Sediment dynamics	Flood regime to maintain the sediment distribution patterns and aquatic habitat (instream physical habitat) so as not to exceed TPCs for biota (see above)	8.1 River inflow distribution patterns (flood components) differ by more than 10% (in terms of magnitude, timing and variability) from that of the Present State 8.2 Suspended sediment concentration from river inflow deviates by more than 10% of the sediment load discharge relationship to be determine as part of baseline studies	Modification to inflow at head of estuary
	Changes in sediment grain size distribution patterns not to cause exceedance of TPCs in benthic invertebrates (see above).	8.3 The median bed sediment diameter deviates by more than a factor of two from levels to be determined as part of baseline studies (Present State). 8.4 Sand/mud distribution in middle reaches (8-20 km) change by more than 20% from Present State 8.5 Changes in the channel bathymetry in the upper reaches (above 20 km upstream of the mouth) change by more than 20% from Present State 8.6 Changes in tidal amplitude below the Steenboksfontein of more than 20% from Present State	Modification to inflow at head of estuary; Catchment activities