Enviro-EAP
Environmental Consultants

ESTUARINE IMPACT ASSESSMENT FOR KNOR VARKIE RESORT DEVELOPMENTS ON FARM KLIPHOEK 8/59, BERG RIVER ESTUARY

February 2024

ANCHOR environmental

Anchor Environmental Consultants Report No. 2161/1

Cover photo: Jessica Dawson

ESTUARINE IMPACT ASSESSMENT FOR KNOR VARKIE RESORT DEVELOPMENTS ON FARM KLIPHOEK 8/59, BERG RIVER ESTUARY

February 2024

Report prepared for:

Johmandie Pienaar
Enviro-EAP (Pty) Ltd
PO Box 205
Agulhas
7282

by:

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

Authors: Megan Jackson, Michael Armitage and Jessica Dawson

Citation: Jackson M, Armitage MPA, & J Dawson. 2024. Estuarine Impact Assessment for Knor Varkie Resort developments on Farm Kliphoek 8/59, Berg River Estuary. Report no. 2162/1 prepared by Anchor Environmental Consultants (Pty) Ltd for Enviro-EAP Environmental Consultants. 83 pp.

EXECUTIVE SUMMARY

Introduction

Anchor Environmental Consultants (Pty) Ltd (Anchor) was appointed by Enviro-EAP to conduct an Estuarine Impact Assessment for a Section 24G Application for the developments undertaken on the Knor Varkie Resort on portion 8/59 of Farm Kliphoek within the Berg River Estuarine Functional Zone on the West Coast of South Africa. This Estuarine Specialist Study conducts a Section 24G on the unauthorised developments that have taken place within the Berg River EFZ and the affect thereof on the environment and ecological function of the estuary, as well as providing recommendations for mitigation measures to implemented to reduce the diversity and significance of potential negative impacts. In addition, an impact assessment was undertaken for proposed future developments and essential mitigation methods provided should these future developments be approved.

A Section 24G application is undertaken where a person/company has commenced with a listed or specified activity without first obtaining an environmental authorization. In September 2019 Mr Gielie Visser who rents the property, expanded an existing historical, informal camping site to create a terraced cut and to fill an embankment area to accommodate additional camping and caravan sites. Since then, additional camping sites, ablution and recreational facilities, a restaurant/venue and parking areas have also been added to the facilities. The new Knor Varkie Camp and Caravan Site with associated new access road and facilities created currently has a total footprint of ±0.9 ha and falls within the Berg River Estuary Functional Zone (EFZ). These developments were undertaken without first conducting an Environmental Impact Assessment, which is now required under Section 24G of the National Environmental Management Act (NEMA).

The EFZ is defined as the 'space' within which estuaries function over longer time scales. The EFZ encapsulates the areas of the system influenced by long-term estuarine sedimentary processes and encompasses all floodplain and estuarine vegetation that contribute detritus (food) and provide refuge during flood events. All new developments within the EFZ must follow regulations laid out in the National Environmental Management Act (NEMA), Appendix 6 of the Amended EIA Regulations, GN No. R. 326 (April 2017) and the procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes (Government Gazette 43110 no. 320 of March 2020).

Affected Environment

Estuaries are rich and productive systems that produce a wide range of benefits to society. They derive their richness and productivity from nutrient and sediment inputs received from river and sea water, combined with the relatively sheltered aquatic habitat that they provide. Their characteristic biodiversity assemblages have arisen from the need for biota to cope with their salinity gradients and fluctuations. These unique characteristics make estuaries among the most valuable types of ecosystems on earth.

The Berg River Estuary is a cool temperate, predominantly open system located on the west coast of South Africa, approximately 140 km north of the City of Cape Town. The 2018 National Biodiversity Assessment (NBA) classifies the system as "moderately modified", which means that, while some loss of natural processes and patterns have occurred, basic estuarine function is still present. The Berg River Estuary is one of the largest estuaries in South Africa and encompasses about 60% of the estuarine habitat on the West Coast. The estuary supports large areas of salt marsh, and high numbers and diversity of water birds and fish, making it one of the most important estuaries in the country in terms of its biodiversity. It is also an extremely important nursery area for angling species (elf, white

steenbras, leervis) and other commercially important fish species (harders) and provides a range of other ecosystem goods and services that support the local economy. The estuary extends far inland, with salinity extending up to 70 km upstream, making it one of the longest estuaries in the country.

The system is among the top three most important estuaries in the country, and one of the most valuable biodiversity assets along the West Coast of South Africa. A range of estuarine ecosystem services support the local economy; indeed, the value of the Berg River Estuary was estimated to be in the order of R378 million per year as of 2020. The estuary has been specifically recognised as an Important Bird Area, has unique estuarine vegetation, is a valuable nursery area for fish and is an important tourist attraction. Indeed, the Berg River Estuary is rated as a 'Highly Important' system, especially as a nursery for red data species and exploited fish stocks (it is rated as a DFFE 'high-medium' fish nursery). In early 2022, the Berg River Estuary was declared a RAMSAR site, i.e., a wetland recognised both nationally and internationally as a site of ecological importance. The system also forms part of the biodiversity priority core set on both a national and regional level (as the core conservation area of the West Coast Biosphere Reserve).

Impact assessment

Impacts pertaining to the Section 24G are summarised below, with their significance rating before and after the implementation of mitigation measures (Table 1.1). Without mitigation, the significance of the five impacts pertaining to the Section 24G ranges from 'Medium' to 'High'. It is therefore essential that mitigation measures are implemented to reduce the significance of the developments which have already taken place, in order to reduce the negative effects on the sensitive estuarine environment. The applicant is also advised to adhere to all relevant legislation and procedures going forward.

Additionally, potential impacts that may be experienced during construction and operational phases of the proposed future development, both before and after mitigation, are summarised in Table 1.1 below. A total of eight negative potential environmental impacts were assessed. After mitigation, none of the identified impacts were assessed as being above 'Low' significance.

The primary cumulative impacts for this development are related to loss of and disturbance to estuarine habitat, and cumulative effects of increased human activity. The cumulative impacts are expected to be of slightly higher intensity than those assessed for the construction phase but are assessed as 'Low' significance with the implementation of suitable mitigation measures (Table 1.1).

Given that this is a Section 24G, it is recommended that an independent authority conduct regular checks on the Resort during the construction, operational and rehabilitation phase to ensure that mitigation measures are being correctly implemented.

Table 1.1. Summary of the retrospective assessment of the Section 24G application and the potential impacts of proposed future developments at the Knor Varkie Resort. The table shows the significance of each impact, before and after mitigation.

Phase	Impact identified	Consequence	Probability	Significance	Status	Confidence
Retrospective Assessment of Impacts	Impact 1: Removal and disturbance of estuarine vegetation.	Medium	Definite	MEDIUM	-ve	High
	With mitigation	Low	Possible	VERY LOW	-ve	High
	Impact 2: Presence and addition planting of invasive species.	Medium	Definite	MEDIUM	-ve	High
	With mitigation	Very Low	Improbable	INSIGNIFICANT	+ve	High
	Impact 3: Waste generation and disposal from construction.	High	Definite	HIGH	-ve	High
	With mitigation	Low	Improbable	LOW	-ve	High
	Impact 4: Pollution emanating from activity on site due to the development of the resort.	High	Definite	HIGH	-ve	High
	With mitigation	Low	Improbable	VERY LOW	-ve	High
	Impact 5: The effects of increased human activity associated with the Resort	Medium	Definite	MEDIUM	-ve	High
	With mitigation	Low	Probable	LOW	-ve	High
Construction Phase	Impact 6: Direct disturbance and loss of estuarine habitat	Medium	Probable	MEDIUM	-ve	High
	With mitigation	Low	Possible	VERY LOW	-ve	High
	Impact 7: Waste generation and disposal from construction	High	Possible	MEDIUM	-ve	High
	With mitigation	Low	Improbable	VERY LOW	-ve	High
	Impact 8: The effect of spillage of hazardous substances on estuarine biota	Medium	Possible	LOW	-ve	High
	With mitigation	Low	Improbable	VERY LOW	-ve	High
	Impact 9: The effect of spillage of hazardous substances on estuarine biota	Low	Probable	LOW	-ve	High
	With mitigation	Very Low	Possible	INSIGNIFICANT	-ve	High
	Impact 10: Noise impacts during construction	Very Low	Probable	LOW	-ve	High
	With mitigation	Very Low	Possible	VERY LOW	-ve	High
Operational Phase	Impact 11: Loss of estuarine habitat	Medium	Definite	MEDIUM	-ve	High
	With mitigation	Low	Definite	LOW	-ve	High

Phase	Impact identified	Consequence	Probability	Significance	Status	Confidence
	Impact 12: Pollution emanating from activity on site due to the development of the Resort	High	Probable	**HIGH**	-ve	High
	With mitigation	Very Low	Improbable	**INSIGNIFICANT**	-ve	High
	Impact 13: The effects of increased human activity due to the development of the resort	Low	Definite	**LOW**	-ve	High
	With mitigation	Very Low	Definite	**VERY LOW**	-ve	High
Cumulative Impacts	Without mitigation	High	Definite	**HIGH**	-ve	High
	With mitigation	Low	Probable	**LOW**	-ve	High

Section 24G essential mitigation measures:

Based on the impacts assessed in this report, it is recommended that the already completed developments be allowed to remain if:

- The areas designated in the updated site plan are rehabilitated according to a plan devised by a qualified individual, especially the salt marsh area where the temporary caravan site is currently situated.
- All invasive species must be removed, and an alien and invasive species programme must be implemented.
- A zero tolerance to litter policy is implemented on the property.
- Sewage systems are properly implemented and maintained so that no sewage enters the estuary.
- Noise levels remain within those allowed within rural areas.
- Visitors are informed of the sensitivity and importance of the estuarine habitat and biota present in the area.
- The Environmental Management Plan (Pienaar, 2023a) is implemented.
- It is further recommended that additional areas composed of salt bush be rehabilitated with indigenous vegetation to improve ecosystem functioning.
- The applicant is also advised to adhere to all relevant legislation and procedures going forward.

Essential mitigation for the Construction and Operational phase of future developments

Based on the impacts assessed in this report, it is recommended that the proposed development be permitted to proceed with the implementation of strict environmentally responsible practices as outlined in the mitigation measures below. However, it is strongly recommended that no additional jetty be built given the presence of *Zostera capensis* beds within the estuary.

Mitigation measures required to reduce the severity of the impacts during the **construction/operational phase** as outlined above are as follows:

- The Environmental Management Plan (Pienaar, 2023a) is implemented.
- A rehabilitation plan must be devised by qualified personnel and implemented to restore and improve saltmarsh habitats and other estuarine vegetation in the vicinity of the proposed development.

- Alien species must be removed.
- Limit the extent and duration of construction activities within the Estuarine Functional Zone as far as practically possible.
- Areas of bare ground resulting from the proposed construction activities should be appropriately revegetated or appropriately covered to prevent erosion and turbidity within the EFZ.
- Erosion control measures in areas at risk of erosion/runoff must be implemented.
- All staff and visitors must be informed about sensitive estuarine habitats and species and the responsible disposal of waste.
- A zero tolerance to litter policy should be implemented on the property.
- Reduce, reuse, recycle.
- Sewage systems must be properly implemented and maintained so that no sewage enters the estuary.
- Noise levels to remain within those allowed within rural areas.
- Suitable handling and disposal of waste protocols must be clearly explained, and sign boarded.
- Intentional disposal of any substance into the environment is 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 equipment or 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.
- Spill kits must be available on site at all times, and staff must be trained in their proposed use.

Additionally, it is important that the conditions within the system be monitored to enable adaptive management. If conditions become detrimental to the ecosystem, the impacts of construction and/or operation will need to be reassessed and adjusted mitigation measures applied. To this end, it is recommended that an Environmental Control Officer be employed of the duration of the construction phase and perhaps include an annual site visit for two years after the construction is completed.

TABLE OF CONTENTS

EXECUTIVE SUMMARY I

TABLE OF CONTENTS VI

DECLARATION OF INDEPENDENCE VIII

BACKGROUND AND QUALIFICATIONS OF SPECIALIST CONSULTANTS VIII

GLOSSARY X

LIST OF ABBREVIATIONS XIII

1 INTRODUCTION 1

1.1 BACKGROUND 1
1.2 TERMS OF REFERENCE 2
1.3 REASON FOR SECTION 24G 3
1.4 OVERVIEW OF THE UNAUTHORISED DEVELOPMENTS AND PROPOSED FUTURE DEVELOPMENTS 6

2 APPROACH 8

2.1 INTRODUCTION 8
2.2 DEFINITIONS 8
2.3 DATA SOURCES 9
2.4 SITE VISIT 9
2.5 ASSUMPTIONS AND LIMITATIONS 9

3 LEGISLATIVE CONTEXT 11

3.1 INTRODUCTION 11
3.2 ESTUARY MANAGEMENT 11
3.3 ESTUARY WATER QUANTITY AND QUALITY REQUIREMENTS 14
3.4 COASTAL PROTECTION ZONE 15
3.5 SECTION 24G 16
3.6 ALIEN SPECIES 16

4 DESCRIPTION OF THE AFFECTED ENVIRONMENT 17

4.1 INTRODUCTION 17
4.2 CATCHMENT AND RAINFALL 18
4.3 HYDRODYNAMIC FUNCTION 19
4.4 SEDIMENTS AND EROSION 22
4.5 WATER QUALITY 23
4.6 ECOLOGY 25
4.6.1 Aquatic and riparian vegetation 25
4.6.2 Invertebrates 28
4.6.3 Fish 29
4.6.4 Avifauna (Birds) 30
4.7 SENSITIVITY AND SIGNIFICANCE 32

5 IMPACT ASSESSMENTS 34

5.1 RETROSPECTIVE ANALYSIS OF IMPACTS (SECTION 24G) 34
5.1.1 Removal and Disturbance of Estuarine Vegetation 35
5.1.2 Presence and Additional Planting of Invasive Species 37
5.1.3 Waste generation and disposal From Construction 38
5.1.4 Pollution Emanating from Use of the Facilities 39

5.1.5 The Effects of Increased Human Activity Associated with the Resort *42*
5.2 CONSTRUCTION PHASE OF PROPOSED UPGRADES 43
5.2.1 Direct disturbance and loss of estuarine habitat *43*
5.2.2 Waste generation and disposal from Construction *44*
5.2.3 Hazardous substance spills during construction *45*
5.2.4 Water quality and quantity impacts associated with runoff *45*
5.2.5 Noise impacts during construction *46*
5.3 OPERATIONAL PHASE OF PROPOSED UPGRADES 46
5.3.1 Loss of Estuarine Habitat *46*
5.3.2 Pollution Emanating from Use of the Facilities *47*
5.3.3 The Effects of Increased Human Activity due to the Development of the Resort *48*
5.4 CUMULATIVE IMPACTS 48
5.5 SUMMARY OF POTENTIAL IMPACTS 51
6 CONCLUSIONS AND RECOMMEMNDATIONS 53
7 REFERENCES 55
APPENDIX I: RQOS FOR THE BERG RIVER ESTUARY 58
APPENDIX II: IMPACT ASSESSMENT METHODS 61

DECLARATION OF INDEPENDENCE

Anchor Environmental Consultants (Pty) Ltd is an independent consultant and has no business, financial, personal or other interest in the activity, application or appeal in respect of which the company was appointed other than fair renumeration for work performed in connection with the activity, application or appeal. No circumstances arose during the course of the project that compromised the objectivity of the specialists that performed the work.

BACKGROUND AND QUALIFICATIONS OF SPECIALIST CONSULTANTS

The study was undertaken by Dr Jessica Dawson, Megan Jackson and Michael Armitage

Dr Jessica Dawson is a Senior Consultant at Anchor Environmental Consultants and has a background in marine biology, estuarine community ecology and food webs, benthic invertebrate biology and taxonomy. She has her PhD in Zoology from the University of Cape Town. Her academic training has enabled her to acquire skills in a wide variety of scientific disciplines, exposing her to a broad array of scientific methods. Jessica has worked on the taxonomic descriptions of new species (BSc Hon. UCT), the effects of grazers on community structure of soft-sediment estuarine and rocky shore communities (BSc Hon. and MSc., UCT) and the indirect effects of the presence of large herbivore species on benthic estuarine communities and food web structure during a drought (PhD, UCT). Jessica has additionally been working as a taxonomic specialist on the benthic invertebrates of the Western Indian Ocean, as well as species from the Southwest Atlantic Ocean and numerous estuaries around the South African Coastline. Through her ecological training and work conducted for Anchor, she has gained experience to consult on a variety of research projects including estuarine and marine baseline assessments and monitoring programs, estuarine valuations, specialist impact assessments, basic assessment reports and the development of Estuarine Management Plans, as well as being a marine and estuarine taxonomic specialist for benthic invertebrates. Jessica has co-authored seven peer-reviewed articles in well recognised scientific journals, as well as conducting a review for the Quarterly Review of Biology.

Megan Jackson is an evolutionary ecologist with an MSc. (Botany) from Stellenbosch University and, a BSc. Hons. (Biological Sciences) and a BSc. (Genetics and Ecology & Evolution) from the University of Cape Town, and. Megan's MSc. used a Next-Gen sequencing approach and bioinformatic processing to look at the population genomics of Cape Dwarf eelgrass in estuaries around the South African coastline to inform conservation planning and preserve the genomic diversity of the species. Following the completion of her studies, she spent a year working on Bird Island in the Algoa Bay MPA, as a Seabird Monitor, to aid with the conservation of the endangered African Penguins and Cape Gannets. Megan has recently started working as a Junior Consultant at Anchor Environmental Consulting, where she is involved in carrying out benthic species taxonomic IDs and Environmental Impact Assessments. She has broad research interests, and the combination of molecular and general biology has given her a unique perspective on conservation, as well as experience in both field and laboratory work across a diverse range of species in both marine and terrestrial environments.

Michael holds an MSc in Environmental and Geographical Science (EGS) and a BSc in EGS and Archaeology. His MSc research involved field research and comparative analysis on heavy metal contamination in the Knysna Estuary in South Africa and the Yangtze Estuary in China. His key focus areas are the integrated management of environment, estuaries and water resources, with strong interests in pollution issues and archaeology. He is invested in pursuing integrated, "nature-based" solutions to problems traditionally solved with grey infrastructure design choices. Michael thrives on unpacking the complexities of dynamic systems and using this knowledge to optimise integrated management strategies.

GLOSSARY

Alien species: Species that become established in areas outside their natural, native range.

Amphipods: Crustaceans with no carapace and a laterally compressed body.

Anthropogenic: Environmental pollution originating from human activity.

Baseline: Information gathered at the beginning of a study which describes the environment prior to development of a project and against which predicted changes (impacts) are measured.

Benthic/benthos: The ecological region at the lowest level of a body of water such as an ocean, lake, or stream, including the sediment surface and some sub-surface layers.

Biodiversity: The variability among living organisms from all terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems.

Biota: Living organisms within a habitat or region.

Bioturbation: The disturbance/reworking of soils and sediments by animals or plants. It includes burrowing, ingestion, and defecation of sediment grains.

Black tide: An event of low oxygen water on the West Coast of South Africa that cause mass mortalities of marine species that results from the decay of large plankton blooms under calm conditions.

Chenopods: A family of plants, ranging from annual herbs to trees, which are commonly found in deserts and especially in saline or alkaline soils. The flowers are very small and inconspicuous, but some species bear showy masses of fruits.

Chlorophyll-a: A green pigment, present in all green plants (including algae) and cyanobacteria, which is responsible for the absorption of light to provide energy for photosynthesis.

Community composition: The number of species in that community and their relative numbers.

Construction phase: The stage of project development comprising site preparation as well as all construction activities associated with the development.

Ecosystem engineers: A species that that directly or indirectly modulate the availability of resources (other than themselves) to other species by causing physical state changes in biotic or abiotic materials. In so doing they modify, maintain and/or create habitats. These organisms can have a large impact on species richness and landscape-level heterogeneity (diversity) of an area.

Ecosystem services: The goods and services provided by ecosystems to humans.

Environment: The external circumstances, conditions and objects that affect the existence of an individual, organism or group. These circumstances include biophysical, social, economic, historical and cultural aspects.

Environmental Authorisation: Permission granted by the competent authority for the applicant to undertake listed activities in terms of the NEMA EIA Regulations, 2014.

Environmental Impact Assessment: A process of evaluating the environmental and socio-economic consequences of a proposed course of action or project.

***Escherichia coli* (*E. coli*)**: Bacteria found in the environment, foods, and intestines of warm-blooded animals. Across the water sector, *Escherichia coli* is the preferred microbial water quality indicator and current guidance upholds that it indicates recent faecal contamination.

Estuarine dependent species: Species that rely on estuaries for a specific part of their life cycle, such as spawning and/or as a nursery habitat.

Estuarine Functional Zone: Delineated by a 5 m above mean sea level (MSL) contour as proxy indicator, the area in and around an estuary which includes the open water area, estuarine habitat (such as sand and mudflats, rock and plant communities) and the surrounding floodplain area.

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

Eutrophication: nutrient enrichment results in excessive plant and algal growth within a water body, depleting the water of oxygen and often causing the die-off of aquatic organisms in the area.

Floodplain: Broad and relatively flat area on either side of a stream, river or estuary that are inundated by water during floods.

Halophytes: salt-tolerant plant species (e.g. saltmarsh which grows in saline environments).

Head (of estuary): The upstream part of the system where freshwater enters.

Hydrology: The branch of science concerned with the properties of the earth's water, and especially its movement in relation to land.

Hyperbenthic/ Hyperbenthos: Benthic organisms that live just above the sediment.

Impact: A change to the existing environment, either adverse or beneficial, that is directly or indirectly due to the development of the project and its associated activities.

Intertidal (areas/zone): Also known as the foreshore or seashore; the area that is above water level at low tide and underwater at high tide.

Invasive species: Alien species capable of spreading beyond the initial introduction area and have the potential to cause significant harm to the environment, economy or society.

Invertebrate: An animal without a backbone (e.g. a starfish, crab, or worm).

Macroalgae: Also known as seaweed; refers to several species of macroscopic, multicellular, marine algae. The term includes some types of Rhodophyta, Phaeophyta and Chlorophyta macroalgae.

Macrophyte: An aquatic plant large enough to be seen by the naked eye.

Moderately modified (estuary): While some loss of natural process and pattern has occurred, basic estuarine function is still present.

Operational phase: The stage of the works following the Construction Phase, during which the development will function or be used as anticipated in the Environmental Authorisation.

Pelagic: Within the water column.

Phytoplankton: Microscopic organisms that live in aquatic systems that are able to photosynthesize to feed themselves.

Piscivorous: Fish eating.

Polychaete/a: Segmented worms with many bristles (i.e., bristle worms).

RAMSAR wetland/site: A wetland recognised both nationally and internationally as a site of ecological importance.

Recruit(ment): The process by which very young, small fish survive to become slightly older, larger fish. Specifically, recruitment refers to the act of transitioning between two stages of life.

Red data species: Species classified by the International Union for Conservation of Nature into one of nine Red List Categories: Extinct, Extinct in the Wild, Critically Endangered, Endangered, Vulnerable, Near

Threatened, Least Concern, Data Deficient and Not Evaluated. The IUCN Red List is an inventory of the global conservation status and extinction risk of biological species.

Salinity gradient: A spatial pattern describing the relative proportions of freshwater and seawater along the transition from river to ocean.

Salt marsh: A coastal ecosystem in the upper coastal intertidal zone between land and open saltwater or brackish water that is regularly flooded by the tides.

Salt bush: a hardy salt- and drought-tolerant plant species, commonly planted in South Africa to feed livestock.

Semidiurnal tidal: A tidal cycle with two nearly equal high tides and low tides every lunar day.

Stock (fish): Fish Subpopulations of a particular species of fish.

Subtidal: Applied to that portion of a tidal-flat environment which lies below the level of mean low water for spring tides. Normally it is covered by water at all states of the tide.

Supratidal: The area above the spring high tide line, on coastlines and estuaries, that is regularly splashed, but not submerged by ocean water. Seawater penetrates these elevated areas only during storms with high tides.

Tidal inundation: The total water level that occurs on normally dry ground as a result of the tide and is expressed in terms of height of water above ground level.

Zooplankton: Heterotrophic plankton (i.e. plankton that cannot manufacture its own food by carbon fixation and therefore derives its intake of nutrition from other sources of organic carbon, mainly plant or animal matter. In the food chain, heterotrophs are secondary and tertiary consumers).

LIST OF ABBREVIATIONS

AMSL	Above Mean Sea Level
Anchor	Anchor Environmental Consultants
CBA	Critical Biodiversity Area
CML	Coastal Management Line
CSL	Coastal Setback Line
DEA&DP	Department of Environmental Affairs and Development Planning
DFFE	Department of Forestry, Fisheries and the Environment
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EFZ	Estuarine Functional Zone
EIA	Environmental Impact Assessment
EMP	Estuarine Management Plan
ESA	Ecological Support Area
ICMA	National Environmental Management: Integrated Coastal Management Act, 2008 (Act No. 24 of 2008)
IUCN	International Union for Conservation of Nature
MLRA	Marine Living Resources Act 18 of 1998 (as amended)
NBA	National Biodiversity Assessment
NEM: BA	National Environmental Management: Biodiversity Act (Act No. 10 of 2004)
NEM: PAA	National Environmental Management: Protected Areas Act (Act No. 57 of 2003)
NEMA	National Environmental Management Act No. 107 of 1998 (as amended)
NWA	National Water Act (Act 36 of 1998).
PES	Present Ecological State
RDM	Resource Directed Measures
WCBSP	Western Cape Biodiversity Spatial Plan
WCNCB	Western Cape Nature Conservation Board
WCWSS	Western Cape Water Supply System

1 INTRODUCTION

1.1 BACKGROUND

Located in the coastal zone, on the boundary between the ocean and land, the area where a river meets the sea is known as an estuary. In South Africa, such coastal outlets are classified into nine different estuary types and three micro-system types. Based on this classification system, South Africa has 290 functional estuaries and 202 micro-systems (Van Niekerk *et al.*, 2020). Estuaries incorporate much of the only sheltered marine habitat along the South African coastline and are thus extremely important for biodiversity conservation and socio-economic development. The enormous value of estuaries is also reflected in the range and value of ecosystem services they provide including water supply and regulation, nutrient supply and cycling, refugia and migration corridors, raw materials and resources for subsistence and commercial use, outlets for recreational and tourism, and transport services. Ecosystem services provided by estuaries in South Africa are, however, coming under increasing pressure, both as a result of increasing demand for coastal resources to support ever increasing coastal populations as well as due to large-scale environmental change.

The Berg River Estuary is a cool temperate, predominantly open system located on the west coast of South Africa, approximately 140 km north of the City of Cape Town. The 2018 National Biodiversity Assessment (NBA) classifies the system as "moderately modified", which means that, while some losses of natural processes and patterns have occurred, basic estuarine function is still present. The Berg River Estuary is one of the largest estuaries in South Africa and encompasses about 60% of the estuarine habitat on the West Coast. The estuary supports large areas of salt marsh, and high numbers and diversity of water birds and fish, making it one of the most important estuaries in the country in terms of its biodiversity (Turpie *et al.*, 2002; Turpie & Clark, 2007). It is also an extremely important nursery area for angling species (elf, white steenbras, leervis) and other commercially important fish species (harders) and provides a range of other ecosystem goods and services that support the local economy. The estuary extends far inland, with salinity extending up to 70 km upstream, making it one of the longest estuaries in the country.

Anchor Environmental Consultants (Pty) Ltd (Anchor) was appointed by Enviro-EAP to conduct an Estuarine Impact Assessment for a Section 24G Application for the developments undertaken on the Knor Varkie Resort on portion 8/59 of Farm Kliphoek within the Berg River Estuarine Functional Zone on the West Coast of South Africa.

A Section 24G application is undertaken where a person/company has commenced with a listed or specified activity without first undertaking an environmental authorization. In September 2019 Mr Gielie Visser who rents the property, expanded an existing historical, informal camping site to create a terraced cut and to fill an embankment area to accommodate additional camping and caravan sites. Since then, additional camping sites, ablution and recreational facilities, a restaurant/venue and parking areas have also been added to the facilities. The new Knor Varkie Camp and Caravan Site with associated new access road and facilities created currently has a total footprint of ±0.9 ha and falls within the Berg River Estuary Functional Zone (EFZ) (Figure 1.1). These developments were undertaken without first conducting an Environmental Impact Assessment, which is now required under Section 24G of the National Environmental Management Act (NEMA).

Figure 1.1. Knor Varkie Resort Development Site along the west coast and in relation to the Berg Estuarine Functional Zone (EFZ).

The EFZ is defined as the 'space' within which estuaries function over longer time scales (Van Niekerk & Turpie, 2012; Van Niekerk *et al.*, 2013). The EFZ encapsulates the areas of the system influenced by long-term estuarine sedimentary processes i.e., sediment stored or eroded during floods, mouth dynamics, changes in channel configuration, aeolian transport processes, and changes due to coastal storms. It allows for natural variability on decadal timescales and thus represents the 'accommodation space' for key physical processes that influence biodiversity along the South African coastline previously not considered in estuary delineation as well as preventing damage to property by restricting development in this area. The EFZ also encompasses all floodplain and estuarine vegetation that contribute detritus (food) and provide refuge during flood events. All new developments within the EFZ must follow regulations laid out in the National Environmental Management Act (NEMA), Appendix 6 of the Amended EIA Regulations, GN No. R. 326 (April 2017) and the procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes (Government Gazette 43110 no. 320 of March 2020).

1.2 TERMS OF REFERENCE

This Estuarine Specialist Report provides a retrospective assessment of the impacts of the construction of the development footprint and an assessment of the potential impacts of planned future developments. Additionally, it provides the essential mitigation measures for reducing the impacts to the estuarine environment and rehabilitation action for improving the functioning of the estuary associated with the development of the Knor Varkie Resort. Specific Terms of Refence include the following:

Using the architects designs for the constructed developments, a site visit and the available desktop information on the nature of the surrounding environment, the following Terms of Reference (ToRs) for the Estuarine Impact assessment were proposed:

a) Undertake a desktop review of the estuarine biophysical attributes using available literature and GIS information.
b) Undertake a site visit to collect additional first-hand information on the condition of the estuarine environment surrounding the developments to assess the likely habitat that was/is likely to be affected/removed inside the Berg River Estuary Functional Zone.
c) Review any possible conservation planning tools specific to the region.
d) Provide a map representing the existing delineation of estuarine habitat within the study area.
e) Use the site visit and historical satellite imagery to identify and describe potential sensitive habitats and species receptors of impacts e.g. Endangered, Threatened and Protected Species (ETP) - including fish, important feeding, breeding or migration routes, sensitive marine and estuarine habitats, etc.
f) Identify possible impacts on receptors from the development/activity (riparian or estuarine vegetation clearing, infrastructure placement and associated logistical support within the estuarine functional zone, vehicle traffic etc.).
g) Provide recommendations as to the requirements for rehabilitation of the site.
h) Assess the identified impacts (potential, residual and cumulative) using an objective, and consistent methodology.

1.3 REASON FOR SECTION 24G

A Section 24G of the National Environmental Management Act, 1998 (Act 107 of 1998) ("NEMA") application is undertaken where a person/company has commenced with a listed or specified activity without first undertaking an environmental authorization. Any development within an Estuarine Functional Zone automatically triggers a need from an Environmental Impact Assessment (EIA). The developments of the Knor Varkie Resort were undertaken between 2019 and 2023 within an EFZ (Figure 1.2) without first obtaining Environmental Authorisation and triggered the following activities under NEMA (Pienaar, 2023b):

Specifically, the activity triggered Listing Notice 1 of 2014:

Activity 12: The development of (ii) infrastructure or structures with a physical footprint of 100 square metres or more; where such development occurs (c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse;

> Approximately 300m² of the new Knor Varkie main complex were developed within 32m from the edge of the Berg River.

Activity 17: Development (v) if no development setback exists, within a distance of 100 metres inland of the high-water mark of the sea or an estuary, whichever is the greater; in respect of (a) fixed or floating jetties and slipways; (e) infrastructure or structures with a development footprint of 50 square metres or more

> The entire new Knor Varkie camp site and associated facilities were constructed within 100 m radius of the Berg River estuary area with a total development footprint of ±0.9 ha and includes a jetty.

Activity 19A: The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 5 cubic metres from (ii) the littoral active zone, an estuary or a distance of 100 metres inland of the high-water mark of the sea or an estuary, whichever distance is the greater;

More than 5 cubic meters of topsoil material has been removed during developments of the Knor Varkie facilities which falls within 100 m radius of the Berg River Estuary area.

And, Listing Notice 3 of 2014:

Activity 4: The development of a road wider than 4 metres with a reserve less than 13,5 metres. (i) Western Cape (ii) Areas outside urban areas; (aa) Areas containing indigenous vegetation; (bb) Areas on the estuary side of the development setback line or in an estuarine functional zone where no such setback line has been determined;

A new access road was developed for the Knor Varkie main complex of approximately 5 m wide and 165 m long within an area containing indigenous vegetation and within the Berg River Estuary functional zone (100 m radius).

Activity 12: The clearance of an area of 300 square metres or more of indigenous vegetation except where such clearance of indigenous vegetation is required for maintenance purposes undertaken in accordance with a maintenance management plan. (i) Western Cape (i) Within any critically endangered or endangered ecosystem listed in terms of section 52 of the NEMBA or prior to the publication of such a list, within an area that has been identified as critically endangered in the National Spatial Biodiversity Assessment 2004; (ii) Within critical biodiversity areas identified in bioregional plans; (iii) Within the littoral active zone or 100 metres inland from high water mark of the sea or an estuarine functional zone, whichever distance is the greater, excluding where such removal will occur behind the development setback line on erven in urban areas; watercourse;

The vegetation on the developed site of ±0.9 ha was ploughed more than 10 years ago thus it is defined as indigenous vegetation in terms of NEMA and the indigenous vegetation type found within the area is Endangered Saldanha Flats Strandveld, the developed areas are also located within 100 m inland of the Berg River Estuary area.

Activity 14: The development of (ii) infrastructure or structures with a physical footprint of 10 square metres or more; where such development occurs (c) if no development setback has been adopted, within 32 metres of a watercourse, measured from the edge of a (i) Western Cape (i) Outside urban areas: (hh) Areas on the estuary side of the development setback line or in an estuarine functional zone where no such setback line has been determined.

The entire new Knor Varkie camp site and associated facilities were constructed within 100 m radius of the Berg River Estuary area with a total development footprint of ±0.9 ha

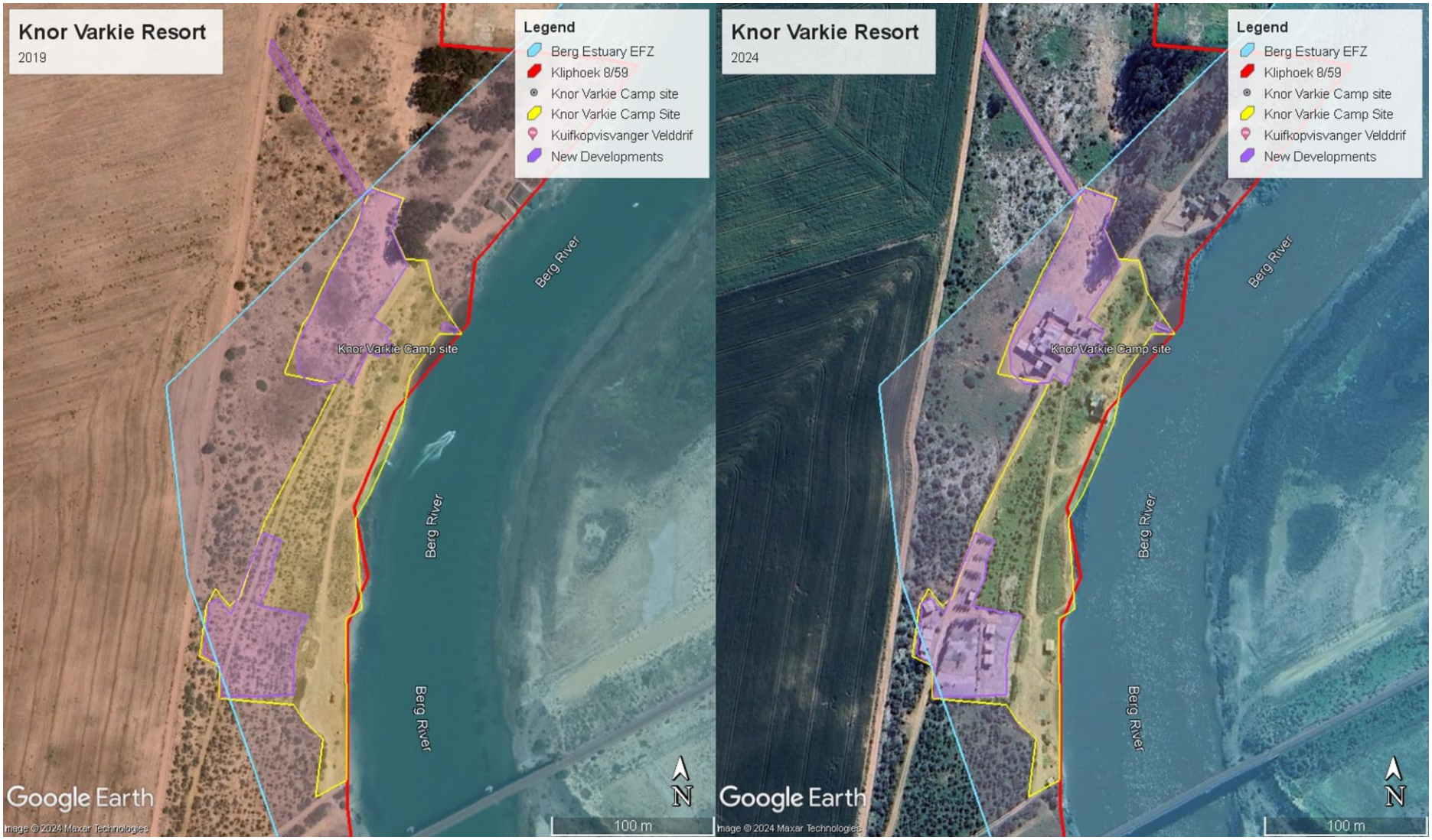

Figure 1.2. Top view of the Knor Varkie Resort pre- and post-development. Left: 2019. Right: 2024.

1.4 Overview of the Unauthorised Developments and Proposed Future Developments

The Knor Varkie Resort Development consists of the following, the majority of which can be seen in Figure 1.3:

- 19 Caravan / camping sites of various sizes as follows:
  - Block A: existing – 770 m²
  - Block B: planned - 492 m²
  - Block C: planned - 2 145 m²
- 4 Self catering Wendy house chalets as follows:
  - 2 x 18 m² each with 2 beds
  - 2 x 15 m² each with 2 beds
- 1 Permanent caravan site with 2 permanent caravans: 1 193 m² in total
- 5 Day visitor sites: 1 762 m² in total
- 3 Ablution facilities as follows:
  - Block A (shared facility): 15 m²
  - Block B: 6 m²
  - Block C (shared facility): 18 m²
- 3 Storage containers as follows:
  - A: 36 m²
  - B: 15 m²
  - C: 15 m²
- Office: 11 m²
- Staff room: 12 m²
- Kitchen: 27 m²
- Restaurant: 265 m²
- Bar: 15 m²
- Covered seating with open deck: 109 m²
- 3 Floating jetties: 39 m² (1 built)
- Sewage conservancy tanks:
  - 5 x existing 1000 L tanks
  - 5 x future 1000 L tanks
- 1 New dirt road connecting the entry road and main complex
- Internal parking areas and existing services infrastructure i.e. sewer lines, roads, etc.
- Total resort development footprint:
  - Existing cleared areas to remain cleared: 9 097 m²
  - Existing cleared areas marked for rehabilitation: 2 607 m²
  - Future planned development for clearing: 1 896 m²
  - Total resort footprint (including planned future development): 1,10 ha

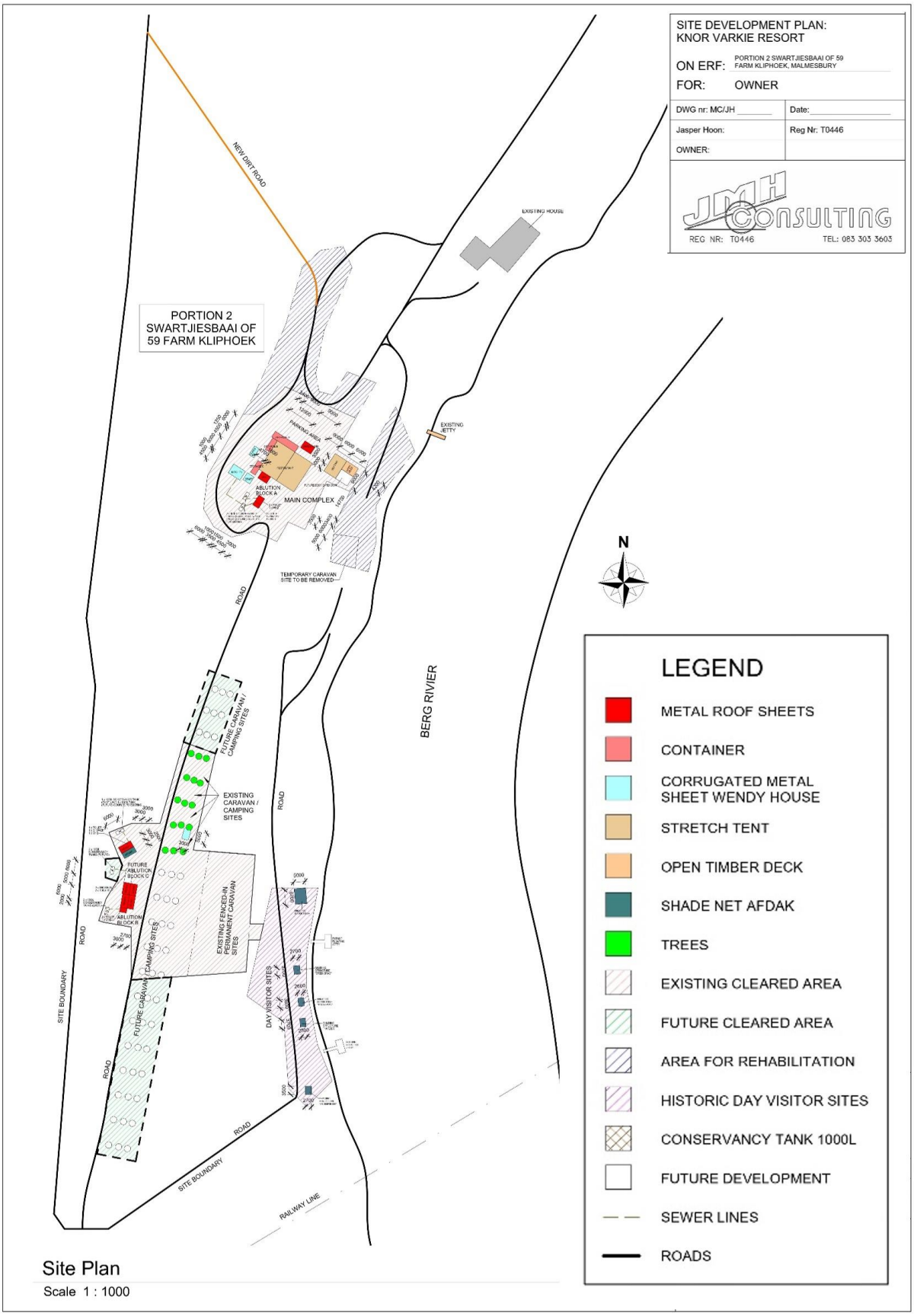

Figure 1.3. Updated site plan for Knor Varkie Resort showing completed and proposed developments (modified).

2 APPROACH

2.1 INTRODUCTION

Potential and cumulative estuarine impacts were identified and described based on the consultant's professional knowledge, previous EIAs for the region, site-specific impacts identified during the site visit and the affected environment description. The assessment of impacts followed a standard, agreed methodology that scores the Extent, Intensity, Duration, Consequence, Probability and overall Significance of potential and cumulative impacts. Indirect impacts, such as increased foot traffic in the vicinity, increased visitor numbers or alteration of water flow etc. were also assessed. Recommended rehabilitation measures have also been identified to compensate for any potential impacts the development may have caused, if any.

2.2 DEFINITIONS

Definitions of estuarine systems are taken from the National Environmental Management: Integrated Coastal Management Act, 2008 (Act No. 24 Of 2008) (ICMA) and the National Environmental Management Act (NEMA) 2014 Environmental Impact Assessment (EIA) Regulations.

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

In South Africa, these systems have historically been classified broadly into six types based on features such as mouth characteristics, tidal prism and catchment size, a system introduced nearly 30 years ago (Whitfield 1992). A revised classification system has recently been introduced which re-categorises coastal outlets into nine different estuary types and three micro-system types. Based on this more recent classification system, South Africa has 290 functional estuaries and 202 micro-systems (Van Niekerk *et al.* 2020).

The Estuarine Functional Zone, as delineated by a 5 m above mean sea level (AMSL) contour as proxy indicator, is defined by 2014 Environmental Impact Assessment Regulations (GNR 985) under NEMA (1998) as "the area in and around an estuary which includes the open water area, estuarine habitat (such as sand and mudflats, rock and plant communities) and the surrounding floodplain area".

Within this report 'the applicant' refers to the applicant of the Section 24G and the person responsible for the management of the Knor Varkie Resort, Mrs Visser. 'The Resort' refers to the Knor Varkie Resort. 'Visitors' are defined as anyone entering or using the Knor Varkie Resort facilities, i.e. restaurant goers, day visitors, overnight visitors etc.

2.3 DATA SOURCES

Considerable work has been done on the Berg River Estuary system in the past, particularly during the period 1993-2008, in response to the planned construction of the Berg River Dam. These efforts have included:

- The Berg River Baseline Monitoring Study undertaken by Anchor for the Department of Water and Sanitation (DWS) in 2002-2005 (Clark & Ractliffe, 2007);
- The Berg Estuary Management Plan prepared for the C.A.P.E. Estuaries Programme (Anchor 2008) and updated in 2019 (DEA&DP, 2019);
- A DWS Study, Determination of Water Resources Classes and Resource Quality Objectives in the Berg Catchment (DWS, 2017a, 2017b);
- Some relevant studies on flows, water quality and alien clearing (i.e., Cullis *et al.*, 2019); and,
- A study undertaken in 2020 by Anchor Research & Monitoring (Pty) Ltd in association with Zutari for DWS, "Environmental flows and the health and value of the Berg Estuary: Potential trade-offs between estuary value and regional water supply under a changing climate" (DEA&DP, 2020).
- The updated Berg Estuary Situation Assessment Report Completed by Anchor (Western Cape Government, 2022).

2.4 SITE VISIT

The site visit was undertaken on 25th of January 2024. An inspection of the existing developments and the proposed development area was undertaken by Jessica Dawson and Megan Jackson, including:

- A bird survey on the property
- A vegetation survey to identify at-risk sensitive estuarine habitats, primarily focussing on the extent of saltmarsh habitat found in the area.
- Collection of photographs to document site observations.

The purpose of the site investigation was to identify estuarine habitats and plant species/vegetation types of concern, estuarine associated fauna (e.g., wading birds, invertebrates, etc.) and areas of important estuarine functions/processes (e.g., nursery areas, roosting areas). The level of assessment and the timing at which the site investigations were undertaken was considered adequate to verify the sensitivity of the site and surrounding habitat, given the availability of recent detailed monitoring studies.

2.5 ASSUMPTIONS AND LIMITATIONS

The accuracy and confidence of this assessment is dependent on the data available for the Berg River Estuary, supported by a site visit. The level of available historical data in combination with the time elapsed since the collection of the data determines the level of confidence of the study. The Berg River Estuary is an extensively studied system, with multiple journal articles,

dissertations, and reports published on the estuary on a yearly basis. In particular, the Present Ecological State (PES) of the estuary was recently assessed in 2022 and is considered to reflect the current state of the system (DEA&DP, 2020). Taken together with observations collected during the site visit conducted in January 2024, the level of confidence for this study is rated as High.

The following list highlights additional assumptions, limitations and knowledge gaps associated with this study which may influence the outcomes and the accuracy of the data collected.

- The following Estuarine Specialist Report is specific to the plans submitted to Anchor for the Section 24G and the proposed upgrades present at this time, any subsequent changes to the project proposal will need to be reevaluated for environmental impact.
- Planning and design for the 1/100 year flood event may not be sufficient to accommodate the increased variability and intensity of climatic events associated with climate change, however, it represents a minimum required flood resilience measure. The development falls within the 5 m elevation contour line (i.e. within the EFZ) and may experience flooding events.

3 LEGISLATIVE CONTEXT

3.1 INTRODUCTION

This section provides an overview of legislation and policy applicable to management of estuaries in South Africa and specifically to the Berg River Estuary. South African policy and law as pertinent to estuaries has been summarised in detail elsewhere (Van Niekerk & Taljaard, 2007).

3.2 ESTUARY MANAGEMENT

South Africa's legal framework has a hierarchical structure with the Constitution (108 of 1996) first and foremost. After which there are three levels (1) national policy and legislation, including national policy and national acts; (2) Provincial policy and legislation, which inlcudes Acts such as Land-use planning and conservation and (3) local policy and legislation - consisting of municipal by-laws such as land-use planning and coastal development.

The key framework legislation for the management of estuarine systems are the National Water Act (Act 36 of 1998) and National Environmental Management: Integrated Coastal Management Act (Act 24 of 2008) (ICMA).

As such, estuary management falls mainly under two national government departments: the Department of Water and Sanitation (DWS), responsible for water resources, and the Department of Forestry, Fisheries and the Environment (DFFE), responsible for other estuarine management aspects including land use and living resources. Environmental management in most instances is devolved to provincial level through the relevant provincial department responsible for environmental matters. Management and conservation of marine living resources is an exception in this respect, with responsibility for coastal and estuarine management issues residing with the DFFE. At a local (municipality) level, municipal councils pass municipal by-laws that cannot conflict with provincial and national laws. Policy and legislation which affects estuaries directly can be roughly divided into that affecting (a) water quality and quantity, (b) land use and infrastructure development, and (c) living resources (Van Niekerk & Taljaard, 2007).

The ICMA set out specific requirements for the development of a National Estuarine Management Protocol (NEMP) (Government Gazette 36432. No 341 of 10 May 2013). Chapter 4 of ICMA aims to facilitate the efficient and coordinated management of all estuaries, in accordance with:

- The National Estuarine Management Protocol (ICMA Section 33) (promulgated in 2013, with amendments finalised in 2021 as per Government Gazette Vol 672, Notice No. 44724, 2021); and
- Estuarine management plans for individual estuaries (ICMA Section 34).

The purpose of the National Estuarine Management Protocol is to manage South Africa's estuaries in accordance with the national vision for estuarine management, which requires that "estuaries…are managed in a sustainable way that benefits the current and future generations". As such, the purpose of the Protocol (as set out in the ICMA) is to:

- Determine a strategic vision and objectives for achieving effective integrated management of estuaries.
- Set standards for management of estuaries.
- Establish procedures or provide guidance regarding how estuaries must be managed and how the management responsibilities are to be exercised by different organs of state and other parties.
- Establish minimum requirements for estuarine management plans.
- Identify who must prepare estuarine management plans and the process to be followed in doing so.
- Specify the process for reviewing estuarine management plans (EMPs) to ensure that they comply with the requirements of the ICMA.

A summary of the most relevant policies is presented in Table 3.1.

Table 3.1. Summary of national policies which affect estuarine management, water quality and quantity in estuaries in general, landing use, development and resource use in the estuarine environment.

White Paper (= Policy)	Bill or Act (= Law)	Lead agent	Implications
National Estuarine Management Protocol (as amended 2021)	National Environmental Management: Integrated Coastal Management Act, 2008 (Act No. 24 of 2008)	DFFE	The National Environmental Management: Integrated Coastal Management Act requires that estuaries be managed in a co-ordinated and efficient manner, in accordance with a National Estuarine Management Protocol through the development and implementation of estuarine management plans (EMPs). The EMPs seek to achieve greater harmony between ecological processes and human activities while accommodating orderly and balanced estuarine resource utilisation. The national vision for estuarine management is that "the estuaries of South Africa are managed in a sustainable way that benefits the current and future generations".
Water quality & quantity			
White Paper on National Water Policy for SA (1997)	National Water Act 36 of 1998	DWS	Defines the environmental reserve in terms of quantity and quality of water; provides for national, catchment and local management of water
White Paper on Integrated Pollution and Waste Management for South Africa (2000)	Marine Pollution (Control and Civil Liability) Act (1981)	DFFE	Provides for the protection of the marine environment from pollution by oil and other harmful substances, the prevention and combating of such pollution, and the determination of liability in certain respects for loss or damage caused by the discharge of oil from ships, tankers and offshore installations.
	Integrated Coastal Management Bill (2007)	DFFE	Provides for the control of dumping of substances in the sea (including estuaries) (replaces the Dumping at Sea Control Act (1980) as amended).
Land use & management			
	Integrated Coastal Management Bill (2007)	DFFE / DEA&DP	Ownership of the seashore (includes the water and land between the low-water mark and the high-water mark in tidal rivers such as the Goukou Estuary) is vested in the State; currently used to control recreational boating activities in estuaries (replaces the Seashore Act (1935) as amended)
White Paper for Sustainable	National Environmental	DFFE	Provides for integrated coastal and estuarine management in South Africa, and sustainable

White Paper (= Policy)	Bill or Act (= Law)	Lead agent	Implications
Coastal Development in South Africa (2000)	Management: Integrated Coastal Management Bill		development of the coastal zone, defines rights and duties in relation to coastal areas; includes a National Estuarine Management Protocol for South Africa, and requires that estuarine management plans be developed and implemented for all estuaries
White Paper on Spatial Planning and Land-use Management (2001)	Local Government: Municipal Systems Act (2000)	Department of Provincial and Local Government (DPLG)	Requires each local authority to adopt a single, inclusive plan for the development of the municipality intended to encompass and harmonise planning over a range of sectors such as water, transport, land use and environmental management.
Protected areas			
	National Environmental Management: Protected Areas Act (2003)	DFFE	Provides for the protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes; and for establishment of a national register of national, provincial and local protected areas, describes the different types of protected areas that can be declared which may also apply to estuaries (repeals Section 43 of the Marine Living Resources Act (1998)).
	World Heritage Convention Act (1999)	DFFE	Provides for the incorporation of the World Heritage Convention into South African Law, and for the recognition and establishment of World Heritage Sites in South Africa
	National Environmental Management: Biodiversity Act (2004)	DFFE	Provide for the conservation of biological diversity, and regulates sustainable use of biological resources
Use of living resources & MPAs			
Marine Fisheries Policy for South Africa (1997)	Marine Living Resources Act (1998)	DFFE	Regulates living resource use within marine and estuarine areas, mainly through licensing.

The Western Cape Government has also released a Coastal Management Policy which includes a suite of goals, objectives and strategies designed to achieve sustainable coastal development in the Western Cape. These are closely aligned with the National Coastal Management Policy and are organised within a number of themes. Various goals within each of these themes are of relevance to the management of the Berg River Estuary and are detailed in Table 3.2.

Table 3.2. Provincial and local government legislation applicable to the Berg River Estuary

Act/Ordinance	Lead agent	Implication
Municipal Ordinance (Cape) (1974)	DEA&DP	Grants local authorities in the province of the Western Cape the power 'to drain storm water into any natural water course'.
Land Use Planning Ordinance (1985) as amended	DEA&DP	Provides for the establishment of the Western Cape Nature Conservation Board. Most planning applications received by the provincial department are in terms of this Act including applications for departure, rezoning or subdivision and appeals against planning decisions taken by a municipality.
Western Cape Planning and Development Act (1999)	DEA&DP	Provides guidelines for the future spatial development in province of Western Cape.

Act/Ordinance	Lead agent	Implication
Nature Conservation Ordinance (1974)	Western Cape Nature Conservation Board (WCNCB)/ CapeNature	Provides for the establishment of provincial, local and private nature reserves and the protection of indigenous species of flora and fauna. Protected and endangered species of flora and fauna are listed in schedules to the ordinance. It is administered by the Western Cape Nature Conservation Board (WCNCB) and grants certain powers to the WCNCB.

3.3 ESTUARY WATER QUANTITY AND QUALITY REQUIREMENTS

Currently, conservation in estuaries is achieved through a number of different legislative Acts including ICMA, the Marine Living Resources Act 18 of 1998 (as amended) (MLRA), the National Environmental Management: Protected Areas Act (Act No. 57 of 2003) (NEM: PAA), and the National Environmental Management: Biodiversity Act (Act No. 10 of 2004) (NEM: BA). With the exception of the ICM Act, all of the acts listed above are able to provide explicit protection for living and non-living resources below the high-water mark only (viz. the MLRA) or above the high-water mark only (the rest).

Maintenance of an adequate supply of freshwater to estuaries is provided for under the National Water Act (NWA) (Act 36 of 1998). This Act also requires a specific water use licence for any development within the 1:100-year flood line. All development in this zone is actively discouraged, due to the predicted changes in climate and associated possibility of increased flood events. In addition, the Estuarine Functional Zone, as delineated by a 5 m above MSL contour as proxy indicator, restricts certain activities within an estuary without prior Environmental Authorisation as per the 2014 Environmental Impact Assessment Regulations (GNR 985) under NEMA (1998).

The White Paper on National Water Policy for SA (1997) promotes efficiency, equity, and sustainability in the use of water resources through its slogan "some, for all, for ever". The policy explicitly recognises the environment as a legitimate user of water and makes provision to protect the environment from overexploitation of water resources. The NWA makes provides the legal framework for this policy making provision for a water "Reserve" required to meet basic human needs as well as provision of water in the required quantity and quality to support aquatic ecosystems and to protect the natural functioning of a water resource. The latter portion of the reserve is known as the Environmental Reserve.

The existing studies listed in Section 2.3 sought to enhance understanding of the linkages between the quantity and quality of freshwater reaching the estuary, level of development hydrodynamic functioning of the system, primary production and ecosystem functioning, estuary health, conservation importance, and delivery of ecosystem goods and services. The RDM and Classification studies have analysed a range of flow scenarios to determine the implications for estuary health. The RDM study included nine scenarios which analysed the effects of the Berg River Dam, raising the Voelvlei dam, raising the Misverstand weir, and setting environmental releases. This study put the estuary in a C-class of health (moderately modified) and predicted that this could remain with the Berg River Dam but that raising the Voelvlei Dam would lower the health of the system to a D-class.

After the construction of the Berg River Dam, the estuary health status was downgraded to a D-class. The Classification study required that the estuary is returned to a C-class mainly by increasing low flows during the dry season. The Resource Quality Objectives (RQOs) for the estuary were finalised in 2019, and stipulate minimum flow and water quality requirements, as

well as a range of standards for the biota of the system (Appendix 1). These were designed to allow the system to return to a C-class under historical climate conditions, but they will only likely achieve a C/D class under projected climate change.

The 2020 Department of Environmental Affairs & Development Planning (DEA&DP) assessment however showed that, since 2010, the overall health of the estuary has changed from 66.3% similarity to Reference condition to 52.9% and has dropped a whole category from a C- (moderate modified) to a D-category (largely modified). The system is thus no longer compliant with the gazetted RQOs which require maintaining the system in a C category (DEA&DP, 2020). This change in health has largely been driven by reductions in physical health (down from 68% to 49%), with changes in biotic health lagging somewhat (down from 66% to 57%) (DEA&DP, 2020).

3.4 COASTAL PROTECTION ZONE

The coastal protection zone consists of land falling within an area declared in terms of the Environment Conservation Act, 1989 (Act No. 73 of 1989), as a sensitive coastal area within which activities identified in terms of section 21(1) of that Act may not be undertaken without an authorization. Under the ICMA (2008 as amended in 2014), the Provincial MEC in consultation with the Local Municipalities is required to define a coastal protection zone. This zone extends 100 m inland of the coastal and estuarine high-water mark in urban areas which are presently zoned for residential, commercial, industrial or multiple-use purposes, and 1 000 m inland for all areas zoned as agricultural or undetermined use and that are not part of a lawfully established township, urban area or other human settlement.

The ICMA (2008) also provides for the establishment of a coastal management line (CML) or Coastal setback Line (CSL), designed to protect the coastal protection zone. Any future development seawards of the coastal management/setback lines will automatically be subject to an Environmental Impact Assessment (EIA) and would have to be compatible with the vision and objectives defined in the Coastal Management Programme. Establishment of coastal management lines around the estuary should prevent development from encroaching too close to the estuary or the adjacent shoreline and hence will ensure an adequate buffer for these areas. The CML will serve to protect ecological functioning and integrity of the coast and estuary, limit disturbance to associated flora and fauna, and will assist in successful rehabilitation of disturbed areas along the coast and enhance its ecotourism appeal.

The CML for the West Coast District Municipality has been defined by DEA&DP (2014) as a risk based coastal overlay zone. Risk projections are defined based on the floodlines and are defined as High within the 1:20 year floodline, Medium (1:50 years) and Low (1:100 years) risk zones (DEA&DP, 2014). As such, any proposed development within the CML for the West Coast District Municipality (2019) as delineated by:

- The 5 m above Mean Sea Level (AMSL) contour (i.e., the EFZ)
- The 1:20 year floodline i.e., low risk;
- The 1:50-year floodline i.e., medium risk and,
- The 1:100 floodline i.e., high risk.

3.5 SECTION 24G

A Section 24G of the National Environmental Management Act, 1998 (Act 107 of 1998) ("NEMA") application is undertaken where a person/company has commenced with a listed or specified activity without first undertaking an environmental authorization. Any development within an Estuarine Functional Zone automatically triggers a need from an Environmental Impact Assessment (EIA). The developments of the Knor Varkie Resort were undertaken in an EFZ between 2019 and 2022 (Figure 1.2) without first obtaining Environmental Authorisation. The specific activities triggered by the Knor Varkie Resort is covered in Section 1.3.

3.6 ALIEN SPECIES

In South Africa the presence of invasive species is governed by the following legislation:

- National Environmental Management Act (Act 107 of 1988) or NEMA Act
- National Environmental Management: Biodiversity Act (Act 10 of 2004) or NEMBA Act
- Conservation of Agricultural Resources Act (ACT No. 43 of 1983) or CARA Act

It is the responsibility and legal liability of the landowner to control invasive vegetation on their property. It is also their responsibility to remain informed of updated species lists and regulations. Updated regulations can be found in NEMBA: Alien and Invasive Species Regulations (2020) and updated species lists can be found in NEMBA: Alien and Invasive Species Lists (2020). Briefly,

- Category 1a Listed Invasive Species are those which are prohibited, and which must be combatted and eradicated if present.
- Category 1b Listed Invasive Species are prohibited and must be controlled if present.
- Category 2 Listed Invasive Species require a permit to carry out a specified restricted activity within a specific area.

If any of these species are present the land owner is obligated to allow authorised officials onto the property to monitor or control the invasive species (DEFF, 2020).

4 DESCRIPTION OF THE AFFECTED ENVIRONMENT

4.1 INTRODUCTION

The Berg River Estuary is one of four permanent estuaries on the West Coast of South Africa. The cool temperate, predominantly open system empties into St Helena Bay, 140 km north of Cape Town and some 285 km downstream from the Berg River source in the Groot Drakenstein and Franschhoek mountains. The EFZ of the Berg River Estuary was defined as the 5 m contour AMSL as reported in the 2018 NBA (Van Niekerk *et al.*, 2019). The lower reaches of the main channel are dominated by the marine tidal influences of St Helena Bay, while the upper reaches are freshwater dominated. The Berg River Estuary is a somewhat unusual South African system because it has a very shallow gradient, rising <1 m in 50 km. The estuarine system itself extends some 70 km inland from the mouth and includes an extensive floodplain covering an area of 61-69 km^2 that comprises of ephemeral pans, salt marshes and intertidal mud flats (Figure 4.1) (Turpie & Clark, 2007; Ractliffe, 2009; Schumann, 2009; van Ballegooyen, 2010). The main channel of the estuary is 100-200 m wide at Velddrif (4 m deep), becoming narrower and shallower further upstream (150 m wide and 3 m deep on average) (Taljaard *et al.*, 2010; van Ballegooyen, 2010).

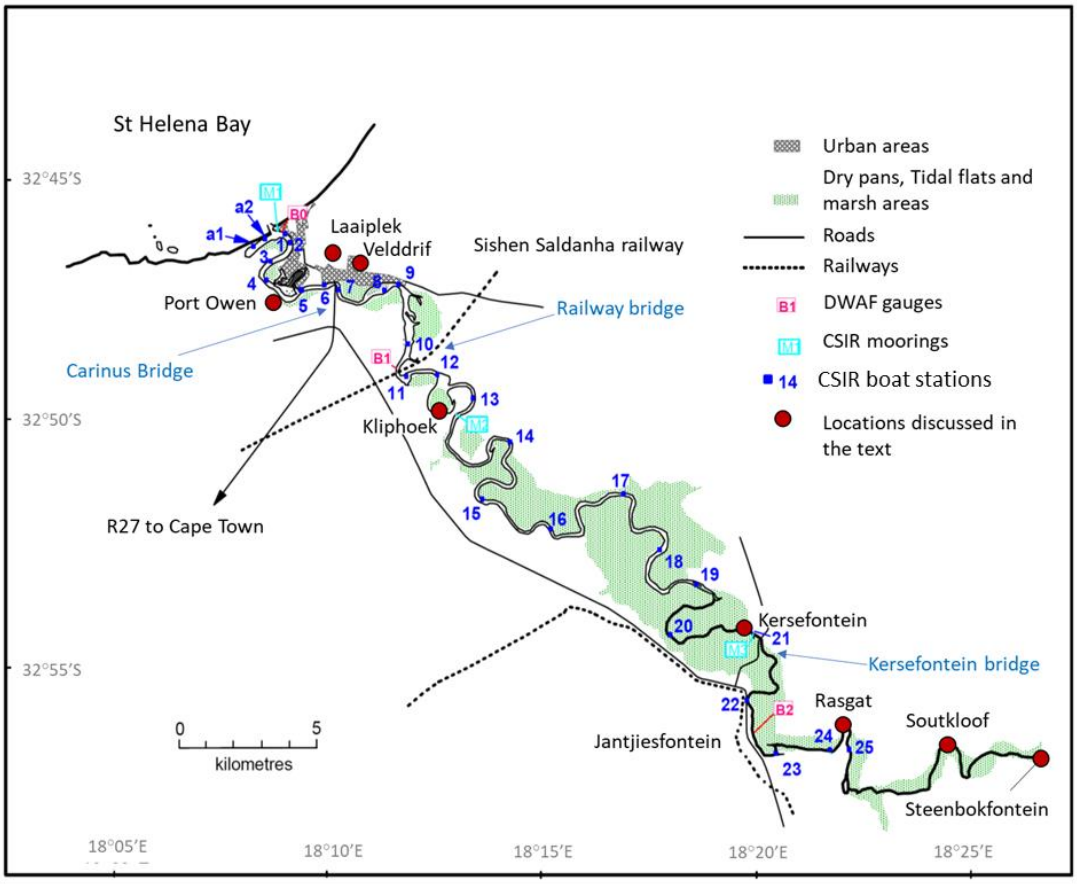

Figure 4.1. The Berg River Estuary floodplains, roads and urban areas (from DEA&DP, 2020, adapted from Schumann, 2009 and van Ballegooyen, 2010).

4.2 CATCHMENT AND RAINFALL

The catchment of the Berg River covers an area of some 7700 km² (Aecom, 2023). The river Berg River flows from the Jonkershoek and Franschhoek mountains in a north-westerly direction through Paarl and Wellington to Misverstand Dam, continuing north through Porterville and Moorreesburg eventually discharging into the sea at Laaiplek on the West Coast (Figure 4.2). The major tributaries are the Franschhoek, Wemmers, Krom, Kompagnies, Klein Berg, Vier-en-Twintig Rivieren, Matjies, Platkloof, Boesmans and Sout Rivers.

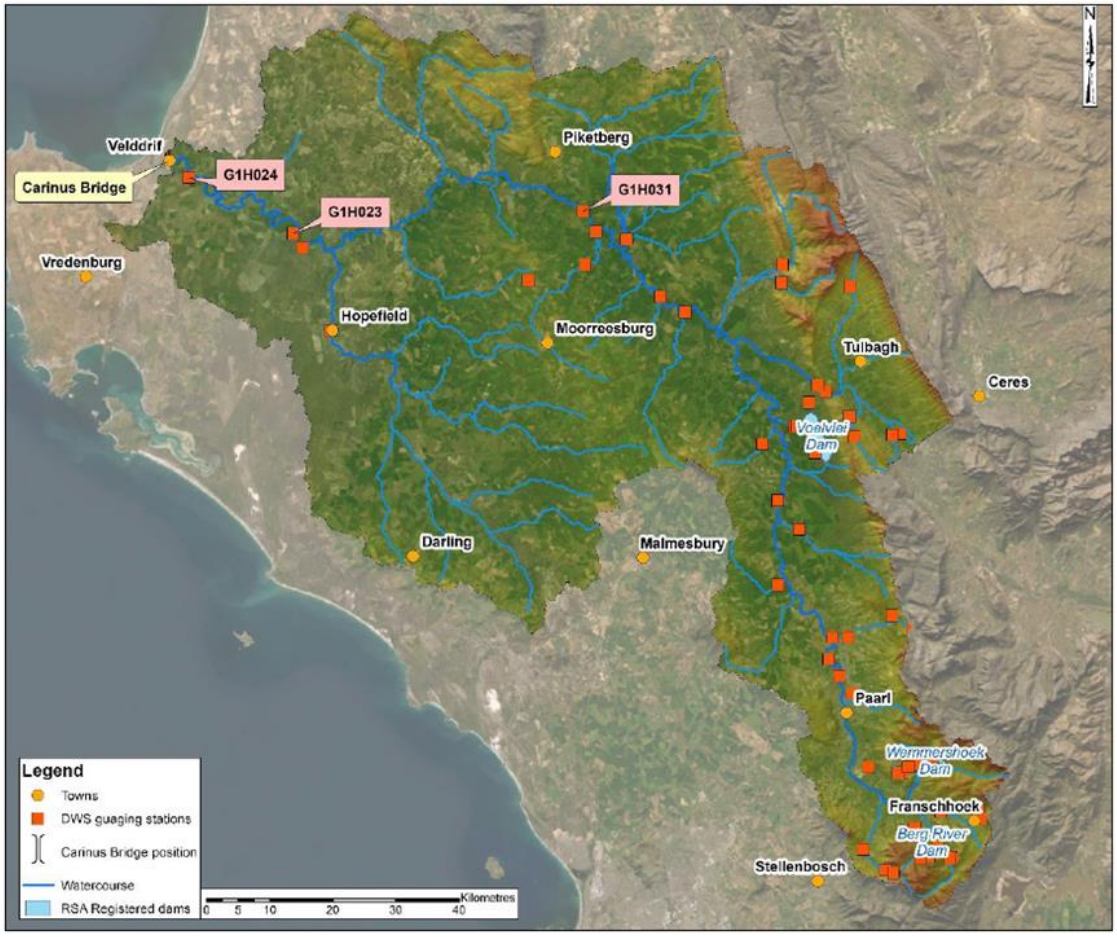

Figure 4.2. Catchment of the Berg River Estuary (from AECOM, 2023).

Major dams located in the catchment are the recently constructed Berg River Dam (2007), Wemmershoek Dam, Voëlvlei Dam and Misverstand Dam and these are managed as part of the Western Cape Water Supply System (WCWSS) which supplies water to the City of Cape Town as well as several other smaller municipalities and to agriculture. Water is also supplied to major industrial developments such as the Saldanha Industrial Development Zone via the West Coast Municipality which receives water from the WCWSS via a diversion and treatment plant at Misverstand Dam. The allocation to agriculture is largely managed through the Upper and Lower Berg River Irrigation Boards or Water User Associations

The system experiences a strongly seasonal hydrological regime linked to the Mediterranean climate of the region. During the warm dry summers (November-February), there is little to no river inflow to the Estuary, with sea water penetrating up the estuary as far as Kliphoek,

some 14 km from the mouth (i.e., a marine dominated estuarine system). During the wet winters (May to August), strong river inflow results in a river-dominated estuary and low salinities throughout the system (Schumann, 2009; Taljaard *et al.*, 2010; van Ballegooyen, 2010; DEA&DP, 2020).

High rainfall events may result in floods during the wet winters, which have a proportional effect on inundation of the adjacent floodplains – at freshwater inflows of above 80 m^3/s, the water level rises to such an extent that the estuary breaks its banks and flows out onto the adjacent floodplain (Taljaard *et al.*, 2010) While in the upper reaches, the estuary is bounded by steep banks covered in riparian woodland, the downstream estuarine system is flanked by a floodplain that varies in width from 1.5 to 4.0 km in the middle reaches, to <1.5 km in the lower reaches (Figure 4.3) (van Ballegooyen, 2010). This extensive floodplain is somewhat atypical in relation to most South African estuaries and forms an integral part of the estuarine ecosystem (Beck & Basson, 2007).

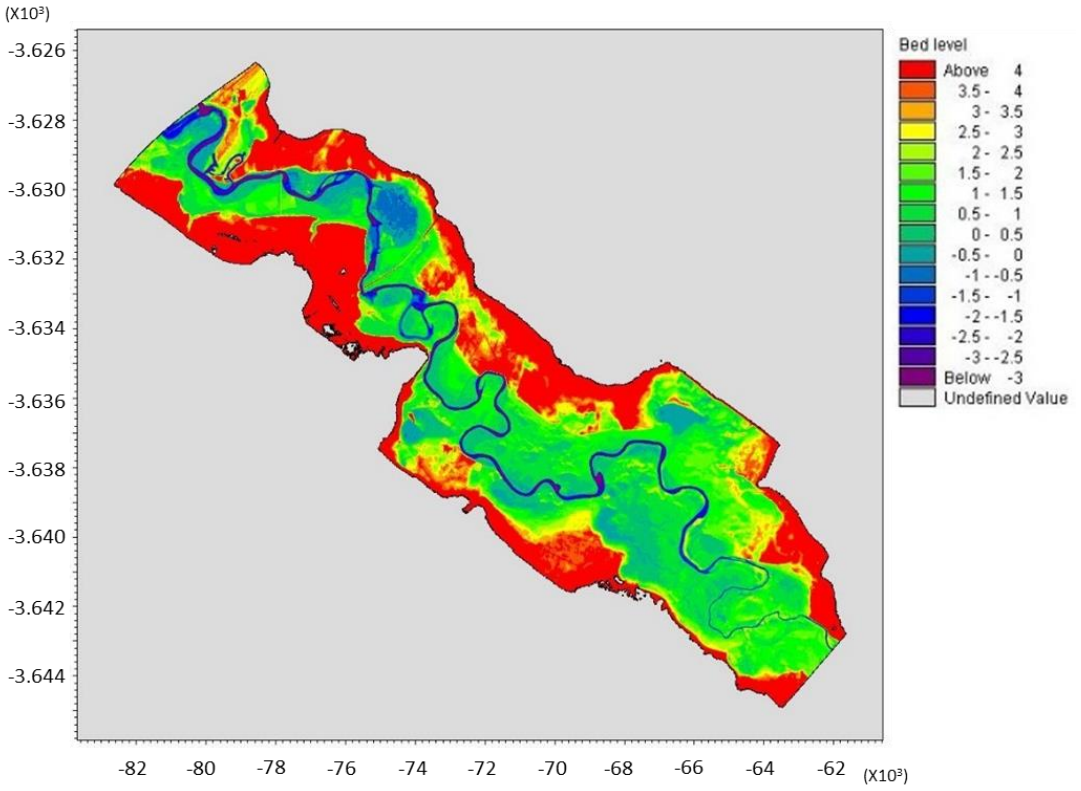

Figure 4.3. Bathymetry of the Berg River Estuary and topography of the Berg River Estuary flood plain (Beck & Basson, 2007).

4.3 HYDRODYNAMIC FUNCTION

The hydrodynamic functioning and characteristics of estuaries are affected by a number of key drivers. As estuaries form the interface between the marine and freshwater environment, oceanic factors can play a significant role in the hydrodynamic and biogeochemical characteristics of a system. These oceanic influences include sea level variations from tides and weather effects (i.e., storm surges), as well as water quality. In a similar fashion, the quantity and quality of freshwater entering the system (and changes thereof) is critical in shaping form and function. Channel morphology, sediment structure and vegetation (which is

often determined by freshwater inflow) as well as external influences on the system such as wind, rain, air temperature, insolation and evaporation also affect the manner in which the water circulates and mixes within the estuarine system. Water quality and circulation patterns in the estuary are influenced by renewal of water in the estuary (flushing, which in turn is influenced by tides and freshwater inflows at the head of the estuary), the effects of sub-tidal water level variations in the adjacent ocean, intrusions of cold upwelled oceanic waters and local wind stress (air-sea interactions).

The hydrodynamics of the Berg River Estuary are driven by seasonality in inflow, bathymetry as well as the gentle gradient (rising <1 m in 50 km) and the long length of the estuary (van Ballegooyen, 2010; DEA&DP, 2020). The strongly seasonal hydrography influences water levels, with high flows causing the channel to burst its banks and inundate the surrounding floodplains, and flushing (Largier *et al.* 2000, DEA&DP 2020). The somewhat unusual lack of stratification in the system means that there is little classical estuarine circulation (where the difference in density between seawater and freshwater drive the circulation), and flood events easily flush seawater that enters the canalised mouth and penetrates upriver with incoming tides (van Ballegooyen, 2010). Indeed, freshwater spates exceeding 140 m^3/s are sufficient to fully flush the estuary of saline water (Schumann, 2009, DEA&DP, 2020).

The marine exchange is driven mostly by changes in water level (i.e., tides), with only a limited influence of processes associated with density differences between fresher estuarine waters and the ocean (van Ballegooyen, 2010). The tidal effects in the Berg River Estuary are directly linked to the tides of St Helena Bay, which are characterised, as is the rest of South Africa, by a semidiurnal tidal cycle, with two nearly equal high tides and low tides every day. The tidal variation on the West Coast usually ranges between 0.28 m (relative to the chart datum) at mean low water springs and 1.91 m at mean high water springs, with the highest and lowest astronomical tide being 2.25 m and 0.056 m, respectively. Tidal range within the estuary is 0.5-1.5 m at the mouth, 0.2-0.8 m in the middle of the estuary and <0.2 m in the upper estuary, with the canalised entrance channel maintaining a relatively unconstricted exchange of water between the estuary and St Helena Bay (Taljaard *et al.*, 2010). Tidal flows in the lower estuary (at the R27 bridge) are 50-100 m^3/s and 200-300 m^3/s during neap and spring tides, respectively (Beck & Basson, 2007). Intertidal areas (i.e., areas that are exposed and covered by outgoing and incoming water linked to the tides) occur mainly downstream of the Railway Bridge (Taljaard *et al.*, 2010, DEA&DP, 2020). Other mechanisms influencing water circulation in the system include the effects of subtidal water level variations in the adjacent ocean, intrusions of cold upwelled oceanic waters and local wind stress (Taljaard *et al.*, 2010).

There has been significant modification to the Berg River in the last 50 years, most notably at the mouth. This has had specific impacts on channel morphology and floodplain dynamics, and as such, have altered the hydrodynamic functioning of the system. Historically, the estuary terminus flowed parallel to the coast, with the mouth emptying at the southwestern end of an extended coastal berm (Figure 4.4). There were large floodplains inland of the mouth, which appeared to be regularly inundated by tidal and/or fluvial action (Figure 4.4) (Beck & Basson, 2007).

Figure 4.4. Historical photographs of the Berg River Estuary mouth, in 1942 (with the natural mouth) and in 1976 (after canalisation and construction of the artificial mouth). Note the new, permanent mouth and 'blind arm' parallel to the coast in the 1976 image (Beck & & Basson, 2007).

4.4 SEDIMENTS AND EROSION

Typically, estuarine sediments comprise a mixture form marine sources and riverine sources, depending on the extent of oceanic influence (the amount of water moving in and out of the estuary during a tidal cycle) riverine base flows and floods (DEA&DP, 2020). Higher flows can carry larger particles, but which settle out as flow is reduced. Therefore, sediments tend to be coarse (sand or gravel) in areas of strong currents, and fine (mud and silt) where current speeds are low (DEA&DP, 2020). The sediment in both the lower and upper reaches of the Berg River Estuary are characterised by a higher percentage of larger sediment particles (i.e., a mostly sandy environment) than the middle reaches, due to strong current velocities of the tides in the lower reaches, and river inflow in the upper reaches (Figure 4.5).

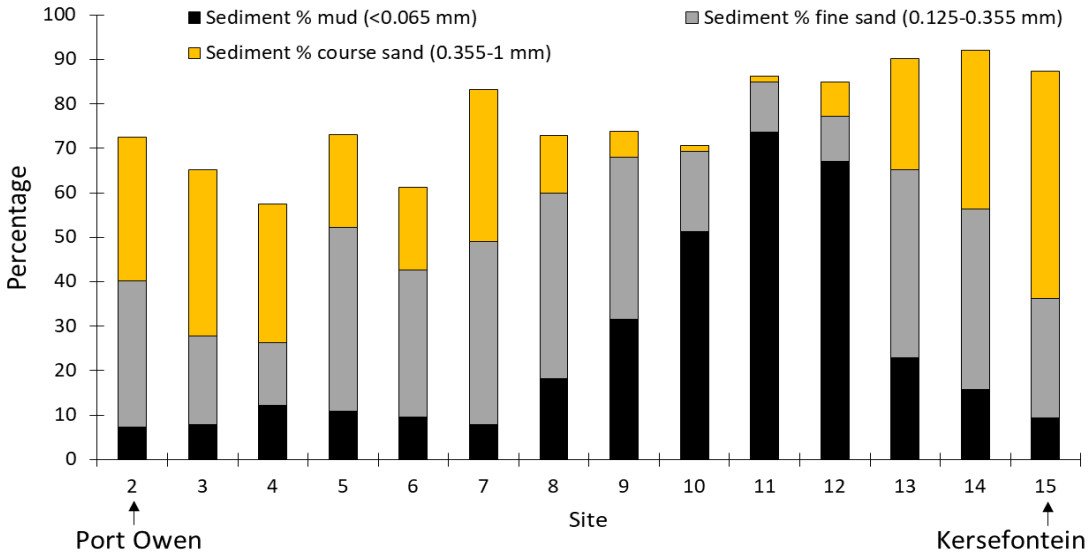

Figure 4.5. Particle size percentage composition (i.e., sediment type) up the Berg River Estuary from Port Owen (3 km from the mouth, site 1) to Kersefontein (47 km, site 15) (based on data from Wooldridge, 2007; from DEA&DP 2020).

There is also an accumulation of fine sediments in the middle estuary, so that the channel and inter-tidal areas become muddier and shallower with time (DEA&DP, 2020) (Figure 4.5). In a similar fashion, the finer sediments of the middle reaches of the estuary also typically contain higher levels of organic matter compared with the coarser sediments of the upper and lower reaches (DEA&DP, 2020) (Figure 4.6).

During flood events, silt is carried into the system from the catchment, and is deposited wherever floodwaters slow down significantly, such as on the floodplain (DEA&DP, 2020).. Floods also scour sediments in both the channel and the lower inter-tidal areas, while very large floods may scour the floodplain as well (DEA&DP, 2020). The area of scouring versus deposition is likely to depend on the size of a particular flood: under low flow conditions, erosion and deposition is also confined to the main channel in the upper reaches of the estuary and the sediment transport is very small, with a maximum scour of about 0.2 m (Beck & Basson, 2007, DEA&DP, 2020). Under flood conditions, model simulations show that erosion and deposition patterns are much more extensive, with scouring and deposition of up to 0.3 m in the main channel (Beck & Basson, 2007, DEA&DP, 2020).

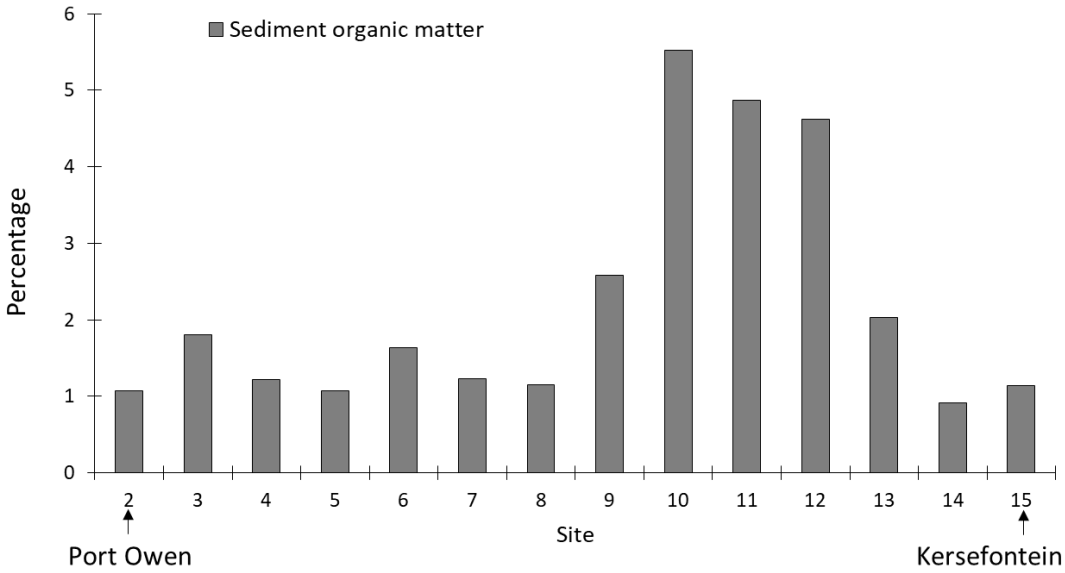

Figure 4.6. Particle size percentage composition (i.e., sediment type) up the Berg River Estuary from Port Owen (3 km from the mouth, site 1) to Kersefontein (47 km, site 15) (based on data from Wooldridge, 2007; from DEA&DP 2020).

Erosion of channel banks in the Berg River Estuary is a well-documented phenomenon, with potential causes investigated as part of the estuary valuation study by DEA&DP (2020). Bank erosion threatens important estuarine habitat at Admiral Island, Carinus Bridge, Cerebos Saltworks, Kuifkopvisvange and Kliphoek. Erosion at Admiral Island (located mainly on the inside of a bend) appears to be related to wave action, possibly caused by boats and wind, while erosion at the other sites (located on the outside of bends) appears to be due to flow and waves with the possibility of the channel moving slowly as would be expected in this environment (DEA&DP, 2020).

4.5 WATER QUALITY

The term "water quality" is often associated the trophic (nutrient) status of an estuary and the presence of heavy metals and pathogens (such as faecal coliforms), but also includes the physical properties such as temperature, salinity and dissolved oxygen. These different aspects of water quality have different drivers. The physical properties such as temperature and salinity are closely linked to hydrodynamics; dissolved and suspended constituents are introduced into the system from the river catchment area, the sea, atmospheric inputs and internal recycling (Stanley & Hobbie, 1977; Fisher, Carlson & Barber, 1982); while pathogens are introduced from urban areas and particularly poorly serviced, growing informal settlements (Taljaard *et al.*, 2010; Cullis *et al.*, 2019). All of these are influenced by river inflow, and therefore are also sensitive to floods and drought.

There have been significant changes to the water quality of the Berg River Estuary over the last several decades. The estuary mouth has been canalised, and a number of bridges have been built across the system. Pollutants have also increased due to agricultural runoff and expanding human settlement in the catchment area and along the margins of the estuary (Taljaard *et al.*, 2010; Cullis *et al.*, 2019; DEA&DP, 2020). The effects have been exacerbated by a reduction of freshwater inflows due to changes in the Berg River Catchment (i.e., transformation of land in the catchment for agriculture, urban and industrial development, and changes in rainfall patterns) (DEA&DP 2020). These effects are summarised below:

- Salinity changes with depth and distance upriver during varying tides and seasons of a year. During summer (low flow), the saline water from St Helena Bay penetrates between 43 km to 45 km up the estuary, and salinity remains high in the lower reaches. During winter months with higher incoming freshwater flow, the salinity intrusion is greatly reduced to 3 km to 15 km, with more variable salinity due to flushing of seawater by freshwater inflows. Reduced freshwater inflow during the 2016-2018 drought impacted maximum salinity levels attained in the estuary – in the middle reaches, maximum levels attained each year increased from ~32 in 2016, to ~35 in 2017, and ~39 in 2018, which is substantially higher than normal sea water (34.5) (DEA&DP, 2020).

- Natural levels of dissolved oxygen are governed by temperature and salinity, as well as the organic content of the water (DEA&DP, 2020). Oxygen is removed from the water column by the respiration of biota and through decomposition of organic matter. Marine waters entering the mouth of the Berg River Estuary have a wide range of dissolved oxygen values (1-10 mg/l). Oxygen levels in the freshwater entering at the head of the estuary are mostly high (8-12 mg/l) (DEA&DP, 2020). If there is reduction in winter inflows, there is a reduction in the 'flushing out' of low oxygen water that forms during the low flow summer season, with impacts on species that cannot tolerate low levels of dissolved oxygen (DEA&DP, 2020) (below 4 mg/l, juvenile fish species may start to be negatively affected, while mass mortalities of fish can occur at concentrations below 2 mg/l).

- While nutrient cycling drives biological production in estuaries, anthropogenic inputs of nutrients through land clearing, application of fertilizer, discharge of human wastes, animal production, and urban runoff may disrupt natural nutrient cycling processes. This may impact the systems' food web (trophic structure), and cause eutrophication. Increased nutrient levels stimulate undesirable plant growth, such as phytoplankton. Phytoplankton growth reduces the amount of light reaching other plant species, thereby inhibiting their growth. Other undesirable effects include oxygen depletion from the decomposition of phytoplankton and plant biomass. Indeed, Dissolved Inorganic Nitrogen levels have doubled in the last decade, and appear to predominately enter the system through freshwater inflow (i.e., from increased agricultural activities and expansion of human settlements in the catchment) (DEA&DP, 2020). There is also evidence that elevated ammonia levels being introduced into the estuary through discharge from the fish factory near the mouth (DEA&DP, 2020). Levels of total ammonia entering the estuary during the high flow season from the catchment have also increased in the last decade (DEA&DP, 2020).

- *Escherichia coli* (E. coli), an indicator of pathogenic micro-organisms, in lower and middle reaches of the estuary fluctuate throughout the year, with peaks in both high and low flow periods (DEA&DP, 2020). Averaging the data at each station shows overwhelmingly that the major source of *E. coli* contamination is at the mouth of the estuary, next to the Laaiplek Fishing Harbour and Amawandle Pelagic (DEA&DP, 2020). The limits above which a water body is considered "poor" or "unfit" for recreational purposes were exceeded at this site (DEA&DP, 2020).

4.6 ECOLOGY

4.6.1 AQUATIC AND RIPARIAN VEGETATION

The Knor Varkie Camp Site and Caravan development is located within the EFZ of the Berg River Estuary. The site which is made up of four vegetation types: the Saldanha Flats Strandveld vegetation type (Endangered: (SANBI, 2018)) and the non-terrestrial estuarine vegetation types: salt marsh, reeds & sedges and estuarine functional zone (Mucina, Rutherford & Powrie, 2018) (Figure 4.7).

Figure 4.7. Vegetation types associated with the Knor Varkie Resort (Mucina *et al.*, 2018).

The area is further highlighted as a Critical Biodiversity Area (CBA) under the Western Cape Biodiversity Spatial Plan (WCBSP). Specifically, the site is demarcated as CBA 1: Aquatic, CBA 2: Aquatic, ESA 2 and CBA: Terrestrial (Pool-Stanvliet *et al.*, 2017), as well as NFEPA wetlands (Figure 4.8).

Indeed, the system has the largest and most diverse riparian vegetation and wetland habitat of any permanently open estuary in South Africa. The main vegetation communities associated with the Berg River Estuary are macroalgae, submerged macrophytes, salt marsh, and reeds and sedges. Their distribution is largely dependent on the longitudinal salinity profile of the system, with marine communities towards the mouth and freshwater communities further upstream.

The vegetation of the Berg River Estuary has been shaped by a strongly seasonal flow and flood regime which maintains the floodplain systems. A prolonged decline in river input results in a decline in the frequency and intensity of winter floods in the system and causes the dieback of floodplain vegetation dependent on periodic inundation. Decreased river input may also result in a shift in the salinity profile of the system, impacting species that survive only within specific salinity levels. Extended dry periods will therefore have consequences for the riparian vegetation community structure, composition and function. This will in turn affect other biological components of the estuary, such as birds and fish. These impacts are compounded by historical and current anthropogenic pressures. For example, historical flow data presented in the 2020 DEA&DP estuarine health assessment indicate a noticeable decrease in summer flows associated with increased irrigation demand from the early 1990s to the present day. Under present conditions (as of 2020), there is typically no flow reaching the estuary in the summer months, as it is all being used to meet irrigation demands downstream of Misverstand. Floods in the Berg River Estuary occur mostly during the winter months of June, July and August. While there was no clear evidence of climate change impacts on annual maximum flood peaks up to now, the Berg River Dam has had an impact on flood peaks since its construction in 2007 (DEA&DP 2020).

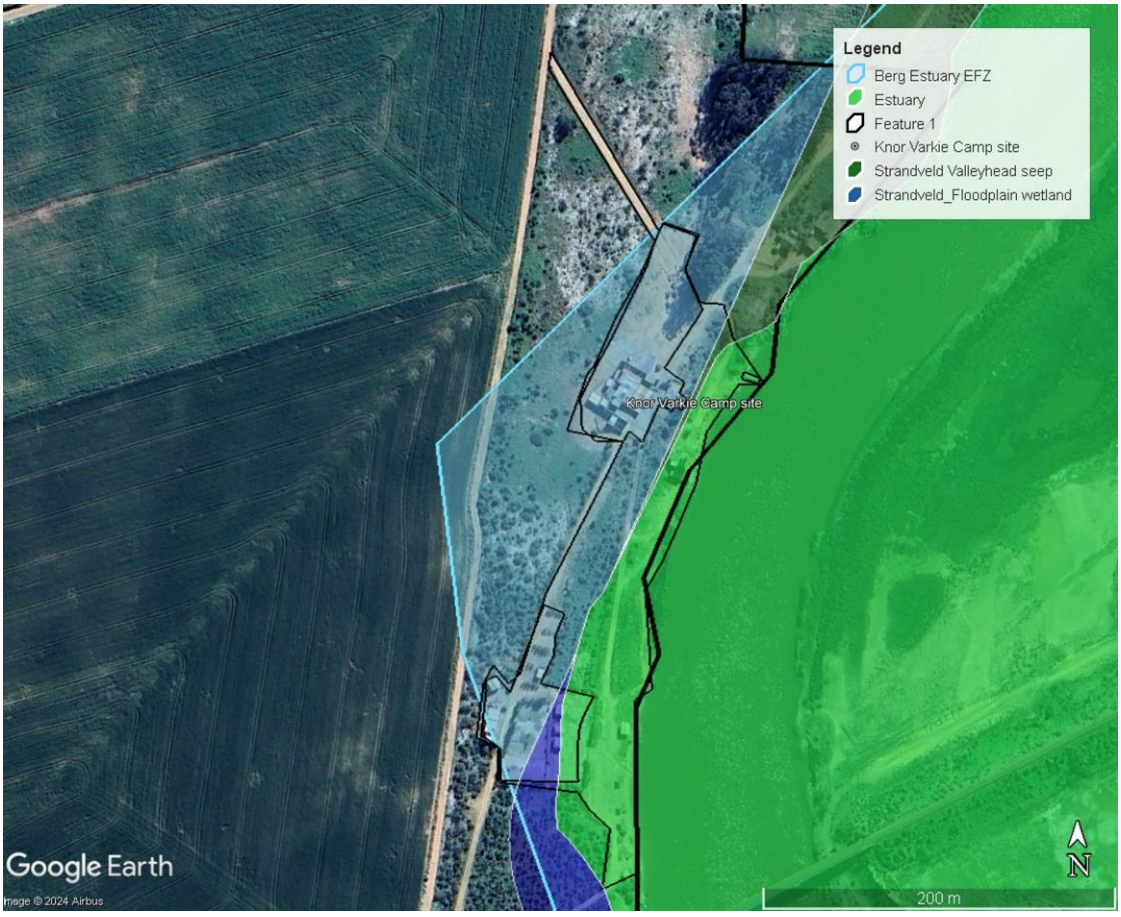

Figure 4.8. NFEPA wetlands. Feature 1 refers to the Knor Varkie Resort footprint.

SITE VEGETATION ASSESSMENT

The site visit undertaken on the 25th of January 2024 showed that the EFZ of the Berg River Estuary at the proposed development area consists of small patches of functional intertidal and supratidal estuarine habitat (salt marsh and reeds & sedges) but is mostly dominated by areas

of disturbed vegetation i.e. salt bush and alien trees. A total of nine estuarine or estuarine associated plants were identified on the project area (Table 4.1). Eight of these plants were classified as least concern, however, one species, *Zostera Capensis,* is listed as *Endangered.* Several invasive species were also identified including Beefwood, Eucaplytus and Wattle. These species are all listed as category 1b) invasives within riparian zones, which is of particular concern to this assessment.

Table 4.1. List of plant species identified during the site visit.

Family name	Scientific names	Common name	Conservation status
Zosteracea	*Zostera capensis*	Cape dwarf eelgrass	Endangered
Amaranthaceae	*Chenolea diffusa*	Soutbossie	Least concern
Plantaginaceae	*Plantago crassifolia*	Fleshy plantain	Least concern
Juncaceae	*Juncus kraussii subsp. Kraussii*	Matting rush	Least concern
Poaceae	*Phragmites australis*	Common reed	Least concern
Asteraceae	*Cotula coronopifolia*	Water button	Least concern
Aizoaceae	*Mesembryanthemum canaliculatum*	Vingerkanna	Least concern
Aizoaceae	*Mesembryanthemum pallens*	Pale Preenfig	Least concern
Plumbaginaceae	*Limonium scabrum*	Sea lavender	Least concern

Areas with permanent eradication, removal or elimination of vegetation and bare ground were evident within the EFZ during the site visit, which, based on historical satellite images, had not been previously cleared (Figure 1.2). These areas are disproportionately vulnerable to erosion and soil mobilization due to the cohesive influence of plant root systems.

Of particular importance was the confirmed presence of salt marsh habitat in the vicinity of the proposed development during the site visit undertaken on 25 January 2024. Saltmarsh communities are comprised of herbs, grasses and low shrubs that grow in sheltered estuaries at the interface of saline waters and the terrestrial environment, in areas that are periodically flooded by the adjacent estuarine water body due to tidal forcing or freshwater flooding (Adams, Veldkornet & Tabot, 2016; Adams, 2020). Saltmarshes serve as critical habitats for migratory fish and birds and provide a number of ecosystem services, such as coastal protection, erosion regulation, water purification, maintenance of fisheries and carbon sequestration (Saintilan *et al.*, 2019; Adams, 2020). Indeed, the largest monetary value of provision of these services in temperate regions is derived from saltmarsh systems (followed by seagrasses and mud flats) (Davidson *et al.*, 2019). Halophytic (salt tolerant) macrophyte (i.e., saltmarsh) community composition is dictated by the tidal inundation gradient and occurs in distinct zones. In South Africa, these include the intertidal saltmarsh communities (which experience regular inundation) and the seldom flooded supratidal habitats. The latter occurs some 1.5 m above mean sea level and may only experience flooding during exceptional spring tide events, sometimes only twice a year (Adams *et al.*, 2016; Adams, 2020). As such, the communities of the supratidal saltmarsh differ from those that characterise intertidal saltmarsh, due in part to the different abiotic forcing experienced by these different areas of shore (Adams, 2020).

Although this biome is rich in floral diversity, it is under threat, the saltmarshes are altered due to filling, dredging, ditching, impounding and draining, as well as pollution. Freshwater withdrawal results in an increase in salinity and loss of the species preferring brackish habitats

(e.g., *Juncus kraussii, Cotula coronopifolia*). Subsequently, this may cause poor development of halophytic plant species. Other threats include cultivation, rapid urban development, and expansion of residential and industrial activities. As a result, much of these activities usually favour the growth of alien invasive species.

The Berg River Estuary in particular, has the largest area of intertidal and supratidal saltmarshes in South Africa (Adams 2020), with the most recent estimate suggesting a total salt marsh of 2700 ha (DEA&DP 2020). In South Africa, only 13% of estuaries are permanently open (37 of 289 estuaries between the Orange River and Kosi Bay) with most intertidal saltmarsh habitats occurring in these permanently open estuaries. The loss and degradation of these intertidal saltmarsh habitats is predominantly due to developments (i.e., causeways, bridges or encroaching housing and business developments).

The Cape Estuarine Salt Marshes comprises of flats and low riverine terraces supporting various herb lands and shrublands dominated by succulent chenopods and other flood-tolerant halophytes. These salt tolerant plants are mainly found on supratidal terraces and in middle and lower tidal zones. There is a presence of salt-marsh meadows dominated by rushes and sedges indicating freshwater seeps. *Spartina* species usually stand tall within the estuarine flats and submerged *Zostera* spp. are in sea meadows at the lower boundary of the tidal zone. In South Africa, these include the intertidal salt marsh communities (which experience regular inundation) and the seldom flooded supratidal habitats. The latter occurs some 1.5 m above mean sea level and only experience flooding during exceptional spring tide events, sometimes only twice a year (DEA&DP, 2020). As such, the communities of the supratidal salt marsh differ from those that characterise intertidal salt marsh, due in part to the different abiotic forcing experienced by these different areas of shore (DEA&DP, 2020). Other environmental factors that influenced species distribution were groundwater salinity, groundwater electrical conductivity, sediment electrical conductivity and sediment moisture content (DWS, 2017b, 2017a). The important and endemic plant species of the Cape Estuarine Salt Marshes are presented in Table 5.1.

4.6.2 INVERTEBRATES

The Berg River Estuary has one of the highest invertebrate biomass and densities when compared to other African estuaries (DWA 2010, DEA&DP 2020). The patterns of invertebrate community distribution are shaped by several physical environmental characteristics, including salinity, sediment grain size, temperature and nutrients (Wooldridge & Deyzel, 2009a; DEA&DP, 2020). In estuarine systems, salinity is often very important in driving these patterns, because few organisms can tolerate the full estuarine salinity range (i.e., exposure to both marine and fresh water). Indeed, estuarine invertebrate assemblages are known to shift up or down an estuary in response freshwater inflow and the state of the mouth due in part to their relatively short life cycles and rapid responses to changes in the environment (Mackay & Cyrus, 2001; Rutger & Wing, 2006; DEA&DP, 2020). Invertebrates in the Berg River Estuary follow the salinity profile, with marine species preferring the lower reaches, typical estuarine species in the middle reaches and brackish water species inhabiting the upper reaches. The marine species spread further upstream during times of drought, or downstream when salinities are low during flood conditions.

Invertebrates inhabiting estuaries can also be divided into a number of sub-groups based on where they reside in the estuary. Zooplankton live mostly in the water column, benthic organisms live in the sediments on the bottom and sides of the estuary channel, and hyperbenthic organisms live just above the sediment surface. Benthic organisms are frequently

further subdivided into estuarine intertidal (those living between the high and low water marks on the banks of the estuary) and subtidal groups (those living below the low water mark):

- Most (98%) of the zooplankton community in the estuary consists of copepods, followed by fish larvae, brachyuran (crab) larvae, amphipods, and other organisms (Wooldridge & Deyzel, 2009a, 2009b; DEA&DP, 2020)
- The hyperbenthic community is predominantly composed of larvae and post larvae of the South African Crown Crab *Hymenosoma orbiculare*, mysid shrimp, and fish larvae (DEA&DP, 2020). There is also a notable seasonal shift in community composition, with mysid shrimps and amphipods becoming the dominant species during the winter months (DEA&DP, 2019, 2020, 2021).
- The subtidal benthos is dominated by amphipods and polychaetes. The most prevalent amphipods are *Grandidierella lutosa* and *Corophium triaenonyx*, and the polychaete *Capitella capitata*. The subtidal benthic community does not appear to vary with the seasons (DEA&DP 2020). Polychaetes appear to be more abundant than other taxonomic classes in the lower reaches of the estuary. Importantly, the Berg River Estuary has an abundant community of mudprawns *Upogebia africana* and sand prawns *Kraussillichirus kraussi* in the lower reaches. These mudprawns and sandprawns are important ecosystem engineers by virtue of the bioturbation created by their burrows. They have been shown to influence community structure, water flow patterns, sediment biogeochemistry and nutrient exchanges between burrows and the overlying water column (Moyo, Pillay & Wright, 2018). These invertebrates have also been shown to have a positive effect on water quality in urban estuaries, principally by reducing chlorophyll-a concentrations in the water column and maintaining benthic-pelagic coupling (Venter, Pillay & Prayag, 2020). The presence of both prawn species in the Berg River Estuary is likely leading to localised improvement in water quality.

4.6.3 FISH

As the Berg River Estuary is one of three permanently open systems on the west coast of South Africa, it is therefore of particular importance to species that use estuarine habitats during some portion of their life cycle (DEA&DP 2020). The system is of particular importance to fish and is considered crucial in maintaining the range and stock integrity of estuarine and estuarine dependent species along the entire west coast. Of the recorded fish species, 48% are regarded as either partially or completely dependent on the estuary for their survival (Lamberth, Van Niekerk & Hutchings, 2008; DEA&DP, 2020). Indeed, the Berg River Estuary is considered to be an important nursery area for exploited marine and estuarine species before they move out of the estuary to recruit into the marine environment (Lamberth *et al.*, 2008; DEA&DP, 2020). West Coast estuaries have higher dependence ratios than those observed in South Coast and East Coast estuarine systems, which may mean that estuaries on the west coast must be disproportionately important from a fish conservation perspective than those elsewhere in the country, and that degradation of these estuarine habitats will have disproportionally worse consequences (Bennett, 1994; DEA&DP, 2020). The Berg River Estuary has also been shown to serve as an important refuge for fish when low oxygen "black tide" events occur in St Helena Bay, with abundance of both marine and estuarine species increasing in the estuary during these events (Lamberth, Branch & Clark, 2010; DEA&DP, 2020)

Species important to small scale and recreational fishers in the Berg River Estuary include harders *Chelon richardsonii*, Elf *Pomatomus saltatrix*, and White steenbras *Lithognathus lithognathus* (DEA&DP 2020). Harders are a species of greatest importance for the local fisheries as they

are the main target species of the west coast inshore net fishery (DEA&DP 2020). This fishery is over 100 years old and has substantial economic and cultural value (Figure 4.9). There are a number of alien species present in the system, namely Carp *Cyprinus carpio* and Mozambique tilapia *Oreochromis mossambicus* (Hutchings *et al.*, 2008; DEA&DP, 2020).

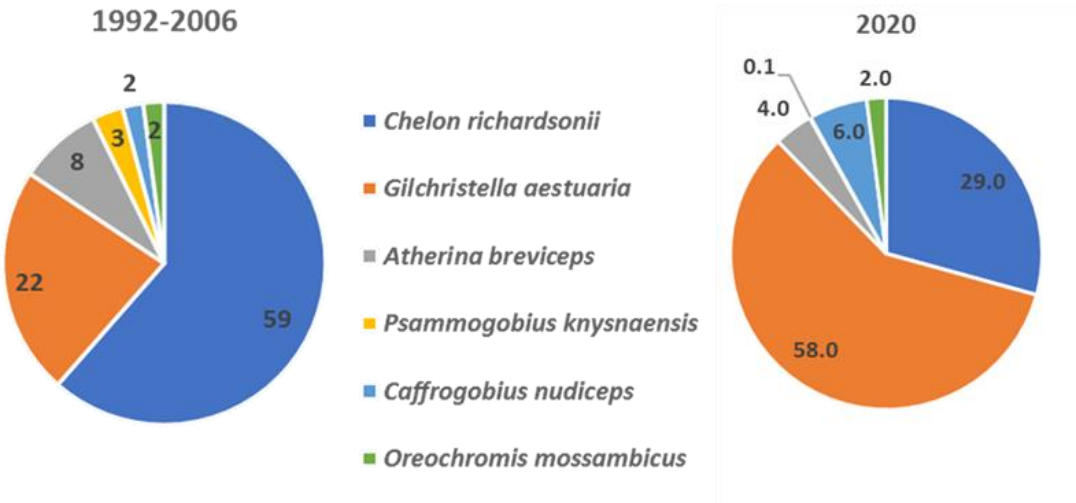

Figure 4.9. Relative proportion (%) of the six most abundant species in Berg River Estuary fish samples from historical (1992-2006) and recent (2020) seine net surveys (from Clark et al., 2009; DEA&DP 2020).

The fish community has clear, consistent patterns in distribution along the course of the estuary, with habitat selection based on salinity – freshwater preferring (predominantly alien) species prefer the upper reaches, while marine and salt-tolerant species prefer the lower, more saline, reaches (Clark, Hutchings & Lamberth, 2009; DEA&DP, 2020). Some estuarine associated species, however, prefer the middle to lower reaches. Commercial *C. richardsonii* catches are correlated with freshwater inflows into the estuary. Despite it being critical that sufficient freshwater inflows are maintained in the system, the Berg River Estuary fish community appears to be quite resilient to seasonal fluctuations in freshwater inputs, and therefore overall system salinity (DEA&DP 2020).

4.6.4 AVIFAUNA (BIRDS)

The Berg River Estuary is extremely important in terms of the high diversity and abundance of bird populations that it supports, providing extensive and varied estuarine associated habitat for waterbirds. The estuary is recognised as an Important Bird and Biodiversity Area by BirdLife International and is also a newly designated RAMSAR site, i.e. a wetland of international importance. Because of its permanently open status, the estuary supports a relatively large area of intertidal habitat, which is important foraging area for waders and roosting area for a number of other waterbird species. The intertidal and shallow subtidal habitats have a variable cover of eelgrass and the filamentous alga *Enteromorpha sp*. which is particularly abundant in spring and dies back during summer. This cover affects the abundance and accessibility of invertebrates, and thus affects avian foraging (Western Cape Government, 2022).

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, including African Marsh Harrier and Cape Cormorant (regionally endangered), Caspian Tern and Great White Pelican (regionally vulnerable), Lesser Flamingo, Crowned Cormorant, Chestnutbanded Plover, Eurasian Curlew and Maccoa Duck (regionally and globally near threatened), Greater Flamingo and Greater Painted Snipe (regionally near threatened), and Bar Tailed Godwit and Red Knot (globally near threatened) (Western Cape Government, 2022).

Increasing demands on water for domestic, industrial and agricultural use have resulted in reduced freshwater input into the lower floodplain wetlands and estuary. This has altered habitats and food resources for waterbirds. Between 1994 and 2006 species richness remained relatively stable, however, since 2007, the average number of waterbird species recorded on the estuary has declined (DEA&DP, 2019, 2020). There has been an exponential decline in numbers of waterbirds since 1994 (Figure 4.10), with bird numbers in recent counts only 34% of the numbers recorded in the baseline count of 1994.

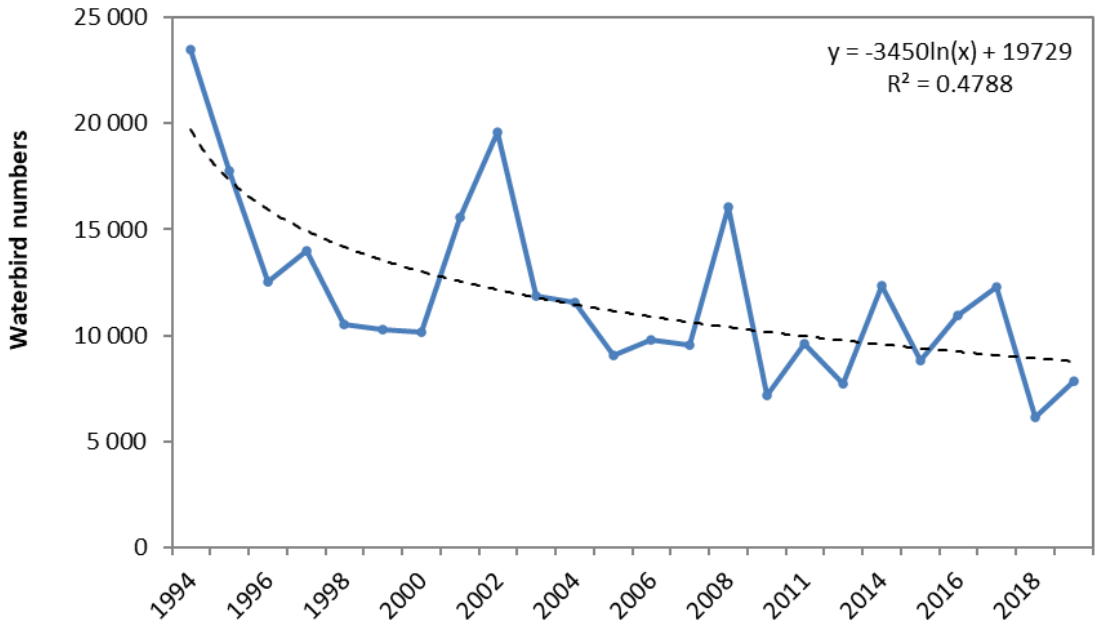

Figure 4.10. Changes in waterbird bird abundance at the Berg River Estuary 1994-2019 (excluding marine cormorants). Source: CWAC data (DEA&DP 2020).

The January 2024 site visit bird survey found species in three broad categories: piscivorous (fish eating) birds, invertebrate consuming wading birds, and opportunists (Table 4.2). The piscivorous species were primarily found closer to the main estuarine channel, whereas the waders occupied the saltmarsh habitat fringing the estuary. Piscivorous species included the Pied kingfishers *Ceryle rudis* (seen sitting on posts of the jetty by the white farmhouse), African darters, Cape cormorants and a Caspian tern flying over the main channel of the estuary. A number of species were also observed foraging on the sand bank slightly down river (such as black-winged stilts and greater sand plovers) and in the saltmarsh habitat across the river (such as little and Intermediate egrets).

Table 4.2. Bird species observed during the site visit.

Common name	Scientific name	Diet
African Darter	*Anhinga rufa*	Piscivorous
African Sacred Ibis	*Threskiornis aethiopicus*	Benthivorous wading birds
Blacksmith Lapwing	*Vanellus armatus*	Benthivorous wading birds
Black-winged Stilt	*Himantopus himantopus*	Benthivorous wading birds
Cape Cormorant	*Phalacrocarax capensis*	Piscivorous
Cape Wagtail	*Motacilla capensis*	Benthivorous wading birds
Caspian Tern	*Sterna caspia*	Piscivorous
Egyptian Goose	*Alopochen aegyptiacus*	Herbivorous
Greater Sand Plover	*Charadrius leschenaultii*	Benthivorous wading birds
Hamerkop	*Scopus umbretta*	Omnivorous wading birds
Hartlaub's Gull	*Chriococephalus hartlaubii*	Piscivorous
Intermediate Egret	*Ardea intermedia*	Omnivorous wading birds
Kelp Gull	*Larus dominicanus*	Piscivorous
Little Egret	*Egretta garzetta*	Omnivorous wading birds
Namaqua Dove	*Oena capensis*	Herbivorous
Pied Kingfisher	*Ceryle rudis*	Piscivorous
Yellow-billed kite	*Milvus aegyptius*	Bird of Prey (incl. fish)

4.7 SENSITIVITY AND SIGNIFICANCE

Estuaries are rich and productive systems that produce a wide range of benefits to society. They derive their richness and productivity from nutrient and sediment inputs received from river and sea water, combined with the relatively sheltered aquatic habitat that they provide. Their characteristic biodiversity assemblages have arisen from the need for biota to cope with their salinity gradients and fluctuations. These unique characteristics make estuaries among the most valuable types of ecosystems on earth (Costanza *et al.*, 2014).

The Berg River Estuary is among the top three most important estuaries in the country, and one of the most valuable biodiversity assets along the West Coast of South Africa (Turpie *et al.* 2012). A range of estuarine ecosystem services support the local economy; indeed, the value of the Berg River Estuary is estimated to be in the order of R378 million per year (DEA&DP 2020). The estuary has been specifically recognised as an Important Bird Area, has unique estuarine vegetation, is a valuable nursery area for fish and is an important tourist attraction. Indeed, the Berg River Estuary is rated as a 'Highly Important' system, especially as a nursery for red data species and exploited fish stocks (it is rated as a DFFE 'high-medium' fish nursery) (Van Niekerk *et al.*, 2019). In early 2022, the Berg River Estuary was declared a RAMSAR site, i.e. a wetland recognised both nationally and internationally as a site of ecological importance. The system also forms part of the biodiversity priority core set on both a national and regional level (as the core conservation area of the West Coast Biosphere Reserve).

The development site does have some salt marsh habitat present. In South Africa, approximately 43% of salt marsh habitat has been lost from the 1930 to 2018, due to encroaching development and agriculture (Adams 2020). Reductions in salt marsh reduces the capacity of the habitat to render the provision of ecosystem services. For example, removal or degradation of supratidal salt marsh habitat reduces the mitigating effect that the vegetation provides against erosion and flood scouring, and results in increased sediment input into the system. In addition, a reduction in the area of salt marsh habitat may result in a reduction in

productivity and numbers of larger waders and other waterbirds (DWS 2015). The loss of salt marsh extent also reduces the capacity of the system to act as a natural carbon sink, while degradation and disturbance of these habitats also directly releases large amounts of carbon back into the atmosphere in the form of CO_2 emissions (Pendleton *et al.* 2012, Adams 2020). Loss of these habitats also influences regulating services such as the filtering function through reduced nitrogen uptake, with significant consequences for the water quality of the system and functioning of the estuary as a whole (Adams 2020).

In the Berg River system itself, the impacts of disturbance or destruction of saltmarsh habitat on the site are compounded by the historical and current anthropogenic impacts on the vegetation and habitats of the estuary and floodplain. Some 26% of total estuarine area has been lost due to agricultural, urban and other activities (DEA&DP, 2019). These impacts include total transformation of the habitat (with near complete loss of vegetation) such as found at Cerebos salt works and Port Owen, farming activities, including grazing and cropping, which have reduced vegetation cover to less than 5% in some areas, and associated erosion of the riverbanks (Boucher & Jones in DWAF 2007). Approximately 40% of the original estuarine vegetation has been lost, including intertidal mudflats (5% lost), open pans (73% lost) and other vegetated areas (approximately 50% lost) (DWA 2010).

5 IMPACT ASSESSMENTS

Identified impacts of the unauthorised developments and the potential impacts of the proposed developments and operation of the Knor Varkie Resort were assessed as part of this study. The impacts identified for the already developed component of the Resort were high and require mitigation. Construction phase impacts 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 11 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.

Negative impacts associated with the proposed activities fall into three main categories:

- Unauthorised development impacts include loss of habitat, presence of invasive species and pollution.
- Construction impacts are largely minimal and also include loss of estuarine habitat, especially *Zostera capensis* beds.
- Operational impacts include the increase in human activity and potential increase in pollution.

Each of these impacts is likely to affect estuarine habitats and associated biota in different ways and at varying intensities depending on the nature of the affected habitat and the sensitivity of the biota. In assessing potential impacts on the estuarine biota in the vicinity of proposed activities, consideration was given to the current state of the system. Results of each assessment are presented in Table 5.2 to Table 5.15, and are summarised in Table 5.16.

5.1 RETROSPECTIVE ANALYSIS OF IMPACTS (SECTION 24G)

The retrospective analysis is conducted with regards to Section 24G of NEMA on the developments which have already taken place without prior environmental authorisation (Figure 1.3). Within the retrospective assessment of the development, the likelihood of an impact occurring will automatically be rated as 'Definite' given that the impact has already occurred.

Potential construction phase impacts are likely to include the following:

- Removal and disturbance of estuarine vegetation.
- Presence and additional planting of Alien Species.
- Waste generation and disposal from construction.
- Pollution emanating from Use of the Facilities.
- The effects of increased human activity due to the development of the resort.

The downgrading of the significance rating of each impact is largely dependent on the mitigation measures being implemented. It is, therefore, recommended that an independent authority conducts regular checks on the Resort throughout the construction phase, operational phase

and during the rehabilitation process of the surrounding vegetation, given the failure of the Applicant to obtain Environmental Authorisation prior to construction as well as the current condition of the development during the site visit. Specifically, evidence of sewage leakage is a contravention of NEMWA and the planting of Beefwood trees is a contravention of the NEMBA Alien and Invasive species Act.

5.1.1 Removal and Disturbance of Estuarine Vegetation

The clearing of vegetation for the development of the Knor Varkie Resort took place within the Berg River EFZ, which is made up of three vegetation types: the Saldanha Flats Strandveld vegetation type (Endangered: (SANBI, 2018)) and the non-terrestrial estuarine vegetation types: salt marsh and estuarine functional zone (Mucina *et al.*, 2018). The presence of the estuarine vegetation: reeds and sedges was also observed adjacent to the temporary caravan site during the site visit.

The area is further highlighted as a Critical Biodiversity Area under the Western Cape Biodiversity Spatial Plan (WCBSP). Specifically, the site is demarcated as CBA 1: Aquatic, CBA 2: Aquatic, ESA 2 and CBA: Terrestrial (Pool-Stanvliet *et al.*, 2017), as well as NFEPA wetlands. Removing and replacing indigenous vegetation with hard or altered surfaces within an EFZ impacts the overall functioning of the estuary, as it effects the volume and intensity of water entering the estuary from rain as it prevents the infiltration of rainwater into the ground. This can lead to disruption in food chains and nutrient input, as well as removing essential areas of refuge and flood attenuation plains.

With regards to removing indigenous vegetation, it was observed, in agreement with Pienaar (2023b), that much of the area within the development is characterised by disturbed vegetation and the presence of alien species. These areas (especially outside the EFZ (Figure 1.1) are likely unimportant from a plant biodiversity perspective as they are all composed primarily of salt bush. However, it is also important to consider the loss of ecological services associated with removing vegetation – even non-native vegetation, such as prevention of soil erosion, flood mitigation and the filtering of water before it enters the estuary.

Vegetation acts as a filter, reducing the concentration of contaminants and pollutants, in water passing through the system and improving the quality of water which reaches the estuary. As the Resort is located on the estuarine side of a agricultural land, this vegetation likely plays a critical role in protecting the estuary from harmful chemicals (such as herbicides, which have detrimental impacts on submerged macrophytes (van Wyk, Adams & von der Heyden, 2022)) and excess nutrient runoff from fertilizers that may be employed by the adjacent farm.

Recommendations include the rehabilitation of the salt marsh area, as highlighted in the Draft EMP (Pienaar, 2023a), where the temporary caravan is currently situated and in the area adjacent to the car park with suitable estuarine associated species (Figure 1.1). It is additionally recommended that the applicant rehabilitates the salt bush areas with endemic species (examples listed in Table 5.1), surrounding the developments, to restore lost ecosystem services and promote the proper function of the EFZ.

Table 5.1. Important and endemic plant species of the Cape Estuarine Salt Marshes (Rebelo *et al.* 2006). Endemic species are highlighted in blue.

Important taxa	Family name	Scientific names	Common name	Conservation status
Estuarine water bodies				
Graminoids:	Ruppiaceae	*Ruppia cirrhosa*	Spiral tasselweed	Least concern
		Ruppia maritima	Beaked tasselweed	Least concern
	Zosteraceae	*Zostera capensis*	Eelgrass	Endangered
Tidal saltmarshes				
Succulent shrubs	Amaranthaceae	*Bassia diffusa*	Beach saltbush	Least concern
	Amaranthaceae	*Salicornia perennis*	Perennial glasswort	Least concern
Low shrub	Theophrastaceae	*Samolus porosus*	Water-pimpernel	Least concern
Herbs	Asteraceae	*Cotula filifolia*	Brass button	Vulnerable
	Euphorbiaceae	*Seidelia pumila*	-	Least concern
Geophytic herbs	Juncaginaceae	*Triglochin bulbosa*	Arrow grass	Least concern
	Iridaceae	*Romulea tabularis*	-	Least concern
	Juncaginaceae	*Triglochin striata*	Streaked arrow-grass	Least concern
Succulent herbs	Caryophyllaceae	*Spergularia media*	Perennial sea spurrey	Least concern
	Plantaginaceae	*Plantago crassifolia*	Fleshy plantain	Least concern
	Amaranthaceae	*Salicornia meyeriana*	Annual glasswort	Least concern
	Asteraceae	*Cotula coronopifolia*	Water button	Least concern
		Poecilolepis ficoidea	-	Least concern
		Poecilolepis maritima	-	Least concern
	Amaranthaceae	*Suaeda inflata.*	Seepweed	Least concern
Graminoids	Juncaceae	*Juncus kraussii subsp. Kraussii*	Matting rush	Least concern
	Poaceae	*Spartina maritima*	Cape-cord grass	Least concern
		Sporobolus virginicus	Brackish grass	Least concern
		Puccinellia angusta	Finch alkali grass	Least concern
	Cyperaceae	*Schoenoplectus triqueter*	Triangular club-rush	Least concern
	Poaceae	*Stenotaphrum secundatum*	Buffalo turf grass	Least concern
Supratidal terraces				
Succulent shrubs	Aizoaceae	*Disphyma crassifolium*	Round-leaved pigface	Least concern
	Amaranthaceae	*Salicornia capensis*	Cape glasswort	Least concern
		Salicornia pillansii	Tired glasswort	Least concern
		Salicornia natalensis var. affinis	Sea Coral	Least concern
Herb	Plumbaginaceae	*Limonium decumbens*	Sea-pink	Least concern
Graminoid:	Poaceae	*Stenotaphrum secundatum*	Buffalo turf grass	Least concern

Beds of *Z. capensis* (a submerged macrophyte) were also observed in the subtidal and intertidal zones of the estuary surrounding the new jetty (refer to section 5.3.1 for additional information). *Z. capensis* is listed as an endangered species, and it is likely that the beds were disturbed during the construction of the jetty. This site needs to be monitored to ensure the recovery of the species here, otherwise additional rehabilitation measures will need to be implemented. This needs to be included in the EMP.

With regards to the remaining already undertaken developments, the majority of the removal of vegetation took place in an area that consists of disturbed/previously altered and/or invasive plant species, which usually results in a 'Low' rating. However, the disturbance of the endangered *Z. capensis* beds increases the impact associated with loss of estuarine vegetation to 'Medium'. With mitigation, however, the intensity is reduced to 'Very Low' (Table 5.2).

Table 5.2. Impact 1: Removal and Disturbance of Estuarine Vegetation.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Medium 2	Long-term 3	Medium 6	Definite	**MEDIUM**	-ve	High
Recommendations and essential mitigation measures: • The applicant is advised to adhere to all relevant legislation and procedures going forward. • Once approved, the applicant is advised to adhere to the Environmental Management Programme as prepared by (Pienaar, 2023a). With regards to 5.1.1 this should include: ○ A rehabilitation plan devised by qualified personnel and implemented to restore and improve saltmarsh habitats and other estuarine vegetation (reeds and sedges) in the temporary caravan park and in other areas highlighted in the Draft EMP (Pienaar, 2023a). ○ The development of an alien and invasive species management programme for the removal and ongoing control of alien plants on the property. ○ In areas with exposed soil, temporary measures should be implemented while allowing indigenous vegetation to re-establish to prevent erosion and turbidity in the estuary. ○ Monitoring of stormwater runoff for contaminants and small particles of litter that would have otherwise been trapped within the saltmarsh or other estuarine vegetation.							
With mitigation	Local 1	Low 1	Long-term 3	Low 5	Possible	**VERY LOW**	-ve	High

5.1.2 Presence and Additional Planting of Invasive Species

The vegetation within the site is degraded and consists largely of salt bush which was likely planted for livestock grazing in the past (>20 years ago) (Pienaar, 2023c). Several invasive species were also observed on the premises, such as Eucalyptus sp. and Wattle sp. In addition, the developer has planted Beefwood *Casuarina cunninghamiana* and Rooi Essenhout *Trichilia emetica* to act as wind breakers around the camp sites (Figure 5.1). Beefwood, Eucalyptus and Wattle are all listed as type 1b) invasive species within riparian zones (Department of Environment Forestry and Fisheries (DEFF), 2020b), which means they are prohibited, unless exempted under specific conditions (see section 3.6). These trees, in particular use large amounts of water which may impact the functioning of the estuary as floodplain salt marshes, such as those present in the Berg, depend on groundwater as their major source of water. Rooi Essenhout is listed as a category 2 invasive, and it is recommended that a suitable alternative be found, or a permit obtain for the use of this species within this area.

Figure 5.1. Invasive Species observed during site visit to Knor Varkie Resort. A) Salt bush. B) Beefwood. C) Eucalyptus.

Mitigation measures include the removal of invasive species and the implementation of an alien and invasive species control and management plan and long-term monitoring of the site by an independent authority. Given the presence of planted category 1b invasive species within an EFZ, which could alter the functioning of the estuary, the significance is rated as 'Medium'. However, with the removal of invasives and implementation of an effective invasive species control programme, impact is rated as 'Insignificant' (Table 5.3).

Table 5.3. Impact 2: Presence and Additional Planting of Invasive Species

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	High 3	Medium-term 2	Medium 6	Definite	**MEDIUM**	-ve	High
Recommendations and essential mitigation measures: • The applicant is advised to adhere to all relevant legislation and procedures going forward. • Once approved, the applicant is advised to adhere to the Environmental Management Programme as prepared by (Pienaar, 2023a). With regards to 5.1.2 this should include: o The removal of the planted beefwood (Category 1b within a riparian zone) o No further planting of beefwood or other invasive species (Department of Environmental Affairs (DEA), 2016) to act as windbreakers – use of indigenous species is advised. o The development of an alien and invasive species management programme for the removal and ongoing control of alien plants on the property.							
With mitigation	Local 1	Low 1	Short-term 1	Very Low 3	Improbable	**INSIGNIFICANT**	+ve	High

5.1.3 Waste Generation and Disposal From Construction

During the site visit, both construction material (rubble) and wire were observed on the premises (Figure 5.2).

Figure 5.2. Building Rubble observed during site visit to Knor Varkie Resort. Left: wire. Right: Concrete and brick rubble.

Given the high diversity and abundance of bird species which occur on the estuary, it is critical that the premises be cleared immediately and be cleared regularly going forward, to prevent the risk of injury to animals due to entanglement. Any construction waste should be stored in a waste skip on site before being removed and disposed of at a suitable waste disposal site. Given the relatively slow breakdown time of construction materials, the impact is rated as 'Medium'. With mitigation measures, which include the responsible disposal and storage of materials the impact is rated as 'Very Low' (Table 5.4).

Table 5.4. Impact 3: Waste Generation and Disposal from Construction

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Medium 2	Long-term 3	Medium 6	Definite	**MEDIUM**	-ve	High

Recommendations and essential mitigation measures:
• The applicant is advised to adhere to all relevant legislation and procedures going forward.
• Once approved, the applicant is advised to adhere to the Environmental Management Programme as prepared by (Pienaar, 2023a). With regards to 5.1.4 this should include:
  ○ Unused/excess building material should be stored in a waste skip until it can be disposed of properly.
  ○ Regular checks and removal of rubble and/or dangerous construction material (e.g. wire) found on site.
  ○ During construction, building material should be stored safely so as not to impact surrounding fauna.								

With mitigation	Local 1	Low 1	Long-term 3	Low 5	Improbable	**VERY LOW**	-ve	High

5.1.4 Pollution Emanating from Use of the Facilities

LITTER

The problem of litter entering the environment has escalated dramatically in recent decades, with an ever-increasing proportion of litter consisting of non-biodegradable plastic materials. South Africa has laws against littering, both on land and in the coastal zone. 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 (Gregory, 2009; Wright, Thompson & Galloway, 2013). These materials, being largely plastics, may be transported by currents for long distances out to sea or around the coast. Thus, unlike fuel

or sewage contamination, the spatial extent of the damage is, in theory, limitless. The impact on certain forms of marine life by floating or submerged solid materials cannot be overstressed. Most at risk are seabirds and fish, including rare or endangered species. Given the high diversity and abundance of bird species supported by the Berg River Estuary, as well as its classification as a RAMSAR site, it is imperative that the integrity of the estuary not be allowed to deteriorate further due to increased plastic pollution.

During the site visit, litter was observed on the premises. Given the sensitivity of the area, as it lies within an EFZ which leads to the ocean, and the long break down time of plastics and other litter, it is critical that the premises be cleared immediately and be cleared regularly going forward. In addition, the Resort should have a zero tolerance to litter policy for its staff and Visitors.

Figure 5.3. Litter observed during site visit to the Resort

SEWAGE

Evidence of a sewage discharge was discovered on site (Figure 5.4). This is a contradiction of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) ("NEM:WA") as the Resort does not have a license to discharge effluent into the system. Sewage input into an estuary can lead to nutrient enrichment which is harmful to biota present in the system. It can result in eutrophication which may lead to die off of sedentary organisms due to lack of oxygen as well as alter species composition in the long term. It is important that sufficient provision and maintenance/up-keep of ablution blocks and sewage conservancy tanks be made to ensure that this does not happen again. It should be emphasized that this is detrimental to the estuary and the EMP must specify that this will not be tolerated.

Figure 5.4. Evidence of Sewage leakage observed during site visit.

FOOD WASTE

Although it was not specifically observed, it is worth noting that the addition of a restaurant to the site has most likely resulted in increased food waste present in the area. Untreated, this is likely to attract pests such as rats, crows, gulls, cockroaches or other scavenger species. This poses a risk of displacing the naturally occurring species within the Estuarine Functional Zone. Given the importance of the Berg River Estuary as an area of high avifaunal diversity and as a site for migratory birds, it is critical that food waste be managed and disposed of responsibly to avoid attracting scavengers.

The impact of pollution at the Resort is rated as 'High' without mitigation, largely due to the long lifetime of plastics and their potential to wash out to the ocean through the estuary, which extends their impact extent to 'International'. Implementing a zero tolerance to litter policy at the Resort will significantly reduce this impact to 'Very Low'. Sewage must also be prevented from entering the water of the estuary due to the effects of nutrient enrichment on local biota (Table 5.5).

Table 5.5. Impact 4: Pollution emanating from activity on site due to development of the Resort.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	International 3	Low 1	Long-term 3	7	Definite	HIGH	-ve	High

Recommendations and essential mitigation measures:

- The applicant is advised to adhere to all relevant legislation and procedures going forward.
- Once approved, the applicant is advised to adhere to the Environmental Management Programme as prepared by (Pienaar, 2023a). With regards to 5.1.4 this should include:
  - Litter
    - The Resort should implement a no tolerance to littering approach.
    - Regular checks and removal of litter found on site, especially before predicted rain when litter is most likely to run into the estuary.
    - Bins should be easily accessible to anyone using the site.
    - A suggestion would be to put up signs which inform the users of the site the impacts of plastic pollution within a marine/estuarine environment (potentially collaborate with CapeNature).
  - Sewage
    - The prevention of contaminated water (including sewage) entering the estuary.
    - Regularly conduct checks and routine maintenance on sewage conservancy tanks and ablution facilities to prevent leaks.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
	▪ Any leaks/spills should be reported immediately and fixed as quickly as possible. ○ Food waste ▪ All food waste should be out of reach of scavengers and disposed of responsibly.							
With mitigation	Local 1	Low 1	Long-term 3	Low 5	Improbable	**VERY LOW**	-ve	High

5.1.5 THE EFFECTS OF INCREASED HUMAN ACTIVITY ASSOCIATED WITH THE RESORT

NOISE

The site visit was conducted at around 10am in the morning and it was observed that the recently built restaurant was playing loud music even though the bar was empty. Despite these effects being localised, the Resort is located within the EFZ and close to functional estuarine saltmarsh habitat (especially across the river) which means that there is a probability that this noise will impact local species, including amphibians, invertebrates, and birds.

Of primary concern in this assessment are the potential impacts on the avifauna of the Berg River Estuary, particularly wading birds, which have declined in population on a global scale in recent decades (see Section 4.6.4). Noise pollution affects birds in several ways, including direct physical impacts (damage to hearing), stress, fright-flight and avoidance responses. There are also potential behavioural impacts, including changes in foraging, reproductive success, communication and potential decreased response to audible alerts (from, for example, predators) (Ortega, 2012). Consistent playing of loud music can lead to "noise facilitation" wherein a disproportionately large impact can occur if multiple relatively low intensity sounds occur at the same time over long periods, i.e., loud music occurring concurrently with nearby motorboat activity. Cutts *et al.* (2013) suggests that noise below 55 dB reduces potential for a response (and therefore, potentially negative impact) on birds in the immediate vicinity.

TRAFFIC

With development of the Resort, there has likely been an increase in cars entering the area adding to noise pollution.

BOATS

The presence of canoes was noted during the site visit. While this in and of itself is not a concern, it does suggest an increased presence of boats in the water and increased trampling of sensitive subtidal and intertidal vegetation (i.e. *Z. capensis*) within the estuary. It is recommended that a designated zone be assigned for people carry boats into and out of the water (for example near the remnant of an old slip way) or that the jetty be used to avoid disturbance to the vegetation during higher tides.

The impact of increased human activity is categorised as 'Medium' due to the potential intensity of activity, particularly over the holiday seasons. By implementing zero tolerance to litter policies and reducing the number of hours in which the bar plays music as well as the volume of the music, it reduces the impact to 'Low' (Table 5.6).

Table 5.6. Impact 5: The Effects of Increased Human Activity Associated with the Resort

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	High 3	Medium-term 2	Medium 6	Definite	**MEDIUM**	-ve	High
Recommendations and essential mitigation measures: • The applicant is advised to adhere to all relevant legislation and procedures going forward. • Once approved, the applicant is advised to adhere to the Environmental Management Programme as prepared by (Pienaar, 2023a). With regards to 5.1.5 this should include: ○ Educating users as to the uniqueness of the Berg River Estuary and encouraging Visitors to treat the environment with respect. ○ Raising awareness of the different species inhabiting the area, especially endangered and vulnerable species ○ No tolerance to littering within the site (it is illegal to litter in South Africa). ○ Loud music from the bar should be restricted to weekends, potentially evenings and occasionally for special events. The music volume must adhere to noise regulations for rural areas.							
With mitigation	Local 1	Medium 2	Medium-term 2	Low 5	Probable	**LOW**	-ve	High

5.2 CONSTRUCTION PHASE OF PROPOSED UPGRADES

The construction is relatively small scale, largely focused on building semi-permanent units and clearing vegetation to create space for camping and caravaning sites. Impacts during this phase are likely to be short-term and minimal, especially if mitigation measures are implemented.

Potential construction phase impacts are likely to include the following:

- Direct disturbance to and removal of estuarine habitat and vegetation.
- Waste generation and disposal from construction.
- Hazardous substance spills during construction.
- Water quality and quantity impacts.
- Noise impacts during construction.

5.2.1 DIRECT DISTURBANCE AND LOSS OF ESTUARINE HABITAT

With regards to estuarine vegetation present on the banks of the estuary see Section 5.1.1.

Suggested mitigation measures include constraining the spatial and temporal extents of the development footprint, restricting movement of the construction vehicles and teams to the extent of the development where possible to minimise edge effects, educating staff about the sensitivity of estuarine habitats, and the development of an alien and invasive species management programme for the removal and ongoing control of alien plants as well as restoration measures should the vegetation be damaged during the construction phase.

During the site visit, beds of *Zostera capensis* were observed within the subtidal and intertidal zones of the estuary. *Z. capensis* is an important ecosystem engineer which provides shelter and foraging habitat for several invertebrate species, as well as acting as a nursery environment for fish species. *Z. capensis* is listed as an *Endangered* species, and the building of additional jetties may lead to the loss of cover within the site. As *Z. capensis* is an important nursery environment for commercially important fish species, the loss of cover will likely not only lead to a decline of fish abundance over time within the estuary and marine environment but may have economic impacts within the fishing industry in the long term, especially compounded with the development of multiple jetties within the system. It is very strongly recommended

that no more additional jetties are built at the Knor Varkie Resort to avoid the loss of *Z. capensis* area cover.

As the loss of vegetation will be permanent, this impact is rated as 'Medium'. Excluding the construction of the additional jetties, so as not to disturb the *Z. capensis* beds lowers the intensity of the effect as *Z. capensis* is critical to the function of the estuary but the area in which it can occur is very small. Overall, this reduces the significance to 'Very low" (Table 5.7).

Table 5.7. Impact 6: Disturbance and loss of estuarine habitat and vegetation.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Medium 2	Long term 3	Medium 6	Probable	**MEDIUM**	-ve	High
Essential mitigation measures: • Inform all staff about sensitive estuarine habitats and species. • Constrain spatial extent of impacts to the minimum required. • Keep construction equipment within the developmental footprint, and do not disturb sediment outside this area. • A rigorous environmental management and control plan (including procedures for remediation) must be developed and implemented. • A rehabilitation plan must be devised by qualified personnel and implemented to restore and improve saltmarsh habitats and other estuarine vegetation in the vicinity of the proposed development. Alien species must be removed. Areas of bare ground resulting from the proposed construction activities should be appropriately revegetated.							
With mitigation	Local 1	Low 1	Long term 3	Low 5	Possible	**VERY LOW**	-ve	High

5.2.2 Waste generation and disposal from Construction

Risks of waste generation and disposal associated with post construction are discussed above (Section 5.1.3). During the construction phase of proposed future developments, the risks and impacts are the same.

To reduce the impacts of pollution within the system, all domestic and general waste generated during construction 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 'Medium' without mitigation and is reduced to 'Very Low' with appropriate mitigation actions (Table 5.8).

Table 5.8. Impact 7: Waste generation and improper disposal.

	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 measures: • Inform all staff about sensitive estuarine 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	Local 1	Low 1	Long term 2	Low 5	Improbable	**VERY LOW**	-ve	High

5.2.3 HAZARDOUS SUBSTANCE SPILLS DURING CONSTRUCTION

There is a risk of spillage of a variety of hazardous substances during the use of machinery and construction vehicles. For example, spillage may occur as a result of fuel leaks or during refuelling, and these substances could then be washed into the estuary or fall within the EFZ. 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 a rigorous environmental management and control plan is implemented to limit ecological risks from accidents. All fuel and oil must be stored with adequate spillage protection and no leaking vehicles should be permitted on site. Intentional disposal of any substance into the aquatic environment must be strictly prohibited, while accidental spillage must be prevented, contained, and reported immediately. After mitigation, the impact of accidental spillage is considered very low (Table 5.9).

Table 5.9. 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	Medium 3	Medium term 2	Medium 6	Possible	**LOW**	-ve	High
Essential mitigation measures: • Intentional disposal of any substance into the environment is strictly prohibited, while accidental spillage must be prevented, contained and reported immediately. • A rigorous environmental management and control plan (including procedures for remediation) must be developed and implemented. • All fuel and oil must be stored with adequate spill protection. • No leaking equipment or 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. • Spill kits must be available on site at all times, and staff must be trained in their proposed use.								
With mitigation	Local 1	Medium 2	Medium term 2	Low 5	Improbable	**VERY LOW**	-ve	High

5.2.4 WATER QUALITY AND QUANTITY IMPACTS ASSOCIATED WITH RUNOFF

The construction of the structures within the EFZ can result in the disturbance of sediments which can wash into the estuary and result in localised turbidity plumes. Construction sand or exposed soil, following the removal of vegetation, can also be blown or washed into the estuary, which would generate similar turbidity impacts. These plumes can negatively affect primary production, filter-feeding efficiency, the survival of suspension feeders and invertebrate larvae, which in turn may impact the availability and suitability of food for higher order consumers and can cause a cascade of negative effects through the estuarine food web. It is noted that estuarine faunal communities are generally tolerant of low visibility/high turbidity conditions as these are often experienced due to nutrient-rich waters and turbid freshwater input. Due to the duration of the proposed construction activities, and the dilution of these plumes as they enter the estuary, the effects are likely to be short-term. Therefore, water quality impacts associated with construction activities are assessed as very low significance (Table 5.10).

Essential mitigation measures include erosion control measures such as deploying silt fences and securing sand piles with geotextile, conducting outdoor construction activities in clear weather and repairing erosion damaged post rainfall events. With mitigation, the probability

of this impact is reduced to improbable, and the impact is assessed to be insignificant (Table 5.10).

Table 5.10. Impact 9: Water quality and quantity impacts associated with dust runoff from development.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Medium 2	Short Term 2	Low 5	Probable	**LOW**	-ve	High
Essential mitigation measures: • Implementation of erosion control measures such as silt fences in areas at risk of erosion/runoff. • Should sand piles be left for long periods of times they should be secured with geotextile material to prevent wind mobilisation into the estuary. • Where possible, construction using large volumes of sand should occur during clear weather, and loose sand should be cleared or covered during breaks in construction. • Monitor construction areas post rainfall events and repair any erosion damage that may have occurred.								
With mitigation	Local 1	Medium 2	Short term 1	Very Low 4	Possible	**INSIGNIFICANT**	-ve	High

5.2.5 NOISE IMPACTS DURING CONSTRUCTION

It is likely that construction noise will be minimal given the nature of the structures on the development, therefore the impact is rated as 'Low". However, it is important that contractors are made aware of the sensitivity of the area and any machinery use is kept to a minimum and only during daylight hours, where possible which will reduce the significance of the impact to 'Very Low' (Table 5.11).

Table 5.11. Impact 10: The effect of noise and vibration on estuarine biota.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Medium 2	Short term 1	Very Low 4	Probable	**LOW**	-ve	High
Essential mitigation measures: • Limit duration of construction activities within the Estuarine Functional Zone as far as practically possible. • Efforts must be taken to reduce unnecessary noise or vibrations where possible. • Minimise the duration of construction-related noise as far as practically possible. • Keep construction equipment within the developmental footprint. • Inform all staff about sensitive estuarine habitats and species.								
With mitigation	Local 1	Low 1	Short-term 1	Very Low 3	Possible	**VERY LOW**	-ve	High

5.3 OPERATIONAL PHASE OF PROPOSED UPGRADES

5.3.1 LOSS OF ESTUARINE HABITAT

Operational impacts are similar to those discussed in 5.2.1, and similar mitigations apply here as well.

It is however, recommended that an independent authority conducts regular checks on this development both during and after construction, given evidence that the applicant has been found to not currently be controlling their invasive species and are additionally planting category 1b invasive species.

As long as the mitigation measures are implemented as suggested the impacts will remain low.

Table 5.12. Impact 11: Loss of estuarine vegetation

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Medium 2	Long-term 3	Medium 6	Definite	**MEDIUM**	-ve	High
Recommendations and essential mitigation measures: • Implementation of a rehabilitation plan devised by qualified personnel to restore and improve saltmarsh habitats and other estuarine vegetation (reeds and sedges) in the temporary caravan park and areas surrounding the new developments. • Implementation of an alien and invasive species management programme for the removal and ongoing control of alien plants on the property. • Implementation of permanent measures areas with exposed soil to prevent soil erosion and therefore turbidity within the estuary.								
With mitigation	Local 1	Medium 1	Long-term 3	Low 5	Definite	**LOW**	-ve	High

5.3.2 Pollution Emanating from Use of the Facilities

Operational impacts of pollution resulting from the use of the Resort facilities are dealt with in Section 5.1.4 and remain relevant here. By implementing the proposed mitigation measures, the significance of the impact is reduced for 'High' to 'Insignificant' (Table 5.13).

It is however, recommended that an independent authority conducts regular checks on this development both during and after construction, given the evidence of litter and sewage leaks currently present on the property.

Table 5.13. Impact 12: Pollution emanating from activity on site due to development of the Resort.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	International3	Low 1	Long-term 3	High 7	Probable	**HIGH**	-ve	High

Recommendations and essential mitigation measures:
• Litter
  ○ The Resort should implement a no tolerance to littering approach.
  ○ Regular checks and removal of litter found on site, especially before predicted rain when litter is most likely to run into the estuary.
  ○ Bins should be easily accessible to anyone using the site.
  ○ A suggestion would be to put up signs which inform the users of the site the impacts of plastic pollution within a marine/estuarine environment (potentially collaborate with CapeNature).
• Sewage
  ○ Prevention of contaminated water (including sewage) entering the estuary.
  ○ Regularly conduct checks and routine maintenance on sewage conservancy tanks and ablution facilities to prevent leaks.
  ○ Any leaks/spills should be reported immediately and fixed as quickly as possible.
• Food waste
  ○ All food waste produced by the restaurant should be out of reach of scavengers and disposed of responsibly.
  ○ The Resort should educate Visitors about responsible disposal of food waste and provide facilities which allow them to dispose of food waste without attracting scavengers (i.e. scavenger proof bins)								

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
With mitigation	Local 1	Low 1	Medium-term 2	Very Low 4	Improbable	**INSIGNIFICANT**	-ve	High

5.3.3 The Effects of Increased Human Activity due to the Development of the Resort

Again, the operational impacts associated with the increased human activity due to the development of the resort are dealt with in the above Section 5.1.5, with the addition of the effects of artificial light usage increasing within the area due to the restaurant and camping/caravan sites. Artificial light can impact nocturnal animals and have detrimental effects on species such as, moths, bats and nocturnal birds.

Additionally increased swimming and/or boat activity within the shallow areas of the river may further disturb the sediment and functioning of the intertidal habitat and it is recommended that a designated area be assigned for boat traffic.

The same mitigation measures which were described above apply here to reduce the significance of the impact from 'Low' to 'Very Low' (Table 5.14). It is however, recommended that an independent authority conducts regular checks on this development both during and after construction, given the presence of littering, the lack of any signs prohibiting littering or any other activity which may harm the environment.

Table 5.14. Impact 13: The Effects of Increased Human Activity due to the Development of the Resort

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Medium 2	Medium-term 2	Low 5	Definite	**LOW**	-ve	High
Recommendations and essential mitigation measures: • Educating Visitors as to the uniqueness of the Berg River Estuary and encouraging Visitors to treat the environment with respect. • Raising awareness of the different species inhabiting the area, especially endangered and vulnerable species • No tolerance to littering within the site. • A designated area, potentially where the remnant of an old slipway is, should be allocated for people to use for entering the water with canoes (or other boats) • Loud music from the bar should be restricted to weekends, potentially evenings and occasionally for special events. The music volume must adhere to noise regulations for rural areas. • It is suggested that Visitors be encouraged to use headlights or torches with a 'red light' setting which cause minimal disturbance to nocturnal animals (including fish).							
With mitigation	Local 1	Low 1	Medium-term 2	Very Low 4	Definite	**VERY LOW**	-ve	High

5.4 Cumulative Impacts

Anthropogenic activities can result in numerous and complex effects on the natural environment. While many of these are direct and immediate, the environmental effects of individual activities or projects can interact with each other in time and space to cause incremental or aggregate effects. Impacts from unrelated activities may accumulate or interact to cause additional effects that may not be apparent when assessing the activities individually. Cumulative effects are defined as the total impact that a series of developments, either present,

past or future, will have on the environment within a specific region over a particular period of time (DEAT IEM Guideline 7, Cumulative effects assessment 2004).

By definition, cumulative environmental impacts emanating from the proposed project are related to the overlap with other sources of disturbance in the vicinity. The primary cumulative impacts for this development are related to loss of and disturbance to estuarine habitat in the construction footprint, the presence of invasive species which consume large quantities of water within the EFZ and the increase in human activity in the area due to the development:

- The vegetation likely to be disturbed by the proposed construction activities as well as the majority that has already been lost during the prior developments is currently degraded, except for patches of salt marsh closer to the estuary and the *Zostera capensis* beds within the estuary. Within the Berg River system, some 26% of total estuarine area has been lost due to anthropogenic activities, including 40% of the original estuarine vegetation (DWA, 2010; DEA&DP, 2019). It is critical therefore that the disturbance or loss of estuarine riparian area is rehabilitated, with particular focus on the restoration and improvement of saltmarsh habitats and other estuarine vegetation. It is strongly recommended that no additional jetties be built due to the disturbance of critical *Z. capensis* beds. This, together with implementation of the rehabilitation of the saltmarsh and additional areas of salt bush surrounding the development will improve the functioning of the EFZ compared to its current state and therefore mitigate some of the effects of vegetation removal.

- Although the presence of high-water usage invasive species on the property within the EFZ is concerning, it is more concerning that the Applicant has planted category 1b invasive species, which will exacerbate the problem. It is encouraging to see that the Draft Environment Management Plan (Pienaar, 2023a) aims to implement an alien and invasive species management plan on the property. It is very strongly recommended that this be carried out, in addition to the removal/replacement of the Beefwood with a suitable indigenous species.

- The development of the Resort will likely result in increased human activity within the area. This increase in human activity is an impact which is particularly cumulative, the more people and the longer the duration of human presence, the greater the impact. This is true of waste, noise and light pollution. It is recommended that measures, such as a zero tolerance to litter policy, regular maintenance of sewage facilities and reduced music playing hours be implemented on site. It is also recommended that the Resort put up notices which inform Visitors of the sensitivity of the estuary and encourage Visitors to treat the area and its inhabitants with respect.

The cumulative impacts are therefore expected to be of slightly higher intensity than those assessed in Section 5.1, and these impacts before mitigation are rated as of high significance (Table 5.15). The implementation of suitable mitigation reduces this impact to low significance (Table 5.15).

Table 5.15. Cumulative impacts.

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	International 3	Medium 2	Medium term 2	High 7	Definite	HIGH	-ve	High
Essential mitigation measures: • A rigorous environmental management and control plan (including procedures for remediation) must be developed and implemented. • A rehabilitation plan must be devised by qualified personnel and implemented to restore and improve saltmarsh habitats and other estuarine vegetation in the vicinity of the proposed development. • Alien species must be removed. • Areas of bare ground resulting from the proposed construction activities should be appropriately revegetated or covered to prevent dust run off. • Efforts must be made to inform staff and Visitors of the sensitivity and importance of the estuarine environment. • Efforts must be taken to reduce unnecessary noise and light where possible. • A zero tolerance to litter policy must be implemented. • Sewage and litter must not enter the estuary.								
With mitigation	Local 1	Medium 2	Medium term 2	Low 5	Probable	LOW	-ve	High

5.5 SUMMARY OF POTENTIAL IMPACTS

The impacts associated with already undertaken activities, as well as those that may be experienced during proposed future construction and operation before and after mitigation are summarised in Table 5.16. A total of 13 impacts were identified.

Table 5.16. Summary of the retrospective assessment of the Section 24G application and the potential impacts of proposed developments at the Knor Varkie Resort. The table shows the significance of each impact, before and after mitigation.

Phase	Impact identified	Consequence	Probability	Significance	Status	Confidence
Retrospective Assessment of Impacts	Impact 1: Removal and disturbance of estuarine vegetation.	Medium	Definite	MEDIUM	-ve	High
	With mitigation	Low	Possible	VERY LOW	-ve	High
	Impact 2: Presence and addition planting of invasive species.	Medium	Definite	MEDIUM	-ve	High
	With mitigation	Very Low	Improbable	INSIGNIFICANT	+ve	High
	Impact 3: Waste generation and disposal from construction.	High	Definite	HIGH	-ve	High
	With mitigation	Low	Improbable	LOW	-ve	High
	Impact 4: Pollution emanating from activity on site due to the development of the resort.	High	Definite	HIGH	-ve	High
	With mitigation	Low	Improbable	VERY LOW	-ve	High
	Impact 5: The effects of increased human activity associated with the Resort	Medium	Definite	MEDIUM	-ve	High
	With mitigation	Low	Probable	LOW	-ve	High
Construction Phase	Impact 6: Direct disturbance and loss of estuarine habitat	Medium	Probable	MEDIUM	-ve	High
	With mitigation	Low	Possible	VERY LOW	-ve	High
	Impact 7: Waste generation and disposal from construction	High	Possible	MEDIUM	-ve	High
	With mitigation	Low	Improbable	VERY LOW	-ve	High
	Impact 8: The effect of spillage of hazardous substances on estuarine biota	Medium	Possible	LOW	-ve	High
	With mitigation	Low	Improbable	VERY LOW	-ve	High
	Impact 9: The effect of spillage of hazardous substances on estuarine biota	Low	Probable	LOW	-ve	High
	With mitigation	Very Low	Possible	INSIGNIFICANT	-ve	High
	Impact 10: Noise impacts during construction	Very Low	Probable	LOW	-ve	High

Phase	Impact identified	Consequence	Probability	Significance	Status	Confidence
	With mitigation	Very Low	Possible	**VERY LOW**	-ve	High
Operational Phase	Impact 11: Loss of estuarine habitat	Medium	Definite	**MEDIUM**	-ve	High
	With mitigation	Low	Definite	**LOW**	-ve	High
	Impact 12: Pollution emanating from activity on site due to the development of the Resort	High	Probable	**HIGH**	-ve	High
	With mitigation	Very Low	Improbable	**INSIGNIFICANT**	-ve	High
	Impact 13: The effects of increased human activity due to the development of the resort	Low	Definite	**LOW**	-ve	High
	With mitigation	Very Low	Definite	**VERY LOW**	-ve	High
Cumulative Impacts	Without mitigation	High	Definite	**HIGH**	-ve	High
	With mitigation	Low	Probable	**LOW**	-ve	High

6 CONCLUSIONS AND RECOMMEMNDATIONS

Impacts pertaining to the Section 24G are summarised above, with their significance rating before and after the implementation of mitigation measures (Table 5.16). Without mitigation, the significance of the five impacts pertaining to the Section 24G ranges from 'Medium' to 'High'. It is therefore essential that mitigation measures are implemented to reduce the significance of the developments which have already taken place, in order to reduce the negative effects on the sensitive estuarine environment. The applicant is also advised to adhere to all relevant legislation and procedures going forward.

Additionally, potential impacts that may be experienced during construction and operational phases of the proposed development, both before and after mitigation, are summarised in Table 1.1 below. A total of eight negative potential environmental impacts were assessed including further loss of estuarine habitat, pollution emanating from the use of the facilities and the increased human activity. After mitigation, none of the identified impacts were assessed as being above 'Low' significance.

The primary cumulative impacts for this development are related to loss of and disturbance to estuarine habitat and cumulative effects of increased human activity due to the development of the Resort. The cumulative impacts are expected to be of slightly higher intensity than those assessed for the construction phase but are assessed as low significance with the implementation of suitable mitigation measures (Table 5.16).

Based on the impacts assessed in this report, it is recommended that the already completed developments identified during the Section 24G Assessment be allowed to remain if:

- The areas designated in the updated site plan are rehabilitated according to a plan devised by a qualified individual, especially the salt marsh area where the temporary caravan site is currently situated.
- All invasive species must be removed, and an alien and invasive species programme must be implemented.
- A zero tolerance to litter policy is implemented on the property.
- Sewage systems are properly implemented and maintained so that no sewage enters the estuary.
- Noise levels remain within those allowed within rural areas.
- Visitors are informed of the sensitivity and importance of the estuarine habitat and biota present in the area.
- The Environmental Management Plan (Pienaar, 2023a) is implemented.
- It is recommended that additional areas composed of salt bush be rehabilitated with indigenous vegetation to improve ecosystem functioning.
- The applicant is also advised to adhere to all relevant legislation and procedures going forward.

Additionally, based on the impacts assessed in this report, it is recommended that the proposed future development be permitted to proceed with the implementation of strict environmentally responsible practices as outlined in the mitigation measures below. However, it is strongly recommended that no additional jetty be built given the presence of *Zostera capensis* beds within the estuary.

Essential Mitigation measures required to reduce the severity of the impacts during the **construction/operational phase** as outlined above are as follows:

- The Environmental Management Plan (Pienaar, 2023a) is implemented.
- A rehabilitation plan must be devised by qualified personnel and implemented to restore and improve saltmarsh habitats and other estuarine vegetation in the vicinity of the proposed development.
- Alien species must be removed.
- Limit the extent and duration of construction activities within the Estuarine Functional Zone as far as practically possible.
- Areas of bare ground resulting from the proposed construction activities should be appropriately revegetated or appropriately covered to prevent erosion and turbidity within the EFZ.
- Erosion control measures in areas at risk of erosion/runoff must be implemented.
- All staff and visitors must be informed about sensitive estuarine habitats and species and the responsible disposal of waste.
- A zero tolerance to litter policy is implemented on the property.
- Reduce, reuse, recycle.
- Sewage systems are properly implemented and maintained so that no sewage enters the estuary.
- Noise levels remain within those allowed within rural areas.
- Suitable handling and disposal protocols must be clearly explained, and sign boarded.
- Intentional disposal of any substance into the environment is 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 equipment or 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.
- Spill kits must be available on site at all times, and staff must be trained in their use.

Additionally, it is important that the conditions within the system be monitored to enable adaptive management. If conditions become detrimental to the ecosystem, the impacts of construction and/or operation will need to be reassessed and adjusted mitigation measures applied. To this end, it is recommended that an Environmental Control Officer be employed of the duration of the construction phase and perhaps include an annual site visit for two years after the construction is completed.

7 REFERENCES

Adams, J.B. (2020). Salt marsh at the tip of Africa: Patterns, processes and changes in response to climate change. *Estuar. Coast. Shelf Sci.* **237**, 1–10.

Adams, J.B., Veldkornet, D. & Tabot, P. (2016). Distribution of macrophyte species and habitats in South African estuaries. *South African J. Bot.* **107**, 5–11.

Aecom. (2023). *Replacement of the existing Carinus Bridge B2918 with new Bridge B6144, Velddrif. Hydrology and Hydraulic Design Report*. Roads Branch, Department of Transport & Public Works, Western Cape Government. Project number: 60687670.

van Ballegooyen, R. (2010). Appendix D: Hydrodynamic Modelling Study Report. In *Comprehensive determination of the Environmental Water Requirements for the Berg River Estuary*. CSIR.

Beck, J.S. & Basson, G.R. (2007). Hydraulics and Fluvial Morphology. In *Berg River Baseline Monitoring Programme Initialisation Report – Volume 3*: 20–83. Clark, B. (Ed.). Department of Water Affairs and Forestry.

Bennett, B.A. (1994). The fish community of the Berg River estuary and an assessment of the likely effects of reduced freshwater inflows. *South African J. Zool.* **29**, 118–125.

Clark, B. & Ractliffe, G. (2007). Berg River Baseline Monitoring Programme **5**, 111.

Clark, B.M., Hutchings, K. & Lamberth, S.J. (2009). Long-term variations in composition and abundance of fish in the Berg Estuary, South Africa. *Trans. R. Soc. South Africa* **64**, 238–258.

Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S.J., Kubiszewski, I., Farber, S. & Turner, R.K. (2014). Changes in the global value of ecosystem services. *Glob. Environ. Chang.* **26**, 152–158.

Cullis, J.D.S., Horn, A., Rossouw, N., Fisher-Jeffes, L., Kunneke, M.M. & Hoffman, W. (2019). Urbanisation, climate change and its impact on water quality and economic risks in a water scarce and rapidly urbanising catchment: Case study of the Berg River Catchment. *H2Open J.* **2**, 146–167.

Cutts, N., Hemingway, K. & Spencer, J. (2013). *Waterbird Disturbance Mitigation Toolkit Informing Estuarine Planning & Construction Projects*. Toolkit Produced by the Institute of Estuarine & Coastal Studies (IECS) University of Hull.

Davidson, N.C., Van Dam, A.A., Finlayson, C.M. & McInnes, R.J. (2019). Worth of wetlands: Revised global monetary values of coastal and inland wetland ecosystem services. *Mar. Freshw. Res.* **70**, 1189–1194.

DEA&DP. (2014). *Coastal Management/Set back Lines for the West Coast District: Coastal Processes and Risk Modelling*.

DEA&DP. (2019). *Berg River Estuarine Management Plan: Revised Situation Assessment Report*.

DEA&DP. (2020). *Environmental flows and the health and value of the Berg River Estuary: Potential trade-offs between estuary value and regional water supply under a changing climate*. Cape Town, South Africa.

DEA&DP. (2021). *Berg Estuary Management Plan Berg Estuary Management Plan Document title and version: Western Cape Estuary Management Framework and Implementation Plan*.

Department of Environment Forestry and Fisheries (DEFF). (2020a). *National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004): Alien and Invasive Species regulations*.

Department of Environment Forestry and Fisheries (DEFF). (2020b). National Environmental Management: Biodiversity Act, 2004: Alien and Invasive Species Lists, 2020. *Gov. Gaz.* **66**, 31–77.

Department of Environmental Affairs (DEA). (2016). *National Environmental Management: Biodiversity Act, 2004 (Act no. 10 of 2004) Alien and Invasive Species Lists, 2016*. *Gov. Gaz. 40166*.

DWS. (2017a). *Determination of Water Resources Classes and Associated Resource Quality Objectives in the Berg Catchment: Status Quo Report*. Department of Water and Sanitation.

DWS. (2017b). *Determination of Water Resources Classes and Associated Resource Quality Objectives in the Berg Catchment: Linking Flows and Condition Report*. Department of Water and Sanitation.

Fisher, T.R., Carlson, P.R. & Barber, R.T. (1982). Sediment nutrient regeneration in three North Carolina estuaries. *Estuar. Coast. Shelf Sci.* **14**, 101–116.

Gregory, M.R. (2009). Environmental implications of plastic debris in marine settings- entanglement, ingestion, smothering, hangers-on, hitch-hiking and alien invasions. *Philos. Trans. R. Soc. B Biol. Sci.* **364**, 2013–2025.

Hutchings, K., Clark, B.M., Atkinson, L.J. & Attwood, C.G. (2008). Evidence of recovery of the linefishery in the Berg River Estuary, Western Cape, South Africa, subsequent to closure of commercial gillnetting. *African J. Mar. Sci.* **30**, 507–517.

Lamberth, S.J., Branch, G.M. & Clark, B.M. (2010). Estuarine refugia and fish responses to a large anoxic, hydrogen sulphide, "black tide" event in the adjacent marine environment. *Estuar. Coast. Shelf Sci.* **86**, 203–215.

Lamberth, S.J., 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 J. Mar. Sci.* **30**, 311–336.

Mackay, C.F. & Cyrus, D.P. (2001). Is freshwater quality adequately defined by physico-chemical components? Results from two drought-affected estuaries on the east coast of South Africa. *Mar. Freshw. Res. Res.* **52**, 267–281.

Moyo, R., Pillay, D. & Wright, A. (2018). Density- versus trait-mediated responses of a symbiont (Betaeus jucundus) to burrows of a burrowing crustacean (Callichirus kraussi). *Estuar. Coast. Shelf Sci.* **209**, 183–190.

Mucina, L., Rutherford, M.C. & Powrie, L.W. (2018). The Vegetation Map of South Africa, Lesotho and Swaziland, Version 2018. *South African Natl. Biodivers. Inst.*

Van Niekerk, L., Adams, J.B., Bate, G.C., Forbes, A.T., Forbes, N.T., Huizinga, P., Lamberth, S.J., MacKay, C.F., Petersen, C., Taljaard, S., Weerts, S.P., Whitfield, A.K. & Wooldridge, T.H. (2013). Country-wide assessment of estuary health: An approach for integrating pressures and ecosystem response in a data limited environment. *Estuar. Coast. Shelf Sci.* **130**, 239–251.

Van Niekerk, L., Adams, J.B., James, N.C., Lamberth, S.J., MacKay, C.F., Turpie, J.K., Rajkaran, A., Weerts, S.P. & Whitfield, A.K. (2020). An Estuary Ecosystem Classification that encompasses biogeography and a high diversity of types in support of protection and management. *African J. Aquat. Sci.* **45**, 199–216.

Van Niekerk, L., Adams, J.B., Lamberth, S.J., Mackay, C.F., Taljaard, S., Turpie, J.K., Weerts, S.P. & Raimondo, D.C. (2019). *South African National Biodiversity Assessment 2018: Technical Report. Volume 3: Estuarine Realm*. Pretoria.

Van Niekerk, L. & Taljaard, S. (2007). *Proposed Framework for Estuarine Management Plans*. Stellenbosch.

Van Niekerk, L. & Turpie, J. (Eds.). (2012). Volume 3: Estuary Component. In *South African National Biodiversity Assessment 2011: Technical Report.* Stellembosch: Report Number CSIR/ NRE/ECOS/ER/2011/0045/B.

Ortega, C.P. (2012). Chapter 2: Effects of noise pollution on birds: A brief review of our knowledge. *Ornithol. Monogr.* **74**, 6–22.

Pienaar, J. (2023a). *1st Draft Environmental Management Programme For Knor Varkie Camping And Caravan*

Site And Associated Resort Facilities On Portion 8 Of Farm Kliphoek Nr 59, Velddrif. Velddrif.

Pienaar, J. (2023b). *Pre-Application Draft S24G Application Report for The Alleged Illegal Development of Knor Varkie Camp Site, Caravan Park And Associated Facilities On Farm Kliphoek 8/59, Velddrif, Western Cape DEA&DP Compliance Notice Ref.No. 14/1/1/E1/9/3/3/0604/19*. City of Cape Town and West Coast District.

Pienaar, J. (2023c). *DEA Screening Tool Report and Site Sensitivity Verification Report for Knor Varkie Camp Site and Caravan Park on Portion 8 of Farm Kliphoek no 59 , Velddrif*. Velddrif.

Pool-Stanvliet, R., Duffell-Canham, A., Pence, G. & Smart, R. (2017). *Western Cape Biodiversity Spatial Plan Handbook*. Stellenbosch: CapeNature.

Ractliffe, S.G. (2009). The hydrological characteristics of the Berg River. *Trans. R. Soc. South Africa* **64**, 96–118.

Rutger, S.M. & Wing, S.R. (2006). Effects of freshwater input on shallow-water infaunal communities in Doubtful Sound, New Zealand. *Mar. Ecol. Prog. Ser.* **314**, 35–47.

Saintilan, N., Rogers, K., Kelleway, J.. J., Ens, E. & Sloane, D.R. (2019). Climate Change Impacts on the Coastal Wetlands of Australia. *Wetlands* **39**, 1145–1154.

SANBI. (2018). *National Biodiversity Assessment: The status of South Africa's ecosystems and biodiversity*. *South African Natl. Biodivers. Inst.*

Schumann, E.H. (2009). The Berg Estuary: Water structures and dynamics. *Trans. R. Soc. South Africa* **64**, 164–180.

Stanley, D. & Hobbie, J.E. (1977). *Nitrogen cycling in the Chowan River*.

Taljaard, S., Van Niekerk, L., van Ballegooyen, R., Theron, R. & Huizinga, P. (2010). Appendix C: Physical Dynamics and Water Quality. In *Comprehensive determination of the Environmental Water Requirements for the Berg River Estuary*.

Turpie, J.K., 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.

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.

Venter, O., Pillay, D. & Prayag, K. (2020). Water filtration by burrowing sandprawns provides novel insights on endobenthic engineering and solutions for eutrophication. *Sci. Rep.* **10**, 1–11.

Western Cape Government. (2022). *Berg River Situation Assessment Report Western Cape Department of Environmental Affairs and Development Planning*.

Wooldridge, T.H. & Deyzel, S.H.P. (2009a). The subtidal macrozoobenthos of the river-dominated Great Berg Estuary. *Trans. R. Soc. South Africa* **64**, 204–218.

Wooldridge, T.H. & Deyzel, S.H.P. (2009b). Temperature and salinity as abiotic drivers of zooplankton community dynamics in the Great Berg Estuary. *Trans. R. Soc. South Africa* **64**, 219–237.

Wright, S.L., Thompson, R.C. & Galloway, T.S. (2013). The physical impacts of microplastics on marine organisms: a review. *Environ. Pollut.* **178**, 483–492.

van Wyk, J.W., Adams, J.B. & von der Heyden, S. (2022). Conservation implications of herbicides on seagrasses: sublethal glyphosate exposure decreases fitness in the endangered Zostera capensis. *PeerJ* **10**, 1–22.

APPENDIX I: RQOS FOR THE BERG RIVER ESTUARY

Component	Sub-component	Indicator	RQO Narrative	RQO Numeric												
Quantity	Surface flow	Flow	River inflow should never drop below 0.6 $m^3.s^{-1}$ and should not below 1 $m^3.s^{-1}$ for longer than 4 months; Flood frequency Should not increase/decrease by more than 10% from 2004 baseline conditions	Months	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
				MMR/MAR (% Natural)	31.21 (46%)	12.55 (36%)	3.92 (25%)	1.61 (19%)	1.50 (23%)	1.66 (20%)	9.13 (36%)	22.18 (26%)	64.25 (42%)	123.35 (61%)	137.15 (68%)	78.34 (63%)	486.86 (52%)
Quality	Nutrients	DIN	Inorganic nutrient concentrations not to exceed TPCs for macrophytes and microalgae	Estuary (low flows < 1 $m^3.s^{-1}$, summer): DIN <300 µg/l; DRP <100 µg/l in Zones A and B, DIN <80 µg/l; DRP <30 µg/l in Zones C and D													
				Estuary (high flows > 5 $m^3.s^{-1}$1, winter): DIN <800 µg/l; DRP <60 µg/l in Zones A-D												
		DIP		River inflow (< 1 $m^3.s^{-1}$, summer): DIN <80 µg/l; DRP <20 µg/l												
				River inflow (>5 $m^3.s^{-1}$, winter): DIN <800 µg/l; DRP <60 µg/l												
	Salinity	Salinity	Salinity distribution not to exceed TPCs for fish, invertebrates, macrophytes and microalgae	Salinity <20 for longer than 3 months at 20 km upstream from the mouth; Salinity <1 ppt above 40 km upstream of the mouth; Salinity of Salinity everywhere in estuary <35; Groundwater salinity on floodplain <45; TDS of river inflow <3500 mg/l												
	System variables	Temperature	System variables not to exceed TPCs for biota	"River inflow: 7 < pH < 8.5												
		pH		Estuary: 7 < pH < 8.5 "												
		Dissolved oxygen		"River inflow: DO >4 mg/l												
		Secchi depth		Sechii depth >1 m												
	Pathogens	*Enterococci*	Concentrations of waterborne pathogens not to exceed limits considered suitable for recreational use	Zones A and B <1.0 m during low flow (< 1 $m^3.s^{-1}$)												
		Escherichia coli		≤185 Enterococci/100 ml) (90th percentile, Hazen system)												
				≤500 E. coli/100 ml (90th percentile, Hazen system)												

Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
Habitat	Hydrodynamics	Mouth state	Habitat health adequate for microalgae, macrophytes, invertebrates, fish, birds and recreational use	Permanently open
		Tidal variation		<10% change from present state
	Sediments	Sediment characteristics, Channel shape/size		Bathymetry and sediment MdØ change <10% from baseline
Biota	Microalgae	Biomass and community composition of phytoplankton and benthic microalgae community	Phytoplankton biomass and composition suitable for invertebrates, fish, birds and recreational use	Blue-green algae <10% of phytoplankton cell counts, Benthic microphytobenthic < 40 mg/m2 chlorophyll a, The frequency of dinoflagellates < 5% of the total phytoplankton counts
	Macrophytes	Extent, distribution and richness of macrophytes	Macrophyte cover and composition suitable for invertebrates, fish, birds and recreational use	Maintain the present distribution (2003-2005) and abundance of the different plant community types and estuarine habitats (intertidal mudflats with *Zostera capensis* 206 ha, intertidal salt marsh 499 ha, open pan 1159 ha, halophytic floodplain 1521 ha, xeric floodplain 919.1 ha, reeds and sedges 586.6 ha and sedge pan 292.5 ha), Prevent an increase in mats of macroalgae in the lower intertidal reaches, reduce the area covered by water hyacinth *(Eicchornia crassipes*) in the upper reaches by 50% compared to the present state (2003-2005), prevent an increase in size of the open pan dry areas (1159 ha in 2003-2005), prevent a decrease in size of the sedge pan areas (293 ha in 2003-2005). Prevent the spread of invasive aliens in the riparian zone (e.g. *Acacia mearnsii* and *Eucalyptus camaldulensis*), maintain intact reed and sedge stands along the banks of the estuary by ensuring that salinity is not greater than 20 ppt for 3 months at 20 km from the month during summer, prevent an increase in bare ground in the halophytic and xeric floodplain habitats by maintaining the present-day flooding patterns
Biota	Invertebrates	Macrofauna community composition, abundance and richness	Abundance and community composition of Invertebrates suitable for fish, birds	Retain present species richness, distribution of species and mix (low species abundance, high dominance) in Zones A to the middle reaches of Zone C. One or two species will always be present at high densities compared to others (e.g. *Pseudodiaptomus hessei*, *Grandidierella* sp.) in these Zones (A to C), Indicator species such as Capitella capitata, should not dominate benthic species at any site, *Callianassa kraussi* and *Upogebia africana* distribution patterns remain similar to present state.
	Fish	Fish community composition, abundance and richness	Abundance and community composition of fish community suitable for birds	Retain the full complement of estuarine resident (7 species) and estuary associated marine (5 species) present in the estuary with population sizes sufficient to ensure their persistence in perpetuity, ensure that exotic freshwater species do not increase to levels where they can exclude any more indigenous species through predation or competitive interactions, Maintain recruitment of adult and juvenile fish at present 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.

Component	Sub-component	Indicator	RQO Narrative	RQO Numeric
	Birds	Avifauna community composition, abundance and richness	Health avifauna community contributing to conservation of avifauna species in SA	Retain at least 90% of the baseline species richness, abundance and diversity of the bird community determined using regression slope based on a 3-year running average

APPENDIX II: IMPACT ASSESSMENT METHODS

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.

- **INSIGNIFICANT**: the potential impact is negligible and will not have an influence on the decision regarding the proposed activity.
- **VERY LOW**: the potential impact is very small and should not have any meaningful influence on the decision regarding the proposed activity.
- **LOW**: the potential impact may not have any meaningful influence on the decision regarding the proposed activity.
- **MEDIUM**: the potential impact should influence the decision regarding the proposed activity.
- **HIGH**: the potential impact will affect a decision regarding the proposed activity.
- **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 • Xxxx • 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:

Phase	Impact identified	Severity	Probability	Significance	Status	Confidence
xxxxxx	Impact 1: xxx	Medium	Improbable	**LOW**	–ve	High
	With mitigation	Low	Improbable	**VERY LOW**		High
	Impact 1: xxx	Very Low	Definite	**VERY LOW**	–ve	Medium
	With mitigation	Very Low	Improbable	**INSIGNIFICANT**	–ve	Medium

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.


ANCHOR
environmental