ESTUARINE SPECIALIST STUDY AND IMPACT ASSESSMENT FOR THE PROPOSED EXPANSION OF KLIPHOEK RESORT, VELDDRIF

Anchor Environmental Consulting Report No 1779/1

ESTUARINE SPECIALIST STUDY AND IMPACT ASSESSMENT FOR THE PROPOSED EXPANSION OF KLIPHOEK RESORT, VELDDRIF

December 2017

Report Prepared by:

Anchor Environmental Consultants Pty (Ltd)
8 Steenberg House, Silverwood Close, Tokai 7945, South Africa
www.anchorenvironmental.co.za

for

P.O. Box 45070
Claremont
South Africa
7735

Authors: Amy G. Wright and Barry M. Clark

Citation: Wright A.G. and Clark BM. 2017. Estuarine specialist study and impact assessment for the proposed expansion of Kliphoek Resort, Velddrif. Report prepared by Anchor Environmental Consultants (Pty) Ltd for Eco Impact Legal Consulting (Pty) Ltd. 43pp.

Cover Photo: Anchor (2017)

EXECUTIVE SUMMARY

Project description

Eco Impact Legal Consulting (Pty) Ltd are busy with an application for environmental authorization for expansion of Kliphoek Resort, Velddrif, on behalf of the owner, Mr Jurgen Kotze. Eco Impact contracted Anchor Environmental Consultants (Pty) Ltd (Anchor) to compile a specialist study focusing on estuarine and riverine habitats to better understand the impacts of the proposed expansion, and to allow for the recommendation of alternative new facility/ unit locations with lower environment impact, as well as the possibility of more focused mitigation works (including terrestrial/ estuarine habitat rehabilitation and/ or restoration).

This report draws heavily on the findings of the Berg River Baseline Survey between 2003 and 2005 and research on the Berg estuary conducted by Anchor Environmental subsequent to this (2006-2010), with a supplementary visit to the development site to secure first hand observations on the proposed development in December 2017.

Receiving environment: the Berg River Estuary

The Berg River Estuary is located on the West Coast of South Africa approximately 130 km north of Cape Town with tidal influence measurable up to ~70 km from the mouth. The Berg River Estuary is one of three permanently open estuaries on the west coast, and one of the largest estuaries in the country, with a total area of 61 km^2. The extensive floodplains, extensive dry pans, tidal flats and marsh areas in the middle and upper reaches of the system and the estuary's shallow gradient (rising 1 m in the first 50 km) make it atypical in relation to most South African estuaries.

The estuary is considered one of the most important estuaries in South Africa in terms of conservation value - the system has been identified as an important bird area, and is also considered of high national conservation importance for estuarine fish, invertebrates and vegetation. Anthropogenic threats to the system include water abstraction and dams (there are four major dams within the Berg River Estuary catchment), agricultural and urban encroachment, specifically in terms of changes in hydrodynamics and water quality, frequency and intensity of the flooding of the floodplain and reduction of natural vegetation on the floodplain.

The Berg River Estuary meets the ocean at St Helena Bay, a region that is influenced by the Benguela Current System, which is characterised by the upwelling of colder nutrient-rich deep water. The estuary has a permanently open mouth that was canalised in the late 1960s in an attempt to develop the estuary into a fishing harbour, and ensures a relatively unconstructed exchange of water between the estuary and ocean. A consequence of this stabilised mouth is a strong tidal current in the lower and middle reaches of the estuary. Sediment in the lower reaches is extremely soft, and indicative of a high percentage of fine sediment particles and high organic content. The main channel at Velddrif is 100-200 m wide, and becomes progressively narrower and shallower moving upstream. The average depth ranges between 3-5 m, but reaches as much 9 m in areas, with the lower 4 km of the estuary dredged to a depth of at least 4 m to allow for boat navigation.

The Kliphoek site vegetation includes supratidal salt marsh, and reed and sedge marsh areas. This vegetation is sensitive to trampling and grazing by livestock (Anchor 2010). The eastern and south eastern proposed development area (i.e. area where existing jetties are to be restored) is characterised by low gradients and extensive beds of *Phragmites australis*, which form persistent and dense monospecific stands that outcompete other indigenous estuary-associated species and encroach into the open water area. In terms of benthic invertebrates, the site is dominated by the polychaeta *Capitella capitate*, *Desdemona ornate* and *Ceratonereis erythraeensis*; the Anomuran *Callianassa kraussi* and the amphipod *Grandidierella lutosa*. Although the numbers of fish species present in west coast estuaries is low, they do represent a relatively high proportion (79%) of the total west coast inshore fish community, many of which are endemic to southern Africa and some of which are considered threatened. Marine migrant fish species in the Berg Estuary are represented mostly by juveniles. Some 127 water-associated species (passerine and non-passerine) have been recorded on the estuary and adjacent floodplain. The area is host to significant populations of several threatened bird species, including African marsh harrier and Caspian tern, Lesser flamingo, Black harrier, African black oystercatcher, Eastern white pelican, Cape cormorant, Greater flamingo, Greater painted snipe, and Chestnut-banded Plover. Waders are particularly attracted to the floodplain pans and artificial salt pans as their water levels drop, feeding on the newly exposed shorelines and in shallow water. The Kliphoek site is considered a very important winter feeding ground for wading birds and waterfowl. As such, the estuary is considered a top priority in terms of its overall biodiversity conservation importance.

The economic valuation of the estuary has been estimated at R 75.6 million, which makes it one of the most valuable temperate estuaries in South Africa. The largest component of this value was derived from turnover in the property sector (R 48.6 million), followed closely by visitor expenditure (R 18.3 million) while subsistence and existence value made relatively small contributions to total estimated economic value.

Potential impacts

Potential negative impacts that may arise from the proposed construction phase include ecological effects due to:

- Disturbance to or alteration of soft sediment estuarine habitat;
- temporary loss of artificial wood/concrete habitat;
- mobilisation of contaminants in terrestrial sediments through construction activities and subsequent run-off into the estuary;
- mobilisation of sediment in the water column;
- loss of vegetation (including intact vegetation, ecologically important species and species of conservation concern);
- loss of ecological processes associated with the loss of intact vegetation, ecologically important species and species of conservation concern;
- generation and disposal of waste;
- increased noise and vibration; and
- spillage of hazardous substances.

Possible environmental impacts caused during the operational phase that are likely to impact on estuarine communities include the effects of:

- altered quay design affecting hydrodynamics and sediment movement;
- increased foot and vessel traffic affecting sensitive biota;
- generation and disposal of waste; and,
- noise and vibration.

The assessment of these impacts before and after recommended mitigation is summarised in the table below. After mitigation, none of the impacts are assessed as being above LOW significance. Cumulative estuarine environmental impacts associated with this project are primarily related to operational impacts resulting from increased vessel traffic and wastewater discharge, as well as increased risks from hazardous substances. It is envisioned that only minor routine maintenance will be required over the course of the design life of the proposed development. Impacts expected in the decommissioning phase have been dealt with in the construction phase.

Phase	Impact identified	Significance before mitigation	Significance after mitigation
Construction	Impact 1: Disturbance to or alteration of soft sediment estuarine habitat.	INSIGNIFICANT	N/A
	Impact 2: Temporary loss of artificial wood/concrete habitat.	INSIGNIFICANT	N/A
	Impact 3: Mobilisation of contaminants in terrestrial sediments through construction activities and subsequent run-off into the estuary.	LOW	INSIGNIFICANT
	Impact 4: Loss of vegetation, including intact vegetation, ecologically important species and species of conservation concern as a result of the construction, and the removal of natural areas for the development of infrastructure.	LOW	INSIGNIFICANT
	Impact 5: Loss of ecological processes associated with the loss of intact vegetation, ecologically important species and species of conservation concern.	LOW	VERY LOW
	Impact 6: Waste generation and disposal	MEDIUM	LOW
	Impact 7: Noise and vibration	VERY LOW	INSIGNIFICANT
	Impact 8: Spillage of hazardous substances on estuarine biota.	LOW	VERY LOW
Operation	Impact 9: Altered quay design affecting hydrodynamics and sediment movement.	INSIGNIFICANT	NA
	Impact 10: Increased foot and vessel traffic affecting sensitive biota.	INSIGNIFICANT	NA
	Impact 11: Generation and disposal of waste.	MEDIUM	VERY LOW
	Impact 12: Noise and vibration.	INSIGNIFICANT	NA

Recommended mitigation

Mitigation measures, both best practise and essential, include the following:

- Inform all staff about responsible disposal of waste and reduce, reuse, recycle philosophy;
- The intentional disposal of any substance into the estuarine environment must be strictly prohibited, while accidental spillage must be prevented, contained and reported immediately;
- All fuel and oil must be stored with adequate spill protection, and no leaking vehicles or vessels are to be permitted on site;
- Use bunding where possible, minimise top-soil run-off as much as possible and collect and dispose of polluted soil at appropriate bio-remediation sites;
- Use dust suppression techniques all dust generating surfaces and to enforce strict construction and private vehicle speed limits; and
- The immediate rehabilitation of any areas disturbed as a result of construction activities.

Based on the impacts assessed in this report, it is recommended that the proposed development proceed with the implementation of strict environmentally responsible practices as outlined in the recommended mitigation measures.

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

Anchor	Anchor Environmental Consultants
BAS	Best Attainable State
BRD	Berg River Dam
C.A.P.E.	Cape Action Plan for People & the Environment
CCT	City of Cape Town
CD	Chief Directorate
CPUE	Catch-per-unit-effort
CSIR	Centre of Scientific and Industrial Research
DEA: MCM	Department of Environmental Affairs: Marine and Coastal Management
DIN	Dissolved Inorganic Nitrogen
DIP	Dissolved Inorganic Phosphate
DO	Dissolved Oxygen
DRP	Dissolved Reactive Phosphate
DRS	Dissolved Reactive Silicate
DWA	Department of Water Affairs
DWAF	Department Estuarine Health Index of Water Affairs and Forestry
Eco Impact	Eco Impact Legal Consulting (Pty) Ltd
EHI	Estuarine Health Index
EIS	Estuarine Importance Score
ERC	Ecological Reserve Category
EWR	Ecological Water Requirement
H	High
L	Low
M	Medium
MAR	Mean Annual Runoff
MCM	Million Cubic Metres
MCM/a	Million Cubic Metres per annum
MSL	Mean Sea Level
NMMU	Nelson Mandela Metropolitan University
NWA	National Water Act (1998)
PES	Present Ecological Status
ppt	Part per thousand
RDM	Resource Directed Measures
REI	River Estuary Interface
RQO	Resource Quality Objectives
VV	Voelvlei Dam
WMA	Water Management Area
WCWSS	Western Cape Water System Supply Study
WTP	Willingness to pay

1 INTRODUCTION

1.1 Background

Eco Impact Legal Consulting (Pty) Ltd are busy with an application for environmental authorization for expansion of Kliphoek Resort, Velddrif, on behalf of the owner, Mr Jurgen Kotze. The proposed expansion of the existing resort will entail (Figure 1.4):

- the construction of 9 new jetties one with a deck and the extension of an existing jetty;
- the upgrade and restoration of 3 historical jetties on the same footprint
- the construction of 5 new units (cottages);
- the construction of a new boat storage unit (0.2 ha);
- the construction of a new entertainment hall and ablution facilities on existing infrastructure;
- the construction of a new lapa and braai facilities on the foundation of the existing structure;
- the construction of new ablution facilities on existing infrastructure;
- the construction of new camping grounds with 16 stands (1.1 ha);
- the conversion of the existing old quarry to a dam;
- the development of a BMX bicycle track (1.1 ha);
- the development of a bird hide on the existing access trail to the island; and
- the establishment of 8 new caravan stands.

Eco Impact contracted Anchor Environmental Consultants (Pty) Ltd (Anchor) to compile a specialist study report focusing on estuarine and riverine habitats to better understand the impacts of the proposed expansion, and to allow for the recommendation of alternative new facility/ unit locations with lower environment impact, as well as the possibility of more focused mitigation works (including terrestrial/ estuarine habitat rehabilitation and/ or restoration).

This report draws heavily on the findings of the Berg River Baseline Survey between 2003 and 2005 and research on the Berg estuary conducted by Anchor Environmental subsequent to this (2006-2010), with a supplementary visit to the development site in December 2017 to secure first hand observations on the proposed development.

Figure 1. Location of one of the historical jetties on the site (left). The supports for the old jetty are evident in the photo on the right.

Figure 2. Foundations of the old lapa (left) and quarry (right).

Figure 3. Location of the camp site (left) and bird hide (right).

1.2 Terms of Reference

The objective of this study is to identify, assess and evaluate the potential estuarine ecological impacts associated with the construction, operation and decommissioning of the proposed development. The Terms of Reference (ToR) for this project were as follows:

- Description of the receiving environment highlighting all sensitive and significant habitats, fauna and flora including maps indicating locations of sensitive/significant features and habitats;
- Description and assessment of all potential impacts associated with the proposed development on the Berg River estuary, and
- Recommendations on measures to be adopted/implemented that will mitigate negative impacts on the ecology and other beneficial uses of the environment.

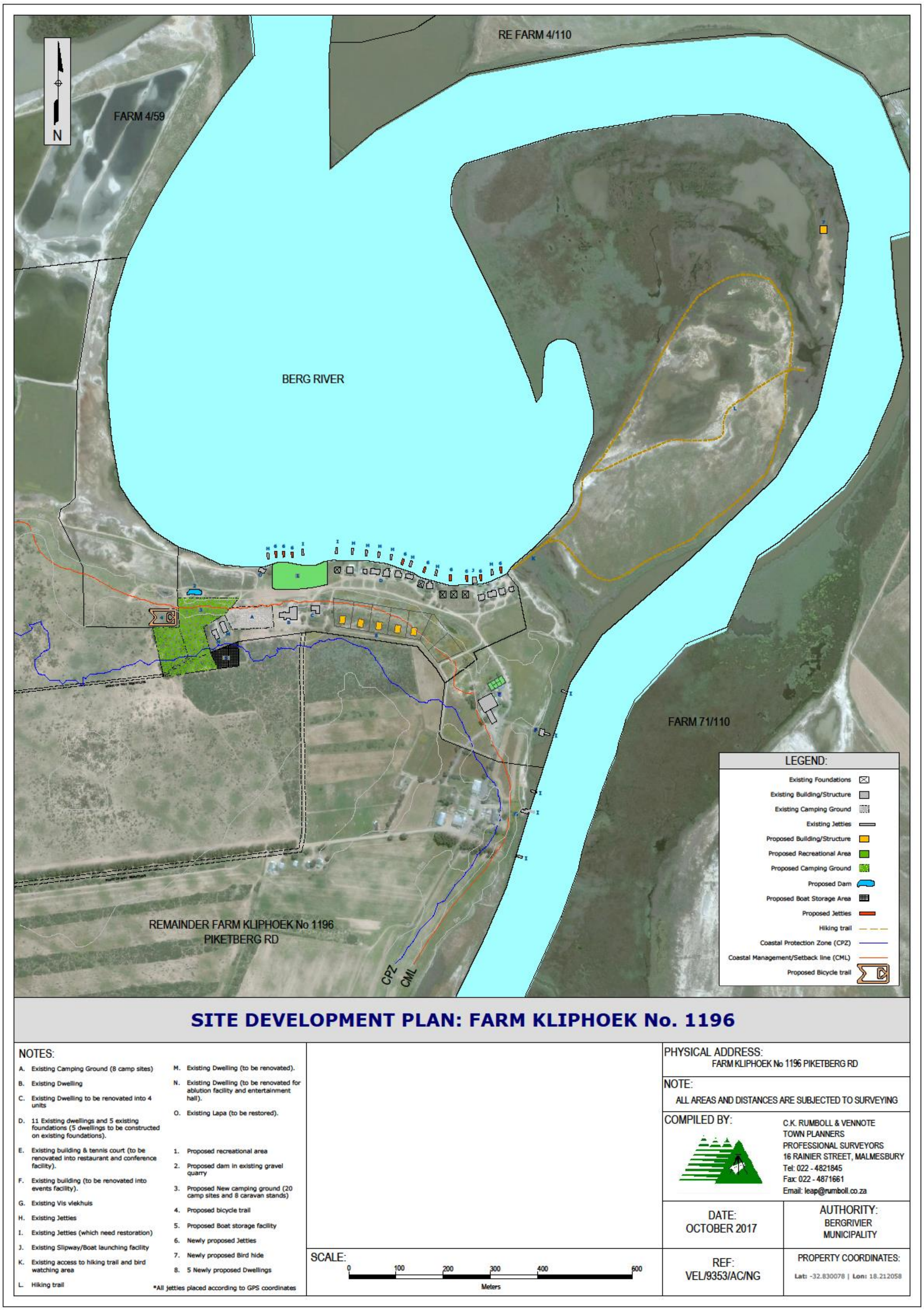

Figure 1.4 Kliphoek site development plan (Eco Impact 2017).

2 DESCRIPTION OF THE RECEIVING ENVIRONMENT

The Berg River Estuary is located on the West Coast of South Africa approximately 130 km north of Cape Town. The Berg River has its source in the Drakenstein and Franschhoek Mountains south of Franschhoek and flows into the sea at St Helena Bay (32°46' S; 18°08' E) some 285 km downstream DWA 2010). It is a river-dominated estuary with tidal influence measurable up to ~70 km from the mouth (Slinger & Taljaard 1994).

The Berg River estuary is considered one of the most important estuaries in South Africa in terms of conservation value, and is categorised as a 'highly important estuary' by DWA (2010). The system has been identified as an important bird area (Barnes 1998), and is also considered of high national conservation importance for estuarine fish, invertebrates and vegetation. The estuary is a desired protected area in the conservation planning assessment conducted for C.A.P.E. (Turpie & Clark 2007) and other studies (e.g. Turpie *et al*. 2002; Turpie 2004).

DWA (2010) list anthropogenic influences such as water abstraction and dams, agricultural and urban encroachment as the predominant treats to the ecological functioning of the estuary, specifically in terms of changes in hydrodynamics and water quality, frequency and intensity of the flooding of the floodplain and reduction of natural vegetation on the floodplain.

For the purposes of this study, the geographical boundaries of the estuary are defined as follows (

Figure 2.1 as per DWA 2010):

Downstream boundary:	Estuary mouth (32° 46.193'S; 18° 8.649'E);
Upstream boundary:	70 km from the mouth (32° 56.388'S; 18° 26.620'E) to the extent of tidal influence
Lateral boundaries:	5-m contour above Mean Sea Level (MSL) along each bank

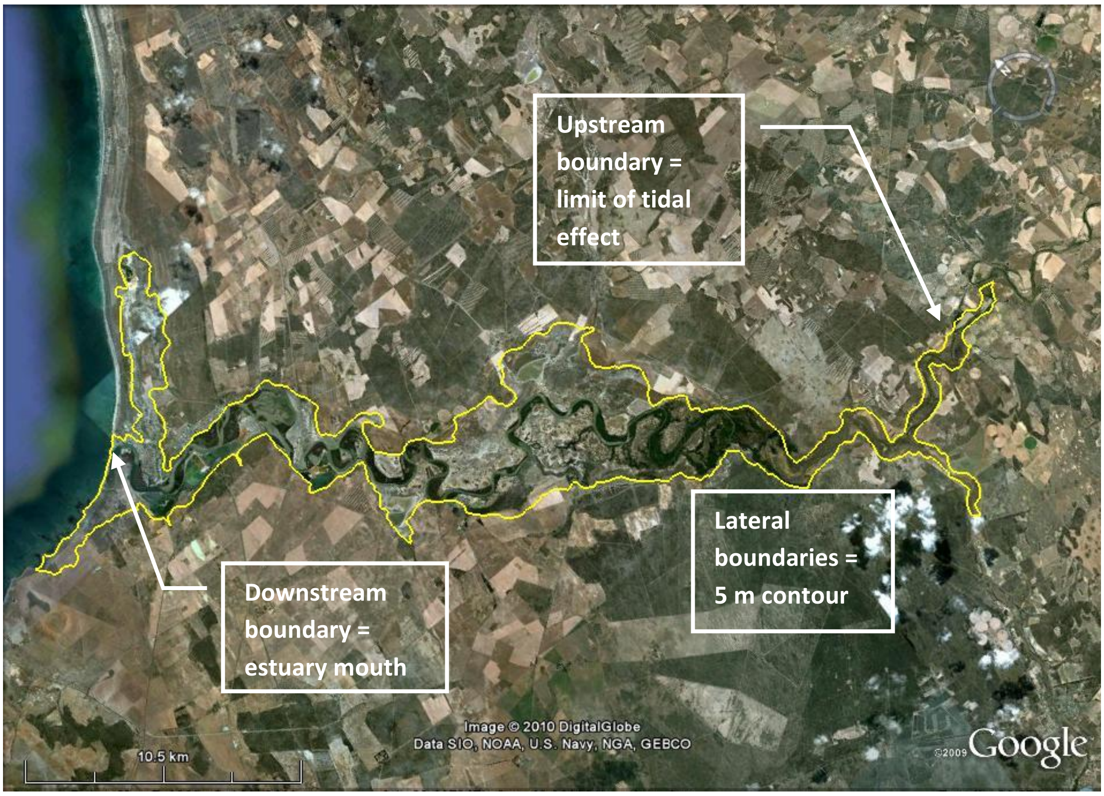

Figure 2.1 Geographical boundaries of the Berg River Estuary (from DWA 2010).

DWA (2010) sub-divided the estuary into four abiotic distinct zones, defined using salinity distributions and channel bathymetry. The Kliphoek site is located within Zone B (**Error! Reference source not found.**), a zone defined as between 12 and 33 km upstream from the mouth.

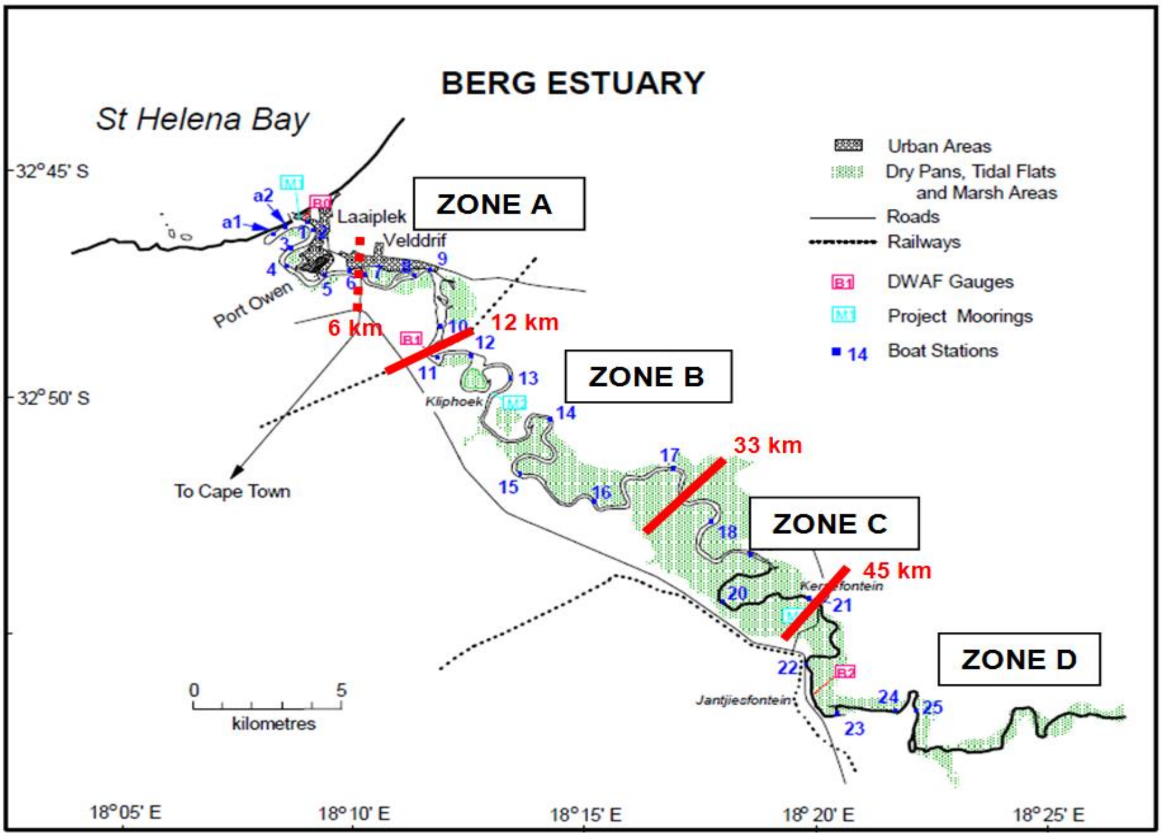

Figure 2.2 Abiotic zones identified for the Berg River Estuary (map adapted from DWAF 2007).

2.1 Catchment and Hydrological Characteristics

Estuaries are by nature shaped by both marine and riverine/freshwater influences, and the interactions between them (Dyer 1997). Estuarine form and function (hydrodynamics, water quality and ecological processes) are also shaped by anthropogenic influences and development, such as agriculture, canalisation and the construction of breakwaters and harbours (DWA 2010).

The Berg River Estuary is one of three permanently open estuaries on the west coast, and one of the largest estuaries in the country, with a total area of 61 km^2. The extensive floodplains, extensive dry pans, tidal flats and marsh areas in the middle and upper reaches of the system and the estuary's shallow gradient (rising 1 m in the first 50 km) make it atypical in relation to most South African estuaries (Day 1981; Schuman 2007).

The estuary is river-dominated, and is one of three South African estuaries that disperse sediment seaward of the river mouth resulting in an offshore mud deposit centre (Cooper 2001).

2.1.1 Marine Influences

The physical oceanography of an area, particularly water temperature, nutrients, oxygen levels, and wave exposure are the principal driving forces that shape the marine communities, and as such, estuarine habitats that fall within the marine ecosystem in question. The Berg River Estuary meets the ocean at St Helena Bay, on the West coast of South Africa. This region is influenced by the Benguela Current System, which extends along the eastern edge of the southern Atlantic Ocean between Cape Agulhas in South Africa, and Southern Angola. The cool Benguela current (10-14°C) is enhanced by the upwelling of colder nutrient-rich deep water (Branch 1981). The area experiences strong southerly and south-easterly winds which are deflected by the Coriolis force. These prevailing conditions deflect the surface waters offshore and draw cold, nutrient rich water to the surface. In winter north-westerly winds cause down-welling, resulting in an increase in surface water temperatures (Shillington 1998).

The mouth of the Berg estuary is permanently open mouth, and was canalised in the late 1960s in an attempt to develop the estuary into a fishing harbour (DWA 2010). "This canalised entrance channel ensures a relatively unconstructed exchange of water between the estuary and the adjacent ocean" (DWA 2010). Another consequence of this stabilised mouth is a strong tidal current in the lower and middle reaches of the estuary (Snow 2010) - sediment in the lower reaches is extremely soft, and indicative of a high percentage of fine sediment particles and high organic content (Snow 2010).

2.1.2 Riverine influences

The Berg River is reported to have a catchment of approximately 9 000 km^2 (Ractliffe 2007). The river flows through mountainous terrain from its source at an altitude of 1 522 m in the Groot Drakenstein Mountains, to the town of Paarl and then through undulating agricultural lands from Paarl towards the sea.

The main channel at Velddrif is 100-200 m wide, becoming progressively narrower and shallower moving upstream. The average depth ranges between 3 and 5 m, but reaches as much as 9 m in areas, with the lower 4 km of the estuary dredged to a depth of at least 4 m to allow for boat navigation (DWA 2010).

There are four major dams within the Berg River Estuary catchment: the Wemmershoek Dam (surface area = 3 km^2, storage capacity = 59.9 Mm^3), the Voëlvlei Dam (surface area = 15 km^2, storage capacity = 170 Mm^3/a), Misverstand Dam (storage capacity = 7.9 Mm^3), and the Berg River Dam (storage capacity = 130 Mm^3/a, surface area = 4.88 km^2) (DWA 2010).

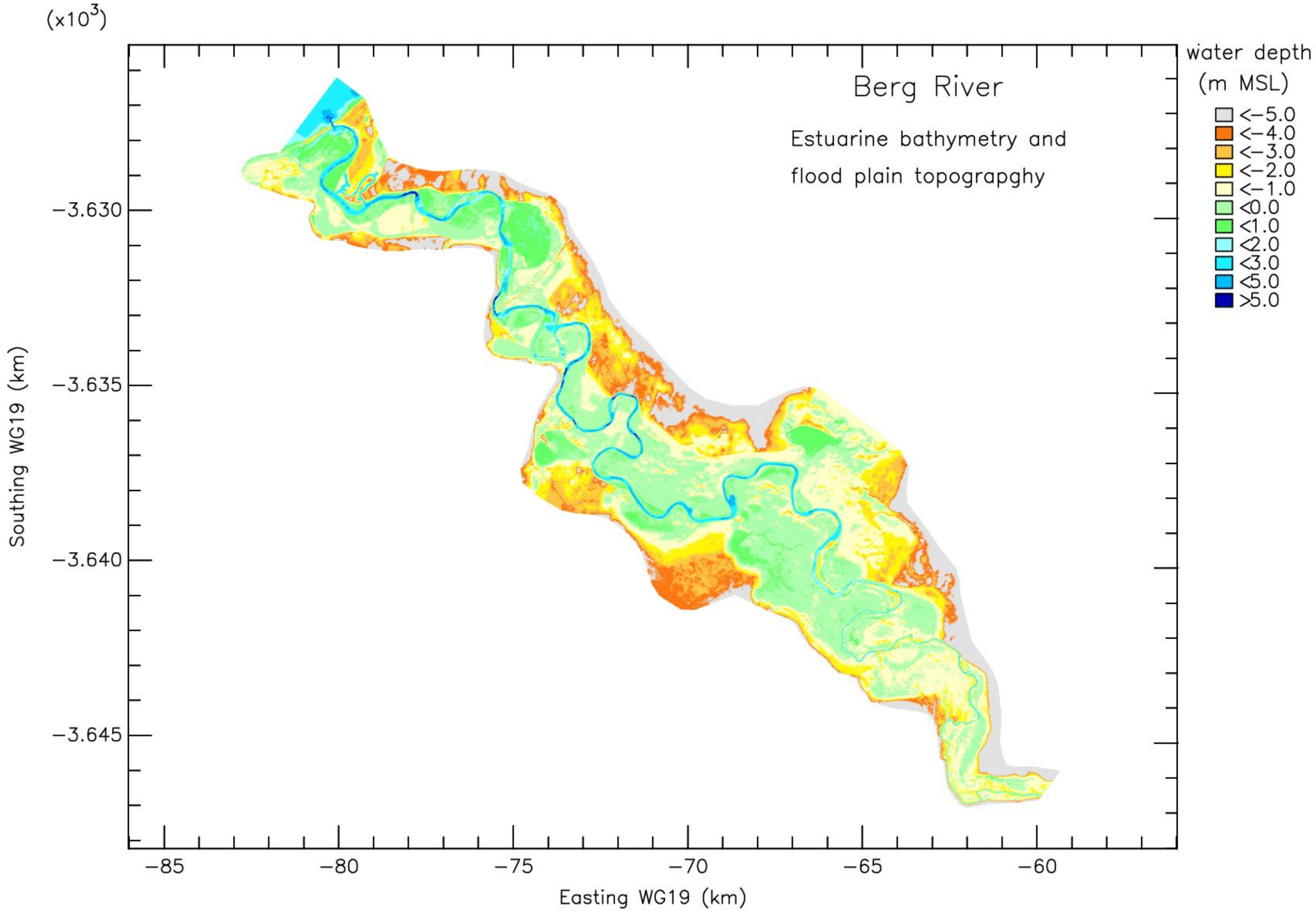

Figure 2.3 **Bathymetry of the Berg Estuary and topography of the Berg Estuary flood plain (DWA 2010).**

2.2 Ecology

The Berg estuary has by far the largest and most diverse saline and freshwater wetlands of all permanently open estuaries in South Africa, making it a unique system worthy of conservation (DWA 2010).

The habitats and ecology of estuaries are dependent on flooding (both tidal and riverine) and suitable salinity. Any changes in these drivers will reduce the species richness, growth, cover and distribution (DWA 2010). The Berg River estuarine habitats are considered degraded, with 40% of total estuarine area lost to agricultural and urban activities (DWA 2010).

2.2.1 Vegetation

Macrophyte habitats and functional groups recorded in the Berg River Estuary include the open water surface area, macroalgae, submerged macrophytes, intertidal salt marsh, supratidal salt marsh, and reeds and sedges (Table 2.1).

In the uppermost 15 km, the estuary is bounded by steep banks covered in riparian woodland. Downstream, the estuary is flanked by a floodplain that varies in width from 1.5 to 4 km in the middle reaches, to <1.5 km in the lower reaches. The largest area is occupied by halophytic floodplain (1547 ha), open pan (1162 ha), sedge pan (1001 ha) and xeric floodplain (998 ha). Intertidal mudflats with eelgrass occupy 206 ha, intertidal salt marsh (505 ha) and reeds and sedges (588 ha) (DWA 2010).

The Kliphoek site vegetation includes supratidal salt marsh, and reed and sedge marsh areas. This vegetation is sensitive to trampling and grazing by livestock (Anchor 2010). The eastern and south eastern proposed development area (i.e. the area affected by jetty restoration) is characterised by low gradients and extensive beds of *Phragmites australis*, which form persistent and dense monospecific stands that outcompete other indigenous estuary-associated species and encroach into the open water area.

Table 2.1 **Macrophyte habitats and functional groups recorded in the Berg River Estuary (from DWA 2010).**

Macrophyte habitat types	Mapping unit (Boucher & Jones 2007)	Dominant species	Cover (ha) (Boucher & Jones 2007)	Cover (ha) within 5-m contour
Open water surface area	River		792.817	850.2
Macroalgae	Macroalgae	*Enteromorpha prolifera, E. flexuosa, Ectocarpus siliculosa and Caloglossa leprieuri.*		~ 200
Submerged macrophytes	Intertidal mudflats	*Zostera capensi, Ruppia cirrhosa, Potamogeton pectinatus*	205.656	206
Intertidal salt marsh	Halophytic salt marsh	*Sarcocornia perenni, Spartina maritima, Triglochin striata, Salicornia meyeriana, Bassia diffusa, Cotula coronopifolia, Leptochloa fusa*	128.860	123.9
	Sedge marsh	*Juncus kraussii*	375.975	375
	Open pan	*Triglochin striata, Salicornia meyeriana*	1 161.668	1158.6
Supratidal salt marsh	Halophytic floodplain	*Sarcocornia pillansii*	1546.764	1520.7
	Xeric floodplain[1]	*Chrysanthemoides incana*	998.001	919.1
Reeds and sedges	Normal tall reed marsh	*Phragmites australis*	514.586	513.5
	Short reed marsh	*Schoenoplectus triquester, Schoenoplectus scirpoideu, Cyperus textilis*	73.059	73.1
	Sedge pan	*Juncus maritimus, Aponogeton distachyos*	1 000.767	975.1

[1] transition habitat between halophytic floodplain and strandveld

2.2.2 Benthic macrofauna

The Berg River Estuary is characterized by high spatial variability in seasonal salinity along its length (Wooldridge & Deyzel 2010) - for example, a higher than average rainfall may result in a freshwater influence extending to the mouth, while the converse would be expected during a time of low rainfall (Slinger & Taljaard 1994). Macrofaunal assemblages have been shown to respond to these temporal changes in freshwater inflow (see Kalke & Montagna 1991; Attrill, Rundle & Thomas 1996; MacKay & Cyrus 2001; Rutger & Wing 2006).

Major invertebrate groups in the Berg River Estuary include copepods, mysids, carid shrimps, sandy subtidal benthos, and muddy subtidal benthos (Table 2.2).

Wooldridge & Deyzel (2010) investigated the macrofaunal community assemblages of the Berg River Estuary[1]. In general, there was a relatively low species richness hypothesised to be linked to the biogeographic region - compared to South Coast estuaries, estuaries on the West Coast tend to have a lower species richness (Wooldridge & Deyzel 2010). The polychaeta *Capitella capitate* (2 183.3 individuals m^{-2}) and *Ceratonereis erythraeensis* (583.3 individuals m^{-2}) dominated the composition and abundance of macrozoobenthic organisms collected in February at the lower most, and most saline sites (Wooldridge & Deyzel 2010). The polychaete *Desdemona ornate* (4 033.3 individuals m^{-2}), the Anomuran *Callianassa kraussi* (666.7 individuals m^{-2}) and the amphipod *Grandidierella lutosa* (1 150 individuals m^{-2}) dominated the sites closest to Kliphoek in February (Wooldridge & Deyzel 2010).

2.2.3 Fish

Estuaries are highly productive with calm, shallow, warm waters, and lowered salinities compared to marine coastal waters (Bennett 1993). These conditions promote rapid growth and/or reduced mortality for fish species, and as a result many species of fish occupy estuaries for either their entire life cycle, or part of it, becoming entirely dependent on estuaries for breeding success. Fish species that are classified as estuarine residents, only breeding in estuaries, (e.g. *Gilchristella aestuaria*) and species that are predominantly marine when adult, but are dependant, either partially or entirely, on estuaries as juveniles, (e.g. *Mugil cephalus*) are often the species of greatest concern when changes occur within an estuary. However, it is important not to lose sight of the fact that fish, irrespective of the group to which they belong, occupy an important position in the food chain within an estuary, and that changes in their composition or abundance will affect other groups, both higher up and lower down in the system (Table 2.3) and those that are less abundant, but remain important due to their being largely or wholly dependent on estuaries for their continued existence (*C. superciliosus, C. multifasciatus, S. bleekeri, P. saltatrix*, *M. cephalus, S. bleekeri, Galeichthyes feliceps*, *Lichia amia,* and *Lithognathus lithognathus*). Many of the latter species are also endemic to southern Africa and some are considered threatened (Mann 2000).

[1] Their results from Stations 4 and 5 are closest to the Kliphoek study site, and are thus the focus of this section. Wooldridge & Deyzel (2010) sampled after the wet (September) and dry season (February).

Table 2.2 Major invertebrate groups found in estuaries with their defining features (from DWA 2010).

Invertebrate groups	Defining features, typical/dominant species
Copepods	Copepods contribute over 85% to total zooplankton abundance both during times of river dominance and dry summers (present day conditions). *Pseudodiaptomus hessei* is the most important species in the Berg River Estuary, making up at least 65% of the 14 species of copepods present during six of the seven visits (note: marine associated species grouped and not identified to the species level). *P. hessei* does not show any correlation to salinity patterns, reflecting its wide salinity tolerance range. Instead, this species responds to pulse events, and is flushed out of the estuary under freshwater dominant states in winter.
Mysids	Four species present in the Berg River Estuary, but only *Mesopodopsis wooldridgei* and *Rhopalophthalmus terranatalis* are important numerically. Both these mysid species attain high densities and because of the population turnover rates (estimated at approx 4-5 times per annum), they contribute significantly to biomass in the water column.
Carid shrimps	Unknown
Sandy subtidal benthos	*Callianassa kraussi* is extremely abundant in the subtidal benthos of the lower estuary (up to 12 km from the mouth). Densities of over 800 ind.m^2 were sampled on a number of occasions. Sand prawns collected in grab samples were newly settled individuals (therefore, near-surface burrowers efficiently sampled with the grab down to 8-10 cm). Adults were not collected, but they were undoubtedly present in deeper sediments. Densities would therefore be greater than the data indicates. Present-day conditions result in lower levels of abundance seawards of the 10-km change due to strong tidal currents and coarser sediments in the channel (current mouth condition and dredging activities that maintain the open mouth channel, even in summer when the mouth became constricted under natural conditions). The blind arm is currently composed of calm waters and fine muddy sediments not suitable for sand prawns). These fine sediments would not have been present under natural conditions.
Muddy subtidal benthos	Like the benthos present in sandy sediments, those inhabiting muddy sediments (Zone B and Zone C) attain extremely high density levels, numerically dominated by amphipods (54% by number – particularly *Corophium triaenonyx* and *Gradiidierella lutosa*) and polychaetes (32% by number – (particularly *Boccardia* sp. and *Ceratonereis keiskama*). Species richness tended to be higher in the dry season, with little spatial shift in population distribution patterns between wet and dry seasons. This reflects the euryhalinty of the macrozoobenthic assemblage to salinity shifts. However, breeding activity is probably curtailed during winter because of low salinity throughout much of the estuary.

The West Coast of South Africa has three river systems that have large enough catchments and sufficient flow to maintain a permanent connection with the sea (Harrison 1997). They are considered to be comparatively poor in fish species richness when compared to estuaries on the south-east and east coasts of South Africa (Harrison 1997; Clark 2010). This trend reflects the well-established eastward increase in species diversity observed for fish, and a number of other taxa, with a change from temperate to subtropical and tropical conditions (Bennett 1993). However, although the numbers of species present in west coast estuaries is low, they do represent a relatively high proportion (79%) of the total west coast inshore fish community (Bennett 1993; Lamberth *et al*. 2008). Marine migrant species in the Berg Estuary were represented mostly by juveniles (Clark 2010). The floodplain surrounding the upper parts of the Berg River Estuary was sampled when significant parts of the floodplain were covered with water (Clark 2010). The number of species captured in these floodplain samples was low (1-6 per survey) and included mostly freshwater species (*Lepomis macrochirus, O. mossambicus, C. carpio* and *Galaxias zebratus*) but also some estuarine residents (*P. knysnaensis* and *C. nudiceps*) and a marine migrant species (*L. richardsonii*) (Clark 2010).

Illegal fishing in the estuary (B. Clark pers. comm. 2010; J. Kotze pers. comm. 2017) is cause for concern, and may be sufficient to eliminate many of the larger fish in the estuary.

Table 2.3 **Dominant fish species in the Berg River Estuary, their estuary association categories (*sensu* Whitfield 1994) and feeding guilds (from DWA 2010).**

Family	Species	Common name	Estuary association category	Mode of feeding[1]
Clupeidae	*Gilchristella aestuaria*	Estuarine round herring	Ia	FF, AC
Gobiidae	*Caffrogobius multifasciatus*	Prison goby	Ia	BI
Atherinidae	*Atherina breviceps*	Silverside	Ib	FF
Clinidae	*Clinus superciliosus*	Super klipvis	Ib	BI
Gobiidae	*Caffrogobius nudiceps*	Nude goby	Ib	BI
Gobiidae	*Psammogobius knysnaensis*	Knysna sand gobi	Ib	BI
Syngnathidae	*Sygnathus temminkii*	Pipefish	Ib	AC
Mugilidae	*Mugil cephalus*	Flathead mullet	IIa	FF, D, H
Soleidae	*Solea bleekeri*	Blackhand sole	IIb	BI
Scianidae	*Argyrosomus coronus*	Kob	IIb	P
Mugilidae	*Liza richardsonii*	Harder	IIc	FF, D, H
Pomatomidae	*Pomatomus saltatrix*	Elf	IIc	P
Carangidae	*Lichia amia*	Leervis, garrick	IIa	P
Galaxiidae	*Galxias zebratus*	Galaxias	IV	AC, BI
Sparidae	*Lithognathus lithognathus*	White steenbras	IIa	BI
Sparidae	*Rhabdosargus globiceps*	White stumpnose	IIc	BI

[1] . FF = Filter feeder, AC = active capture, BI = benthic invertebrate feeder, H = herbivore, P = piscivore

2.2.4 Birds

The Berg River estuary is unusual in that it is functionally linked to a major floodplain area with freshwater wetlands, as well as major artificial saltpans. Some 127 water-associated species (passerine and non-passerine), have been recorded on the estuary and adjacent floodplain (Hockey 1993). Cooper *et al*. (1976) and Ryan *et al*. (1988) recognised the Berg River estuary, with its associated floodplain wetlands, as being of international importance for waterbirds. Indeed, the estuary and wetlands support the highest recorded density of shorebirds on the East Atlantic Seaboard (Velasquez *et al*. 1991, Hockey *et al*. 1992), as well as significant populations of several threatened bird species (Murison & Hockey 2002), including African Marsh Harrier, Caspian Tern, Lesser Flamingo, Black Harrier, African Black Oystercatcher, Eastern White Pelican, Cape Cormorant, Greater Flamingo, Greater Painted Snipe, and Chestnut-banded Plover. Waders are particularly abundant on the floodplain pans (2162 ha) and artificial salt pans (346 ha), especially as their water levels drop, where they feed on the newly exposed shorelines and in shallow water (Hockey *et al*. 1998). The Kliphoek site is considered a very important winter feeding ground for wading birds and waterfowl (Anchor 2010). As such, the estuary is considered a top priority in terms of its overall biodiversity conservation importance (Turpie *et al*. 2002).

Both the natural and man-made pans add considerable diversity to the estuary as well as the area as a whole. In other words these habitats probably allow the estuary to support more birds than it would be able to support in isolation (Turpie 2010). Both the floodplain wetlands and saltworks provide high-tide roosting habitat for birds that forage in the estuary, with different species being prevalent in each (Turpie 2010). These supplementary habitats are thus probably a significant part of the reason for the particularly high density of birds on the estuary (Turpie 2010).

The floodplain area also offers additional habitat for waterbird species that also use intertidal foraging areas, as well as providing habitat for species that are relatively rare or absent in intertidal areas (Turpie 2010). When inundated and during the drawdown period, the floodplain also attracts additional breeding birds that forage elsewhere during the rest of the year. Thus, the floodplain plays a significant role in contributing to the overall species richness and abundance of birds on the lower Berg River, and its overall conservation importance (Turpie 2010).

2.3 Economic Value

The DWA (2010) determination of the Environmental Water Requirements (EWR) study for the Berg River Estuary included an economic valuation of the estuary (an estimated R 75.6 million) that placed it “firmly on the upper end of the value spectrum for temperate estuaries in South Africa” (DWA 2010). The largest component of this value was derived from turnover in the property sector (R 48.6 million), followed closely by visitor expenditure (R 18.3 million) and nursery value (R 8.1 million) (DWA 2010). Subsistence and existence value made relatively small contributions to total estimated economic value (DWA 2010).

Table 2.4 summarises the living resources utilisation and its direct effect on the estuarine biota.

Table 2.4 Summary of the living resources utilisation in the Berg River Estuary (from DWA 2010).

Activity	Present	Describe impact
Recreational fishing	Yes	An increasingly popular destination for recreational fishers. Catch rates are currently higher than those experienced in other estuaries in the country and are driving further increases in effort. Catches include large numbers of juvenile fish under the minimum size, particularly white steenbras and elf and are contributing to the decline in abundance of these species in the system.
Commercial/Subsistence fishing (e.g. gillnet fishery)	Yes	Historically, commercial gill and beach seine net fishers operating in the Berg River Estuary and St Helena Bay have had an enormous impact on fish populations in the estuary through overfishing of adult stocks. All commercial gill net permits on the Berg River Estuary were withdrawn in 2003 and numbers of permit holders in St Helena Bay were dramatically reduced. A dramatic recovery was evident in the abundance of the main target species *Liza richardsonii* as well as many of the bycatch species (*P. saltatrix* and *L. lithognathus*) in the years immediately following the ban largely thanks to active enforcement and good compliance.
Traditional fish traps	No	
Illegal fishing (Poaching)	Yes	Illegal gill net operations have escalated in recent years and now reportedly approaches level seen prior to the ban. Fish populations particularly the marine migrant species, are expected to decline again as a result.
Bait collection	Yes	Localized disturbance of sediments during the collection process.
Aquarium fish collecting	Negligible	
Inappropriate levels of recreational activities (e.g. fishing competitions)	Yes	One marine has been constructed on the estuary and another has been proposed. Recreational boat traffic on the estuary is currently low but is escalating. There is some erosion of banks due to boating and loss of habitat.
Mariculture	No	
Harvesting of mangroves and reeds / sedges	No	
Grazing and trampling of salt mashes	Yes	This has had a severe impact on the salt marsh, xeric floodplain and reed and sedge habitats. Floodplain vegetation is heavily utilised by cattle for grazing during the dry summer months. This has resulted in loss of vegetation cover, erosion and barren windswept areas. The situation will be exacerbated by a decrease in flooding and increase in drought conditions due to freshwater abstraction as well as climate change.
Translocated or alien fauna and flora	Yes	Water hyacinth (*Eichhornia crassipes*) occurs in the upper reaches of the estuary and is indicative of eutrophication. Thick mats of these plants are deposited after flooding on the inundated mudflats, causing die-back of the salt marsh and severely influencing the benthic invertebrate biomass and therefore bird numbers. *Enteromorpha flexuosa*, an alien species native to Europe, is one of several Enteromorpha species that is found on intertidal mudflats in the lower reaches of the estuary.
Bait collection	Yes	Reduction in biomass and destruction of habitat through trampling. Smaller organisms and newly settled prawns most vulnerable to trampling as they burrow in close proximity to the surface.

3 ASSESSMENT OF IMPACTS

In assessing potential impacts on the estuarine biota in the vicinity of proposed construction and maintenance operations, consideration was given to the fact that some proposed development activates would be conducted on areas with existing infrastructure and that the area in question is currently subject to human disturbance and utilised in a variety of ways (fishing, boating, bait collection, swimming, camping etc.). Each of identified impact is likely to affect the associated biota in different ways and at varying intensities depending on the nature of the affected habitat and the sensitivity of the biota. The degree of each impact depends on the construction methods used.

Preliminary identification of potential impacts of the proposed expansion of the expansion of Kliphoek Resort, Velddrif, on the estuarine environment of the Berg River was undertaken during a site visit on 6 December 2017. These included construction phase impacts that are expected to be localised and of temporary duration, while operating phase impacts are of a longer duration.

In the estuarine environment a disturbance can be relatively short-lived (e.g. accidental spill which is diluted in the water column below threshold limits within hours) but the effect of such a disturbance may have a much longer lifetime (e.g. attachment of pollutants to sediment which may be disturbed frequently). The assessment and rating procedure described in Appendix 1 (as per the specialist terms of reference) addresses the effects and consequences (i.e. the impact) on the environment rather than the cause or initial disturbance alone. To reduce negative impacts, precautions referred to as 'mitigation measures' are set and attainable mitigation actions are recommended. In this report, the 'construction footprint' is defined as the total area of new infrastructure as determined by design engineers.

Results of each assessment are presented in Table 3.1 to Table 3.12 and are summarised in Table 4.1.

3.1 Construction phase

Possible environmental impacts caused during the construction phase that are likely to impact on estuarine communities include the effects of:

- removal or alteration of soft sediment estuarine habitat;
- temporary loss of artificial wood/concrete habitat;
- mobilisation of contaminants in terrestrial sediments through construction activities and subsequent run-off into the estuary;
- mobilisation of sediment in the water column;
- loss of vegetation (including intact vegetation, ecologically important species and species of conservation concern);
- loss of ecological processes associated with the loss of intact vegetation, ecologically important species and species of conservation concern;
- generation and disposal of waste;
- increased noise and vibration; and
- spillage of hazardous substances.

3.1.1 Disturbance to or alteration of soft sediment estuarine habitat

Some planned development activities (i.e. the construction of new jetties) is likely to cause disturbance to shallow, subtidal sediment adjacent to the construction footprint. The impact of this is rated 'insignificant' (Table 3.1) as the size of the area likely to be impacted is very small.

Table 3.1 **Impact 1: Disturbance to or alteration of soft sediment estuarine habitat.**

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Low 1	Short -term 1	Very Low 3	Improbable	**INSIGNIFICANT**	-ve	Medium
Mitigation measures: • Not considered necessary due to low significance.								

3.1.2 Temporary loss of artificial wood/concrete habitat

Some planned development activities (i.e. the renovation of new jetties) may require the removal of existing infrastructure that has been colonised by invertebrate fauna and flora. The impact of this is rated 'insignificant' (Table 3.2) as the size of the area likely to be impacted is negligible.

Table 3.2 **Impact 2: Temporary loss of artificial wood/concrete habitat**

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Low 1	Short -term 1	Very Low 3	Improbable	**INSIGNIFICANT**	-ve	Medium
Mitigation measures: • Not considered necessary due to low significance.								

3.1.3 Mobilisation of contaminants in terrestrial sediments through construction activities and subsequent run-off into the estuary

Terrestrial sediment run-off into the marine system has a variety of negative impacts, including increased turbidity (which may impair prey capture in piscivorous fish that rely on visual prey detection methods, and a decrease in autotrophic microphytobenthos and phytoplankton production due to reduced light penetration) and the smothering of benthic marine organisms. A further impact is the input of terrestrial derived pollutants into the estuarine system. There are no information on the level of contamination of the terrestrial sediments at the proposed construction sites, however, it is expected to be low due to an absence of any development on this site. In addition, proposed construction area is small. Thus, this impact was rated as being of 'low' significance that is reduced to 'insignificant' with appropriate mitigation (Table 3.3).

Table 3.3 **Impact 3: Mobilisation of contaminants in terrestrial sediments through construction activities and subsequent run-off into the estuary**

<table>
<tr><th></th><th>Extent</th><th>Intensity</th><th>Duration</th><th>Consequence</th><th>Probability</th><th>Significance</th><th>Status</th><th>Confidence</th></tr>
<tr><td>Without mitigation</td><td>Local
1</td><td>High
3</td><td>Medium-term
2</td><td>Low
5</td><td>Definite</td><td>LOW</td><td>-ve</td><td>High</td></tr>
<tr><td colspan="9"><u>Recommended mitigation measures:</u>
• Use bunding where possible.
• Collect and dispose of polluted soil at appropriate bio-remediation sites.
• Minimise run-off as much as possible i.e. ensure that construction does not coincide with heavy rainfall, cover disturbed sediment etc.
• Dust suppression techniques to be used on all dust generating surfaces. Screening measures to be placed adjacent to roads and residences. Handling of soils is not to be conducted during high winds (25km/h). Soil stockpiles to be covered with hessian or chip/mulch from cleared shrubs/trees to prevent dust generation. The speed of construction vehicles to be restricted within the construction area or near stockpiles. Trucks transporting any form of soil or waste should be covered with a tarpaulin.</td></tr>
<tr><td>With mitigation</td><td>Low
1</td><td>Medium
2</td><td>Short -term
1</td><td>Very Low
4</td><td>Improbable</td><td>INSIGNIFICANT</td><td>-ve</td><td>Medium</td></tr>
</table>

3.1.4 Loss of vegetation

A few activities associated with this development will require the clearing of riparian vegetation. The majority of the area under assessment have already been modified in some way, with the northern sites characterised by open, planted “lawns” and bare ground, the eastern sites dominated by extensive beds of *Phragmites australis*. Therefore, this impact has been given a ‘low’ significance rating prior to recommended mitigation, and an ‘insignificant’ rating after mitigation (Table 3.4).

Table 3.4 **<u>Impact 4</u>: Loss of vegetation, including intact vegetation, ecologically important species and species of conservation concern as a result of the construction, and the removal of natural areas for the development of infrastructure.**

<table>
<tr><th></th><th>Extent</th><th>Intensity</th><th>Duration</th><th>Consequence</th><th>Probability</th><th>Significance</th><th>Status</th><th>Confidence</th></tr>
<tr><td>Without mitigation</td><td>Local
1</td><td>High
3</td><td>Medium-term
2</td><td>Low
5</td><td>Definite</td><td>LOW</td><td>-ve</td><td>High</td></tr>
<tr><td colspan="9"><u>Recommended mitigation measures:</u>
• Immediate rehabilitation of any areas disturbed as a result of construction activities. Use species that are specific to the original vegetation of the affected area (ensure to keep top soil separate).
• Ensure that intact vegetation is temporarily fenced off at all building sites adjacent to natural areas; and
• Rubble and waste is not to be dumped in natural areas.</td></tr>
<tr><td>With mitigation</td><td>Local
1</td><td>Low
1</td><td>Short -term
1</td><td>Very Low
3</td><td>Improbable</td><td>INSIGNIFICANT</td><td>-ve</td><td>Medium</td></tr>
</table>

3.1.5 Loss of ecological processes associated with the loss of vegetation

Impacts on ecological processes occur when intact vegetation is locally lost, leading to fragmentation of the habitat, and when ecologically important species are lost. Therefore, if the topsoil and vegetation can be conserved processes will continue albeit in a modified way. However, as discussed in Section 0, the majority of the area under assessment is considered transformed, and as such, this impact was determined to have a 'very low' significance after mitigation (Table 3.5).

Table 3.5 **Impact 5: Loss of ecological processes associated with the loss of intact vegetation, ecologically important species and species of conservation concern.**

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	High 3	Medium-term 2	Low 5	Definite	**LOW**	-ve	High
Recommended mitigation measures: • Mitigation measures as stated in Impact 4.								
With mitigation	Local 1	Medium 2	Short -term 1	Very Low 4	Definite	**VERY LOW**	-ve	Medium

3.1.6 Waste generation and disposal

South Africa has laws against littering, both on land and in the coastal zone, but unfortunately these laws are seldom rigorously enforced. Objects which are particularly detrimental to aquatic fauna include plastic bags and bottles, pieces of rope and small plastic particles. Large numbers of aquatic organisms are killed or injured daily by becoming entangled in debris or as a result of the ingestion of small plastic particles (Wallace 1985, Gregory 2009, Wright *et al*. 2013). If allowed to enter the ocean, solid waste may be transported by currents for long distances out to sea and around the coast. Thus, unlike fuel or sewage contamination, the extent of the damage caused by solid waste is potentially large. The impact of floating or submerged solid materials on aquatic life (especially birds and fish) can be lethal and can affect rare and endangered species.

The problem of litter entering the aquatic environment has escalated dramatically in recent decades, with an ever-increasing proportion of litter consisting of non-biodegradable plastic materials. In order to reduce this, all domestic and general waste generated must be disposed of responsibly. All reasonable measures must be implemented to ensure there is no littering and that construction waste is adequately managed. Staff must be regularly reminded about the detrimental impacts of pollution on aquatic species and suitable handling and disposal protocols must be clearly explained and sign boarded. The 'reduce, reuse, recycle' policy must be implemented. This impact is rated as 'moderate' without mitigation and is reduced to 'low' by implementing the actions outlined in Table 3.6.

Table 3.6 **Impact 6:** **Waste generation and disposal during construction.**

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	International 3	Low 1	Long-term 3	High 7	Possible	**MEDIUM**	-ve	High
Essential mitigation: • Inform all staff about sensitive marine species and the responsible disposal of construction waste. • Suitable handling and disposal protocols must be clearly explained and sign boarded. • Reduce, reuse, recycle.								
With mitigation	International 3	Low 1	Medium-term 3	Medium 7	Improbable	**LOW**	-ve	High

3.1.7 Noise and vibration

During construction operations, noise may have an impact on aquatic organisms in the vicinity. Noise may be generated by construction activities (e.g. earthmoving vehicles, service vehicles, vessels, cranes, heavy machinery, generators, chopping, drilling, grinding etc.). Benthic invertebrates have been shown to be relatively insensitive to low frequency sound, whilst fish appear to be able to tolerate moderate sound levels (Keevin & Hempen 1997). Foraging birds are expected to avoid the sound source should it reach levels sufficient to cause discomfort. Due to the existence of similar habitats within the surrounding area, it is not expected that avifauna will be excluded from feeding on a particular food source. As a precautionary measure, mobile equipment, vehicles and power generation equipment should be subject to noise tests which are measured against manufacturer specifications to confirm compliance before deployment on site. Noise emissions from mobile and fixed equipment should be subject to periodic checks as part of regular maintenance programmes to allow for detection of any unacceptable increases in noise. After mitigation is considered, the impact of noise and vibration on the marine environment is considered to be 'insignificant' (Table 3.7).

Table 3.7 **Impact 7:** **The effect of increased noise and vibration from construction on estuarine biota.**

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Low 1	Short-term 1	Very Low 3	Definite	**VERY LOW**	-ve	Medium
Recommended mitigation measures: • Subject mobile equipment, vehicles and power generation equipment to noise tests at commencement and periodically throughout the construction phase.								
With mitigation	Low 1	Low 1	Short -term 1	Very Low 3	Improbable	**INSIGNIFICANT**	-ve	Medium

3.1.8 Hazardous substances

The spillage of a variety of hazardous substances can occur during the use of heavy machinery, construction vehicles and construction vessels. For example, spillage may occur as a result of fuel leaks, refuelling, or collision.

Hydrocarbons are toxic to aquatic organisms and precautions must be taken to prevent them from contaminating the environment. This impact can be mitigated successfully if authorities implement a rigorous environmental management and control plan to limit ecological risks from accidents.

All fuel and oil must be stored with adequate spill protection and no leaking vehicles should be permitted on site. Intentional disposal of any substance into the aquatic environment should be strictly prohibited, while accidental spillage must be prevented, contained and reported immediately. After mitigation, the impact of accidental spillage is considered to be 'very low' (Table 3.8**Error! Reference source not found.**).

Table 3.8 **Impact 8: The effect of the spillage of hazardous substances on estuarine biota.**

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	High 3	Medium-term 2	Medium 6	Possible	**LOW**	-ve	Medium
Essential mitigation measures: • Intentional disposal of any substance into the environment must be strictly prohibited, while accidental spillage must be prevented, contained and reported immediately. • Implementation of a rigorous environmental management and control plan (including procedures for remediation). • All fuel and oil is to be stored with adequate spill protection. • No leaking vehicles are permitted on site. • All hazardous substances must be accompanied by a permit, a hazard report sheet, and a first aid treatment protocol and may only be handled by suitably trained operators.								
With mitigation	Local 1	Medium 2	Medium-term 2	Low 5	Improbable	**VERY LOW**	-ve	Medium

3.2 Operational phase

Possible environmental impacts caused during the operational phase that are likely to impact on marine communities include the effects of:

- altered jetty design impacting on hydrodynamics and sediment movement;
- increased foot and vessel traffic impacting on biological organisms;
- generation and disposal of waste; and,
- noise and vibration.

3.2.1 Hydrodynamic impacts

There are little envisioned hydrodynamic impacts given that most of the proposed jetty development will be located on existing infrastructure i.e. existing jetties will be upgraded and refurbished. The new jetties that are proposed are also located amongst existing jetty infrastructure. Given the small area of impact, there should be little to no impact on sediment processes as a result. Consequently, the assessment of the severity of these impacts resulted in the overall significance being 'insignificant' (Table 3.9).

Table 3.9 Impact 9: Effect on hydrology and sediment movement of the new infrastructure.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Low 1	Medium - term 2	Very Low 4	Improbable	**INSIGNIFICANT**	-ve	Medium
Mitigation measures: • Not considered necessary due to low significance.								

3.2.2 Increased foot and vessel traffic

An increase in the frequency of vessel traffic may result in a rise in the amount of noise and vibration, which can have an impact on estuarine biota and shore birds in the area. The Kliphoek site is considered a very important winter feeding ground for wading birds and waterfowl (Anchor 2010).

Increased capacity of the Kliphoek resort may also negatively affect biota through an increase in foot traffic. Access to the jetties and other such infrastructure may result in trampling of riverine vegetation and other disturbance of biota. The owner, Mr Jurgen Kotze, has indicated that walkways will be constructed to the jetties to minimise trampling (J. Kotze, pers. com. 2017).

As the maximum impact radius of vessel traffic noise, and the area that may be disturbed by trampling is very small compared to the population distribution ranges of the birds in question, it is therefore unlikely that there will be significant effects on biota and this impact is therefore rated 'insignificant' (Table 3.10**Error! Reference source not found.**).

Table 3.10 Impact 10: Increased foot and vessel traffic on biological organisms

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Low 1	Medium-term 2	Very Low 4	Improbable	**INSIGNIFICANT**	-ve	Medium
Mitigation measures: • Not considered necessary due to low significance.								

3.2.3 Generation and disposal of waste

All domestic and general waste generated during the operational phase must be disposed of responsibly. All reasonable measures must be implemented to ensure there is no littering and that waste is adequately managed. In order to prevent litter from entering the marine environment, staff must be regularly reminded about the detrimental impacts of pollution on marine species and suitable handling and disposal protocols must be clearly explained and sign boarded. The 'reduce, reuse, recycle' policy must be implemented in all areas of the Port. See impact assessment **Error! Reference source not found.** for impact severity rating and mitigation.

3.2.3.1 Spillage of hydrocarbons

There is a risk of accidental spillage of hydrocarbons associated with the use of equipment, vehicles and vessels during the operational phase. Hydrocarbons are toxic to aquatic organisms and precautions must be taken to prevent them from contaminating the marine environment. This impact can be mitigated successfully if a rigorous environmental management and control plan designed to limit ecological risks from accidents and day to day operations is implemented. All fuel and oil must be stored with adequate spill protection and no leaking vehicles should be permitted on site. See impact assessment Table 3.11 for impact severity rating and mitigation.

3.2.3.2 Hazardous substances associated with increased vessel traffic

An increase in vessel traffic is likely to be accompanied by an increase in the concentration of anti-fouling paint dissolving in the water. Anti-fouling paint is a specialized coating applied to the hull of a vessel to slow the growth of organisms that affect a vessel's performance and durability. Anti-fouling paint is known to contain copper and other noxious products that are toxic to marine life. Accumulation of these substances in the sediment could potentially have a negative effect on the biodiversity and abundance of sandy macrofauna, particularly the mud prawn *Callichirus kraussi*.

If the mitigation measures outlined in Table 3.11 are not strictly followed to obtain a 'very low' significance, contamination of the marine environment by hazardous substances will result in a 'medium' rating.

Table 3.11 Impact 11: Generation and disposal of waste

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	High 3	Medium - term 2	Medium 6	Probable	**MEDIUM**	-ve	Medium
Essential mitigation measures: • Inform all staff about the sensitivity of the marine environment and the suitable disposal of waste. • Suitable handling and disposal protocols must be clearly explained and sign boarded. • All fuel and oil is to be stored with adequate spill protection. • No leaking vehicles are permitted on site. • Intentional disposal of any substance into the marine environment is strictly prohibited, while accidental spillage must be prevented, contained and reported immediately.								
With mitigation	Local 1	Medium 2	Medium-term 2	Low 5	Improbable	**VERY LOW**	-ve	Medium

3.2.4 Noise and vibration

The operational impact of increased noise pollution relates to the utilisation of the new infrastructure (i.e. the entertainment hall, lapa and braai facilities etc.). The impact rating of these activities is rated lower than that of the construction phase increased noise and vibration (see Section 3.1.7). Operation noise impacts are rated as 'insignificant' prior to mitigation (Table 3.12) given their temporary nature and low intensity.

Table 3.12 Impact 12: Increased noise and vibration

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Low 1	Short - term 1	Very Low 3	Improbable	**INSIGNIFICANT**	-ve	Medium
Mitigation measures: • Not considered necessary due to low significance.								

3.3 Decommissioning phase

It is envisioned that only minor routine maintenance will be required over the course of the design life of the proposed development. Impacts expected in the decommissioning phase have been dealt with in the construction phase (see Section 3.1).

3.4 Cumulative environmental impacts

Cumulative marine environmental impacts associated with this project are primarily related to operational impacts resulting from increased waste generation and risk of pollution if not managed correctly.

The results of this study indicate that the relatively small sections of riparian vegetation that may be lost during the construction phase of this project are represented elsewhere in the greater Berg River Estuary, and are not unique in terms of species composition, biomass or abundance when compared to the rest of the area. Furthermore, it is important to note that the impact site is already moderately disturbed by ongoing tourism and recreational activities. While some artificial hard-substratum will be lost during the construction phase, new jetty construction will create new habitat that will be colonised by marine invertebrates shortly after construction.

4 SUMMARY OF POTENTIAL IMPACTS

Table 4.1 **Summary of potential impacts as a result of construction and operation of the proposed facilities.**

Phase	Impact identified	Consequence	Probability	Significance	Status	Confidence
Construction	Impact 1: Disturbance to or alteration of soft sediment estuarine habitat.	Very Low	Improbable	**INSIGNIFICANT**	-ve	Medium
	Impact 2: Temporary loss of artificial wood/concrete habitat.	Very Low	Improbable	**INSIGNIFICANT**	-ve	Medium
	Impact 3: Mobilisation of contaminants in terrestrial sediments through construction activities and subsequent run-off into the estuary.	Low	Definite	**LOW**	-ve	High
	With mitigation	Very Low	Improbable	**INSIGNIFICANT**	-ve	Medium
	Impact 4: Loss of vegetation, including intact vegetation, ecologically important species and species of conservation concern as a result of the construction, and the removal of natural areas for the development of infrastructure.	Low	Definite	**LOW**	-ve	High
	With mitigation	Very Low	Improbable	**INSIGNIFICANT**	-ve	Medium
	Impact 5: Loss of ecological processes associated with the loss of intact vegetation, ecologically important species and species of conservation concern.	Low	Definite	**LOW**	-ve	High
	With mitigation	Very Low	Definite	**VERY LOW**	-ve	Medium
	Impact 6: Waste generation and disposal during construction.	High	Possible	**MEDIUM**	-ve	High
	With mitigation	Medium	Improbable	**LOW**	-ve	High
	Impact 7: Increased noise and vibration during construction.	Very Low	Definite	**VERY LOW**	-ve	Medium
	With mitigation	Very Low	Improbable	**INSIGNIFICANT**	-ve	Medium
	Impact 8: Spillage of hazardous substances on estuarine biota.	Medium	Possible	**LOW**	-ve	Medium
	With mitigation	Low	Improbable	**VERY LOW**	-ve	Medium
Operation	Impact 9: Altered quay design affecting hydrodynamics and sediment movement.	Very Low	Improbable	**INSIGNIFICANT**	-ve	Medium
	Impact 10: Increased foot and vessel traffic sensitive biota.	Very Low	Improbable	**INSIGNIFICANT**	-ve	Medium
	Impact 11: Generation and disposal of waste.	Medium	Probable	**MEDIUM**	-ve	High

Phase	Impact identified	Consequence	Probability	Significance	Status	Confidence
	With mitigation	Low	Improbable	**VERY LOW**	-ve	High
	Impact 12: Noise and vibration.	Very Low	Improbable	**INSIGNIFICANT**	-ve	Medium

5 CONCLUSIONS AND RECOMMENDATIONS

The Berg River Estuary is a large, permanently open estuary on the West Coast, with the extensive floodplains and dry pans, tidal flats and marsh areas as well as the estuary's shallow gradient (rising 1 m in the first 50 km) making it atypical compared to most other South African estuaries. The estuary is considered one of the most important estuaries in South Africa in terms of conservation value - the system has been identified as an important bird area, and is also considered of high national conservation importance for estuarine fish, invertebrates and vegetation. Anthropogenic threats to the system include water abstraction and dams (there are four major dams within the Berg River Estuary catchment), agricultural and urban encroachment as the predominant treats to the ecological functioning of the estuary, specifically in terms of changes in hydrodynamics and water quality, frequency and intensity of the flooding of the floodplain and reduction of natural vegetation on the floodplain.

Twelve potential environmental impacts were assessed for this report, ranging from habitat loss to operational effects (see Table 4.1). Of these, five were of 'insignificant' significance and do not require mitigation. One impact (the generation and disposal of waste) was rated as of 'medium' significance, but the significance rating was reduced to 'very low' after mitigation. No impact was rated as 'high'. Implementation of mitigation measures is expected to reduce these ratings to 'very low' or 'insignificant' (Table 4.1).

Mitigation measures, both best practise and essential, include informing all staff about the suitable disposal of waste; reduce, reuse, recycle; the intentional disposal of any substance into the estuarine environment must be strictly prohibited, while accidental spillage must be prevented, contained and reported immediately; an environmental management and control plan (including procedures for remediation) should be implemented; all fuel and oil must be stored with adequate spill protection, and no leaking vehicles are to be permitted on site; to use bunding where possible, minimise top-soil run-off as much as possible and collect and dispose of polluted soil at appropriate bio-remediation sites; to use dust suppression techniques all dust generating surfaces and to enforce strict construction and private vehicle speed limits; and the immediate rehabilitation of any areas disturbed as a result of construction activities.

Based on the impacts assessed in this report, it is recommended that the proposed development proceed with the implementation of strict environmentally responsible practices as outlined in the recommended mitigation measures.

6 REFERENCES

Anchor Environmental Consultants 2010. Berg Estuary Management Plan. Prepared for C.A.P.E. Estuaries Management Programme. January 2010.

Attrill MJ, Rundle SD & Thomas MR. 1996. The influence of drought-induced low freshwater flow on an upper estuarine macroinvertebrate community. *Water Research* 30: 261-268.

Barnes K. 1998. *The Important Bird Areas of Southern Africa*. Birdlife South Africa, Johannesburg. 394pp.

Bennett BA. 1993. The fish community of the Berg River estuary and an assessment of the likely effects of reduced freshwater inflows. *South African Journal of Zoology* 29: 118-125.

Branch GM. 1981. The Living Shores of Southern Africa. Struik Publishers (Pty) Ltd. Cape Town.

Clark BM. 2010. Western Cape Water System Supply Study Preliminary Phase Comprehensive Determination of the Environmental Water Requirements for the Berg River Estuary Appendix H: Fish. Draft Report prepared by Anchor Environmental Consultants, March 2010.

Cooper JAG. 2001. Geomorphological variability among micro tidal estuaries from the wave-dominated South African coast. *Geomorphology*, 40, 99–122.

Cooper J, Summers RW & Pringle JS. 1976. Conservation of coastal habitats of waders in the southwestern Cape, South Africa. *Biological Conservation*, 10: 239-247.

Day JH. 1981. Summaries of current knowledge of 43 estuaries in southern Africa. In: JH Day (ed.), *Estuarine Ecology with Particular Reference to Southern Africa*. AA Balkema, Cape Town. pp 251-329.

Department of Water Affairs (DWA) 2010. Feasibility Study into the Potential Development of Further Surface Water Supply Schemes for the Western Cape: Comprehensive assessment of the Ecological Water Requirements for the Berg River Estuary. Report No. Pretoria.

Department of Water Affairs and Forestry (DWAF). 2007. Berg River Baseline Monitoring Programme Final Report - Volume 3: Estuary and Floodplain Environment. Clark BM and Ractliffe G. (Eds.). Report prepared for the Department of Water Affairs and Forestry, DWAF Report No. P WMA 19/G10/00/1907. Pretoria.

Dyer K.R, 1997. *Estuaries, a Physical Introduction*, 2nd Edition. John Wiley & Sons, Chichester, 195 pp.

Harrison TD. 1997. A preliminary survey of coastal river systems on the South African west coast, Orange River – Groot Berg, with particular reference to fish fauna. *Transactions of the Royal Society of South Africa,* 52: 277–321.

Hockey PAR. 1993. Potential Impacts of Water Abstraction on the Birds of the Lower Berg River Wetlands. Percy FitzPatrick Institute, University of Cape Town; Unpublished report to DWAF.

Hockey PAR, Navarro RA, Kalejta B & Velasquez CR. 1992. The riddle of the sands: why are shorebird densities so high in southern estuaries? *American Naturalist*. 140: 961-979.

Hockey PAR, Turpie JK & Velasquez C. 1998. What selective pressures have driven the evolution of deferred northward migration by juvenile waders? *Avian Biology* 29: 325-330.

Kalke RD & Montagna PA. 1991. The effect of freshwater inflow on macrobenthos in the Lavaca River Delta and upper Lavacu Bay, Texas. *Contributions in Marine Science* 52:49-71.

Lamberth SJ, van Niekerk L & Hutchings K. 2008. Comparison of, and the effects of altered freshwater inflow on, fish assemblages of two contrasting South African estuaries: the cool temperate Olifants and the warm-temperate Breede. *African Journal of Marine Science* 30: 311-336.

Mackay CF & Cyrus DP. 2001. Is freshwater quality adequately defined by physico-chemical components? Results from two drought affected estuaries on the east coast of South Africa. *Journal of Marine and Freshwater Research* 52: 267-281.

Mann BQ. 2000. *Southern African Marine Linefish Status Reports*. South African Association for Marine Biological Research, Oceanographic Research Institute, Special Publication No. 7.

Murison G & Hockey PAR. 2002. *Conservation Management of the Lower Berg River Wetlands, South Africa – Avian Perspectives*. Unpublished report.

Ractliffe G. 2007. Chapter 2: Berg River Catchment. In Berg River Baseline Monitoring Programme Final Report – Volume 1: Introduction to the Berg River Catchment; Groundwater and Hydrology, Ractliffe, G. (ed.): DWAF Report No. P WMA 19/G10/00/1807, pp 8 – 52.

Rutger SM & Wing SR. 2006. Effects of freshwater input on shallow-water infaunal communities in Doubtful Sound, New Zealand. *Marine Ecology Progress Series* 314: 35-47.

Ryan PG, Underhill LG, Cooper J & Waltner M. 1988. Waders (Charadrii) and other waterbirds on the coast, adjacent wetlands and offshore islands of the southwestern Cape Province, South Africa. *Bontebok* 6: 1-19.

Schumann EH. 2007. Chapter 3: Water Chemistry - Salinity, Temperature, Oxygen and Turbidity. In: Berg River Baseline Monitoring Programme Final Report - Volume 3: Estuary And Floodplain Environment. Clark BM & Ratcliffe G. (Eds). Report prepared for the Department of Water Affairs and Forestry, DWAF Report No. P WMA 19/G10/00/1907. Pretoria, p20-83.

Shillington FA. 1998. The Benguela upwelling system off southwestern Afica. Coastal segment (16, E) In: Robinson AR & Brink KH (Eds), *The Sea*, Vol. 11, 583-604.

Slinger JH & Taljaard S. 1994. Preliminary investigation of seasonality in the Great Berg River Estuary. *Water SA*. 20: 279-288.

Snow GC. 2010. Western Cape Water System Supply Study Preliminary Phase Comprehensive Determination of the Environmental Water Requirements for the Berg River Estuary Appendix E: Microalgae. Draft Report prepared by the Nelson Mandela Metropolitan University, March 2010.

Turpie JK. 1995. Prioritising South African estuaries for conservation: a practical example using waterbirds. *Biological Conservation* 74: 175-185.

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

Turpie JK. 2010. Comprehensive determination of the Environmental Water Requirements for the Berg River Estuary. Appendix I: Draft Specialist Study on Birds. Prepared by Anchor Environmental Consultants (CC). March 2010.

Turpie JK & Clark BM. 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 JK, Adams JB, Joubert A, Harrison TD, Colloty BM, Maree RC, Whitfield AK, Wooldridge TH, 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.

Velasquez CR, Kalejta B & Hockey PAR. 1991. Seasonal abundance, habitat selection and energy consumption of waterbirds at the Berg River Estuary, South Africa. *Ostrich* 62: 109-123.

Whitfield AK. 1994. An estuary-association classification for the fishes of southern Africa. *South African Journal of Science* 90: 411-417.

Wooldridge TH & Deyzel SHP. 2010. Western Cape Water System Supply Study Preliminary Phase Comprehensive Determination of the Environmental Water Requirements for the Berg River Estuary Appendix G: Benthic Macrofauna. Draft Report prepared by the Nelson Mandela Metropolitan University, March 2010.

7 APPENDIX 1

Impact Assessment Methodology

The significance of all potential impacts that would result from the proposed project is determined in order to assist decision-makers. The significance of an impact is defined as a combination of the consequence of the impact occurring and the probability that the impact will occur. The significance of each identified impact was thus rated according to the methodology set out below:

Step 1 – Determine the consequence rating for the impact by determining the score for each of the three criteria (A-C) listed below and then adding them. The rationale for assigning a specific rating, and comments on the degree to which the impact may cause irreplaceable loss of resources and be irreversible, must be included in the narrative accompanying the impact rating:

Rating	Definition of Rating	Score
A. *Extent – the area over which the impact will be experienced.*		
Local	Confined to project or study area or part thereof (e.g. limits of the concession area)	1
Regional	The region (e.g. the whole of Namaqualand coast)	2
(Inter) national	Significantly beyond Saldanha Bay and adjacent land areas	3
B. *Intensity – the magnitude of the impact in relation to the sensitivity of the receiving environment, taking into account the degree to which the impact may cause irreplaceable loss of resources.*		
Low	Site-specific and wider natural and/or social functions and processes are negligibly altered	1
Medium	Site-specific and wider natural and/or social functions and processes continue albeit in a modified way	2
High	Site-specific and wider natural and/or social functions or processes are severely altered	3
C. *Duration – the time frame for which the impact will be experienced and its reversibility.*		
Short-term	Up to 2 years	1
Medium-term	2 to 15 years	2
Long-term	More than 15 years (state whether impact is irreversible)	3

The combined score of these three criteria corresponds to a Consequence Rating, as follows:

Combined Score (A+B+C)	3 – 4	5	6	7	8 – 9
Consequence Rating	Very low	Low	Medium	High	Very high

Example 1:

Extent	Intensity	Duration	Consequence
Regional 2	Medium 2	Long-term 3	High 7

Step 2 – Assess the probability of the impact occurring according to the following definitions:

Probability – the likelihood of the impact occurring	
Improbable	< 40% chance of occurring
Possible	40% - 70% chance of occurring
Probable	> 70% - 90% chance of occurring
Definite	> 90% chance of occurring

Example 2:

Extent	Intensity	Duration	Consequence	Probability
Regional 2	Medium 2	Long-term 3	High 7	Probable

Step 3 – Determine the overall significance of the impact as a combination of the consequence and probability ratings, as set out below:

		Probability			
		Improbable	Possible	Probable	Definite
Consequence	Very Low	**INSIGNIFICANT**	**INSIGNIFICANT**	**VERY LOW**	**VERY LOW**
	Low	**VERY LOW**	**VERY LOW**	**LOW**	**LOW**
	Medium	**LOW**	**LOW**	**MEDIUM**	**MEDIUM**
	High	**MEDIUM**	**MEDIUM**	**HIGH**	**HIGH**
	Very High	**HIGH**	**HIGH**	**VERY HIGH**	**VERY HIGH**

Example 3:

Extent	Intensity	Duration	Consequence	Probability	Significance
Regional 2	Medium 2	Long-term 3	High 7	Probable	HIGH

Step 4 – Note the status of the impact (i.e. will the effect of the impact be negative or positive?)

Example 4:

Extent	Intensity	Duration	Consequence	Probability	Significance	Status
Regional 2	Medium 2	Long-term 3	High 7	Probable	HIGH	– ve

Step 5 – State the level of confidence in the assessment of the impact (high, medium or low).

Impacts are also considered in terms of their status (positive or negative impact) and the confidence in the ascribed impact significance rating. The prescribed system for considering impacts status and confidence (in assessment) is laid out in the table below. Depending on the data available, a higher level of confidence may be attached to the assessment of some impacts than others. For example, if the assessment is based on extrapolated data, this may reduce the confidence level to low, noting that further ground-truthing is required to improve this.

Confidence rating	
Status of impact	+ ve (beneficial) or – ve (cost)
Confidence of assessment	Low, Medium or High

Example 5:

Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Regional 2	Medium 2	Long-term 3	High 7	Probable	HIGH	– ve	High

The significance rating of impacts is considered by decision-makers, as shown below. Note, this method does not apply to minor impacts which can be logically grouped into a single assessment.

1. INSIGNIFICANT: the potential impact is negligible and will not have an influence on the decision regarding the proposed activity.

2. VERY LOW: the potential impact is very small and should not have any meaningful influence on the decision regarding the proposed activity.

3. LOW: the potential impact may not have any meaningful influence on the decision regarding the proposed activity.

4. MEDIUM: the potential impact should influence the decision regarding the proposed activity.

5. HIGH: the potential impact will affect a decision regarding the proposed activity.

6. VERY HIGH: The proposed activity should only be approved under special circumstances.

Step 6 – Identify and describe practical mitigation and optimisation measures that can be implemented effectively to reduce or enhance the significance of the impact. Mitigation and optimisation measures must be described as either:

1. Essential: must be implemented and are non-negotiable; and

2. Best Practice: must be shown to have been considered and sound reasons provided by the proponent if not implemented.

Essential mitigation and optimisation measures must be inserted into the completed impact assessment table. The impact should be re-assessed with mitigation, by following Steps 1-5 again to demonstrate how the extent, intensity, duration and/or probability change after implementation of the proposed mitigation measures.

Example 6:

	Extent	**Intensity**	**Duration**	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Without mitigation	Regional **2**	Medium **2**	Long-term **3**	High **7**	Probable	HIGH	– ve	High
Essential mitigation measures: xxxxx xxxxx								
With mitigation	Local **1**	Low **1**	Long-term **3**	Low **5**	Improbable	VERY LOW	– ve	High

Step 7 – Prepare a summary table of all impact significance ratings as follows:

Impact	**Consequence**	**Probability**	**Significance**	**Status**	**Confidence**
Impact 1: XXXX	Medium	Improbable	LOW	–ve	High
With Mitigation	Low	Improbable	VERY LOW		High
Impact 2: XXXX	Very Low	Definite	VERY LOW	–ve	Medium
With Mitigation:	Not applicable				

Indicate whether the proposed development alternatives are environmentally suitable or unsuitable in terms of the respective impacts assessed by the relevant specialist and the environmentally preferred alternative.