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ONRUS ESTUARINE MANAGEMENT PLAN

Situation Assessment Report

August 2016

ANCHOR environmental

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Cover Photo: Barry Clark

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[1] Note: This version of the Situation Assessment Report for the Onrus Estuary is founded on earlier versions of the same document prepared by Sue Matthews, Liezl Bezuidenhout, and Pieter Badenhorst.

EXECUTIVE SUMMARY

Introduction

The Onrus Estuary, popularly known as Onrus Lagoon, is one of South Africa's approximately 289 functional estuaries and is one of 21 estuaries within the warm temperate biogeographic region to be classified as a temporarily open/closed (Turpie et al., 2012; Van Niekerk and Turpie, 2012). The Onrus is a very small estuary with a relatively small floodplain and covers in total approximately 15 ha. The Onrus Estuary is not particularly important for estuarine biodiversity on a national scale and ranks 94th in terms of its overall conservation importance. The estuary is, however, an important recreational area along the Cape south coast, and is home to a well-established resident community as well as a much larger holidaying community.

The estuary faces pressure from reduced freshwater inflow due to the upstream De Bos Dam, pressure from recreation use and coastal development, particularly around the estuary mouth, and issues relating to deteriorating water quality. Recognising the importance of the Onrus Estuary and estuaries in South Africa more generally, the Overstrand Municipality commissioned Anchor Environmental Consultants (Pty) Ltd to prepare an Estuarine Management Plan for the Onrus Estuary.

This report is the Situation Assessment that forms the background material for the development of the management plan, and should be read in conjunction with the Management Plan itself.

Geographic and socio-economic context

The Onrus catchment lies within the OLM (part of the Overberg District Municipality – ODM) in the Western Cape Province and is included in the Breede-Gouritz Catchment Management Area. The Onrus River rises in the Babilonstoring Mountains and flows 16 km through the Hemel en Aarde Valley before crossing the narrow coastal plain to discharge into the sea via Onrus Lagoon, which is situated approximately 7 km northwest of Hermanus.

The catchment falls within the Fynbos Biome, but most of the area has been transformed through urban development, invasive alien vegetation and agriculture. The catchment is located within the winter rainfall region, although orographic rain originating from the mountain ranges close to the coast result in local concentrations of rainfall (Heinecken and Damstra 1983). Rainfall on the coastal plain is generally lower than in the mountainous areas of the catchment, where Hermanus experiences a mean of approximately 600 mm per annum.

Agriculture (primarily viticulture) is the main land use in the valley, while urban development is limited to the coastal plain. The river course is heavily overgrown in places with invasive alien vegetation, including eucalypt plantations. The average annual growth rate of the OLM population based on the years from 2001 to 2011 is 3.8% and pressures on the Onrus River system and estuary are expected to increase over time.

Ecological characteristics and functioning

The channel and mouth dynamics of the Onrus Estuary have been strongly influenced by anthropogenic developments in the catchment and have not been formally managed since the commissioning of the De Bos dam in 1976. The Mean Annual Runoff (MAR) reaching Onrus Lagoon has been significantly reduced by water use in the catchment, mainly for agricultural activity, and the construction of the De Bos Dam. The annual 'compensation water' released from the dam should amount to 0.47 Mm^3 for downstream water users along with a supplementary environmental release of 1.6 Mm^3 per annum. However, as there is no gauge measuring outflow through the outlet pipe from the dam, which can be opened or closed with a valve, it is considered unlikely that enough water is released for the environmental reserve downstream of the dam.

The Onrus mouth is closed most of the time owing to a large sandbar that develops across the mouth, which reaches an average crest height of +2.8 m MSL (CSIR 1991). During the winter season, following heavy rains, however, a narrow channel is formed typically in the western edge of the sandbar. This narrow channel serves as an overflow rather than a tidal inlet, and seawater only penetrates during high storm spring tides. With the arrival of sufficiently large floods, however, the overflow channel can scour more deeply, enough to allow for a brief period of tidal fluctuation in the estuary. The sandbar starts rebuilding on the seaward side as sand is deposited back on the beach by wave action and usually closes within ten days, reverting back to an overflow channel. The Onrus lagoon can therefore be regarded as being mainly supratidal (the sandbar is higher than the tidal reach).

Historical information suggests that the Onrus estuary has always been a freshwater-dominated system, where instantaneous salinity varied from 0-4 ppt during the closed state (Heinecken and Damstra 1983 S. Lamberth, Pers. Comment, Sue Matthews Overstrand Municipality 2013) and 31.7 ppt while the estuary was open to the sea (e.g. in 1994). Sewage contamination in the Onrus Estuary has been a long-standing concern and the estuary has had to be closed to swimming at times, often during the peak summer season. A sewage pipeline was constructed in 1996 to convey sewage from Kidbrooke Place, as well as any future development adjacent to the line, to the pump station on the northern shore of the Onrus Lagoon. This sewer line is located within the riparian zone, and in places, in the active channel. Sewage spilled from this pipeline affecting water quality in the lower reaches of the Onrus River and also the estuary. Environmental Authorisation was granted on 5 April 2016 for the upgrade the damaged and degraded existing sewer pipeline adjacent to the Onrus River below Bosplasie Crescent in the upper reaches of the Onrus Estuary (Reference: 16/3/1/E2/26/2091/14). The replacement of this sewer lines also involves the construction of two new pump stations and two rising main sewer lines. Construction is currently ongoing and once completed, this section of the Onrus Estuary will be rehabilitated in accordance with the Rehabilitation Plan and River Maintenance Management Plan (MacKenzie 2015).

The estuary is characterised by low gradients and extensive beds of *Phragmites australis*, which form persistent and dense monospecific stands that outcompete other indigenous estuary-associated species and encroach into the open water area of the Onrus Estuary. The spread of this species is thought to be facilitated by the historic shallowing of the lagoon through siltation and excess nutrient input. After considering a multitude of methods to remove the reeds, extensive dredging took place in 1993/1994 to remove the reeds, along with their roots and a good deal of sediment, to

increase the depth of the lagoon. Approximately 30 000 m^3 of organic material and sediment was removed at this time. It is evident that this operation was successful in that the reed edge has since not encroached significantly onto open water area of the Onrus Lagoon.

The north western bank is dominated by alien vegetation and/or is contained within private residential gardens where riparian vegetation has been largely cleared or altered on the estuary banks. The south eastern bank does not have residential gardens and alien vegetation has recently been cleared from this area. Working for Water first became involved in alien-clearing in the Onrus River catchment with the launch of the Greater Hermanus Water Conservation Programme in November 1996. Activities initially focused on the upper reaches of the catchment as a means of increasing runoff into the De Bos Dam, but since 2008, a new project was initiated to increase alien clearing efforts in the lower catchment. The project is funded by the Working for Water Programme to clear on private property within the project boundaries, and by the Overstrand Municipality from the Environmental Management Services budget to clear on municipal properties.

A total of 11 fish species have been recorded from the Onrus Estuary to date, which is considered to be low compared to other temporarily open/closed estuaries in the region. During a survey conducted in September 1994, a total of five species were recorded of which the southern mullet *Liza richardsonii* and flathead mullet *Mugil cephalus* dominated. This survey was undertaken during open mouth conditions and shortly after a large-scale dredging event in 1993/1994 for controlling the spread of *Phragmites.* In 2006, more than a decade after dredging, the estuary was sampled during closed mouth conditions. As expected, abundance of estuarine resident species was substantially higher (69% represented by Gilchrist's round herring *Gilchristella aestuaria* and Knysna sand gobi *Psammagobius knysnaensis*), while *L. richardsonii* remained dominant in terms of biomass. The dominance of estuarine-dependent marine species during open mouth conditions and the prevalence of estuarine resident species during closed mouth conditions indicate that the Onrus Estuary is fulfilling its basic ecological role.

A total of 81 water-associated bird species of 12 taxonomic orders have been recorded at the Onrus Estuary over the last two decades. The most species-rich taxonomic group is the Charadriiformes, which include the waders, gulls and terns. Due to the lack of tidal influence, the estuary is not particularly important for wader species. There are also no important populations of red data species on the estuary.

Ecosystem services

Estuaries provide a range of services that have economic or welfare value. In the case of the Onrus Estuary, the most important of these are the recreational and tourism services. The Onrus Lagoon and adjacent beach are a popular holiday destination, although its use for swimming and canoeing is somewhat constrained by concerns about poor water quality. The Onrus Estuary is not important for subsistence or recreational angling nor is it an important bait collecting site. Studies have shown that the high biomass production of *Phragmites* reed beds favours carbon sequestration, but also produces significant methane emissions. The role of *Phragmites*-dominated wetlands as a source or sink of carbon and their importance to greenhouse gas regulation is thus unclear. However, Onrus Lagoon's small size means that it would make a negligible contribution to climate regulation in any event.

Legislation and management issues

The Onrus Estuary is a highly disturbed system, which has been subjected to urban development, the spread of invasive alien vegetation and extensive dredging for the removal of the common reed *Phragmites australis* in 1993/1994. There are a number of factors that threaten the future health of the system and hence its conservation status and capacity to deliver ecosystem services. The main threats to the system or areas of potential conflict are as follows:

1. Water quantity and quality
    a. Reduction in freshwater inflows due to water use in the catchment, mainly for agricultural activity, and the construction of the De Bos Dam in 1976;
    b. Nutrient enrichment and bacterial contamination due to an aged and damaged sewage system. Parts of the damaged sewer line traverse through the riparian zone and the active channel of the lower Onrus River and upper Onrus Estuary; and
    c. Loss of open water area over time due to encroachment of the common reed *Phragmites australis* as a result of siltation and high nutrient levels in the water column and sediment.
2. Land-use and associated disturbance
    a. Existing and rapidly expanding residential/resort development around the estuary leading to change in sense of place and existence value, increased human disturbance of biota, and damage or loss of estuarine habitat; and
    b. Unmanaged and non-strategic clearing of *Phragmites australis*

The Onrus Estuary was not identified as a priority area for the conservation of South Africa's estuarine biodiversity estate in the recent National Biodiversity Assessment (Van Niekerk and Turpie 2012) but this assessment did highlight a number of focal areas for the rehabilitation of the estuary, including alien plant clearance, increasing freshwater inflow and improving water quality. It has also been recommended that rehabilitation objectives focus on restoring the aesthetic and scenic value of the Onrus Estuary, which could, in part, be implemented in conjunction with a public awareness programme.

The Integrated Coastal Management Act, 2008 (ICMA) requires that a management plan be developed for each estuary in the country. The National Estuary Management Protocol (NEMP) gazetted in the in terms of the Integrated Coastal Management Act in 2013 and provides clear guidance for the management of estuaries through the development of individual estuarine management plans (such as this one). The NEMP also outlines a national vision for estuarine management in South Africa, lays out strategic objectives for effective integrated management of estuaries in this country, and prescribes standards for the management of estuaries. However, the fact that estuaries contain freshwater, terrestrial and marine components, and are heavily influenced by activities in a much broader catchment and adjacent marine area, means that they are also affected by other policies and laws. The National Departments of Water Affairs and Sanitation (DWS) and Environmental Affairs (DEA) are the primary agencies responsible for estuary management in South Africa with a small amount of responsibility (fisheries) attributable to the Department of Agriculture Forestry and Fisheries (DAFF). Environmental management in most instances is devolved to provincial level, aside from water resources and fisheries which remain a national competency. At a municipal level, by-laws are passed which cannot conflict with provincial

and national laws. The Onrus Estuary lies wholly within the Overstrand Local Municipality, which falls within the Overberg District Municipality of the Western Cape Province.

TABLE OF CONTENTS

LIST OF ABBREVIATIONS AND ACRONYMS

C.A.P.E.	Cape Action Plan for People and the Environment
CWDP	Coastal Waters Discharge Permit
DEA	Department of Environmental Affairs
DEADP	Department of Environmental Affairs and Development Planning (provincial)
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
ECA	Environmental Conservation Act (Act No 73 of 1989 as amended)
EIA	Environmental Impact Assessment
GDA	General Discharge Authorisation
ICMA	National Environmental Management: Integrated Coastal Management Act (Act No 24 of 2008 as amended in 2014)
IDP	Integrated Development Planning
MAR	Mean annual runoff
MEC	Member of provincial Executive Council
MLRA	Marine Living Resources Act (Act No 18 of 1998 as amended in 2014)
Mm3	Million cubic metres
MPA	Marine Protected Area
MPRDA	Mineral and Petroleum Resources Development Act (2002)
NEMA	National Environmental Management Act (Act 107 of 1998 as amended)
NEMBA	National Environmental Management: Biodiversity Act (Act No 10 of 2004 as amended in 2013)
NEMPA	The National Environment Management: Protected Areas Act (Act 57 of 2003 as amended in 2014)
NEMWA	National Environmental Management: Waste Act (Act No 59 of 2008 as amended in 2014)
NHRA	National Heritage Resources Act (Act 25 of 1999)
NWA	National Water Act (Act 36 of 1998)
NWA	National Water Act (Act No 36 of 1998)
RDM	Resource Directed Measures
RSA	Republic of South Africa
SAHRA	South African Heritage Resource Agency
SDF	Spatial Development Framework
SPLUMA	Spatial Planning and Land Use Management Act (SPLUMA) (Act 16 of 2013)
WCNCB	Western Cape Nature Conservation Board

1 INTRODUCTION

The Onrus Estuary is one of South Africa's approximately 289 functional estuaries and is one of 21 estuaries within the warm temperate biogeographic region to be classified as a temporarily open/closed (Turpie *et al.*, 2012; Van Niekerk and Turpie, 2012). The Onrus is a very small estuarine lagoon with a relatively small floodplain and covers in total approximately 15 ha (Figure 2). The Mean Annual Runoff (MAR) reaching Onrus Lagoon has been significantly reduced by water use in the catchment, mainly for agricultural activity, and the construction of the De Bos Dam in 1976. This dam constitutes the primary freshwater resource supplying potable water to the Overstrand region. To maintain normal river flow downstream of the dam, it was calculated that 0.23 Mm^3 per month would have to be released between October and April each year, totalling 1.6 Mm^3 (Ninham Shand 1987). However, no gauge that can measure outflow or overflow has been installed to date and it is therefore unknown how much water is released to maintain downstream river and estuarine ecology.

Due to its small size, moderate to low biodiversity and poor water quality, the Onrus Estuary is currently not formally protected and was ranked 94th out of 274 in terms of conservation importance in South Africa (Turpie *et al.*, 2002; Turpie and Clark, 2007). The expansion of the town of Onrus on the river banks and construction of a sewage system that is now aged and has exceeded its capacity, certainly constitute the most important impacts on the health of the estuary. Urban development is accompanied by modest levels of recreational use, including limited natural resource use (such as fishing and bait collection) and non-consumptive activities such as dog walking, bird watching and swimming. Siltation of the lagoon as a result of land use changes upstream of the estuary and concurrent enhanced nutrient input by sewage pollution from the aged sewage line and overflowing pump stations has resulted in the encroachment of the common reed *Phragmites australis* on open water between 1920 and 1993. Dredging in 1993/1994 was successful in restoring some of the open water in the long-term. Alien plant invasion is also considered a threat to biodiversity and water quantity available to the estuary.

The Present Ecological State of the Onrus Estuary banks and valley floor were determined as D and C/D class, respectively. It is expected that the estuary is on a stagnant or even negative trajectory of change due to changes in flow, pollution and habitat loss through alien invasive species, should the situation remain unmanaged (MacKenzie 2015). Increasing developmental pressures in the Onrus Estuary resulting from its increasing popularity as a holiday destination could have further negative impacts on water quality and available water quantity for the ecological reserve. Management intervention is urgently needed to ensure that the estuary can provide continued or even improved ecosystem services, in particular enhanced aesthetic value for the tourism industry.

In line with the National Estuarine Management Protocol published in terms of section 33(2) of the National Environmental Management Integrated Coastal Management Act, 2008 (Act No. 24 of 2008) (ICMA), the Overstrand Municipality is in the process of developing an estuarine management plan for the Onrus Estuary. Before such a management plan can be developed, the current environmental situation (biophysical and socio-economic aspects included) of the Onrus Estuary must be assessed. This document is the Situation Assessment report and provides background information on the estuary, including the geographic and socio-economic context, a description of the ecosystem functioning and biodiversity, the legal and planning context, threats to the system,

and its conservation importance. This document will form the basis of the development of a vision and strategy for the management of the estuary in a participatory process involving stakeholders.

Definition of an Estuary

In South Africa an estuary is considered a partially enclosed, permanent water body, either continuously or periodically open to the sea on decadal time scales, extending as far as the upper limit of tidal action or salinity penetration. During floods an estuary can become a river mouth with no seawater entering the formerly estuarine area, or, when there is little or no fluvial input, an estuary can be isolated from the sea by a sandbar and become a lagoon or lake which may become fresh or hypersaline.

National Biodiversity Assessment 2011: Estuary Component (van Niekerk & Turpie 2012)

2 GEOGRAPHIC AND SOCIO-ECONOMIC EXTENT

2.1 Location and extent of the estuary and its catchment

The Onrus Estuary, popularly known as the Onrus Lagoon, is situated on the West Coast of South Africa, approximately 7 km northwest of Hermanus within the warm temperate biogeographic region of South Africa (Harrison *et al.*, 2000). The Onrus River catchment (G40H) covers an area of only 59 km^2 and lies within the Overstrand Local Municipality (part of the Overberg District Municipality) (Figure 1) in the Western Cape Province and forms part of the Breede-Gouritz Catchment Management Area. The catchment is bordered by the southern slopes of the Babilonstoringberge and the northern slopes of the Kleinrivierberge, both part of the Cape Fold Belt formed as a result of continental collision some 250 million years ago. Lying between these two mountain ridges is the Hemel en Aarde Valley, through which the Onrus River flows. The wide upper Hemel en Aarde Valley lies at an altitude of 600-1000 m, and is separated from the lower Hemel en Aarde valley, a much narrower valley at an altitude of 200-400 m, by the Attaquas Kloof ravine. At the head of this ravine is the dam wall for the De Bos Dam. The main tributary of the Onrus River, the Antjies River, joins at the top of the lower valley. Further downstream, there are a number of streams draining the steep slopes of the Onrus Mountains. The Onrus River runs through the Hermel en Aarde Valley for some 16.8 km and across the narrow coastal plain before discharging into the sea via Onrus Lagoon.

Figure 1 The Onrus River catchment.

According to the National Estuaries Layer, the estuarine functional zone for South Africa's estuaries is defined by the 5 m contour above mean sea level (MSL), and includes the open water area, estuarine habitat and floodplain. The upstream boundary of the estuary is taken to be the limit at which tidal action is evident at spring tides when the estuary is open to the sea, or the salinity is measurably higher as a result of the sea's influence. The boundary of Onrus Lagoon, according to

the National Estuaries Layer, is shown in Figure 2. This is a very small system, covering an area of just over 15 ha.

Figure 2 Aerial view of the Onrus Estuary, showing the estuarine functional zone.

2.2 Catchment climate, geology, vegetation and drainage

2.2.1 Climate

The catchment is located within the winter rainfall region, where rainfall is brought by cyclonic low-pressure cells moving in an easterly direction south of the continent in winter (Heinecken and Damstra 1983). South-easterly winds prevail in summer, often resulting in seasonal drought conditions. River flow is therefore decidedly seasonal with interannual variability occasionally resulting in zero flow conditions during summer. Orographic rain originating from the mountain ranges close to the coast result in local concentrations of rainfall (Heinecken and Damstra 1983). Rainfall on the coastal plain is generally lower than in the mountainous areas of the catchment, where Hermanus experiences a mean of approximately 600 mm per annum (Table 1).

Table 1 **Annual rainfall for the past decade from weather stations in and around the Onrus River catchment (Umvoto Africa 2013).**

Weather station	Period	Mean	Minimum	Maximum
Hermanus Magnetic Observatory	2002-2012	575 mm	397 mm	893 mm
Hamilton Russell Vineyards	2002-2012	844 mm	668 mm	1198 mm
Tokara Siberia Vineyards	2003-2012	796 mm	460 mm	1024 mm
Vogelgat Nature Reserve	2004-2012	1041 mm	705 mm	1235 mm

Table 2 **The location of the weather stations and De Bos Dam relative to the catchment boundary and Onrus Lagoon.**

2.2.2 Geology

The following account of the area's geology is extracted from the Annual Monitoring Report for the Gateway wellfield (Umvoto Africa 2013). The main stratigraphic units represented in the study area belong to the Malmesbury Group, Cape Granite Suite, Table Mountain Group (TMG), Bokkeveld Group and Bredasdorp Group. The deposits of the Malmesbury Group, intruded by the Cape Granite Suite, are the oldest formations in the region, and form the basement on which the thick layers of the Palaeozoic TMG and Bokkeveld Group were deposited. Granite outcrops can be found in the Hemel en Aarde Valley north of the De Bos Dam.

The TMG dominates the Hermanus region, and is composed of the Peninsula, Pakhuis, Cedarberg, Goudini, Skurweberg and Rietvlei Formations (Figure 3). Due to the folded and resistant nature of

the fractured quartzites of the Peninsula and Skurweberg Formations, the TMG outcrops form steep, rocky hills and mountains i.e. the east-west trending topographic backbone of the Onrusberge, Babilonstoringberge and Kleinrivierberge. The Bokkeveld Group is composed of less resistant shales and siltstones, and forms the base of the NE-SW trending Hemel en Aarde Valley.

The long hiatus and non-conformity between the Bokkeveld Group and overlying strata of the Bredasdorp Group represents an interval of nearly 350 million years (Ma). During this interval the TMG and later overlying Palaeozoic units were deformed by folding and thrust-faulting during the Permo-Triassic (~250 Ma) Cape Orogeny, followed by extensional/strike-slip faulting and some igneous activity (e.g. dolerite dyke intrusion) during the Jurassic-Cretaceous break-up of Gondwana.

Following extensive erosion of the coastal plain during the Late Cretaceous and Early Tertiary periods, the Bredasdorp Group was deposited across the exposed marine terraces and forms the youngest formations within the study area. The Bredasdorp Group consists mainly of aeolian sand deposits and littoral sandstone and limestone and occurs along the coastal plain.

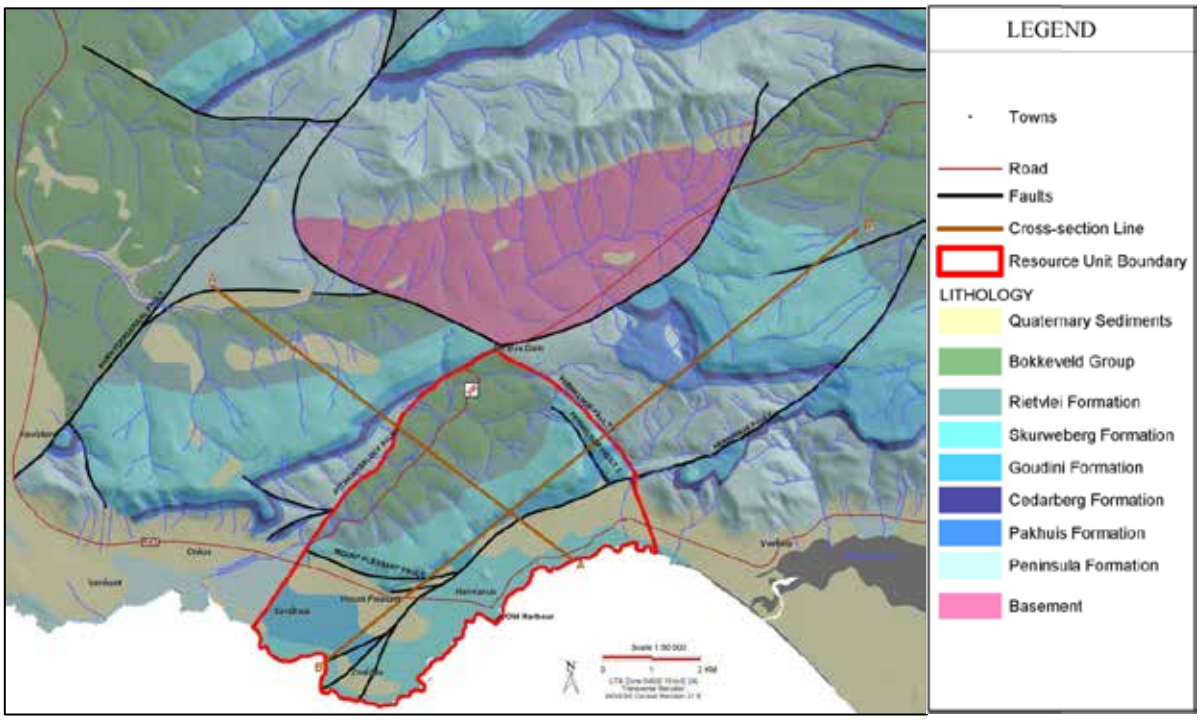

Figure 3 Geology of the Hermanus Area (Umvoto Africa 2013).

2.2.3 Vegetation

Coinciding with the above described geological features are the two dominant vegetation types in the catchment: Overberg Sandstone Fynbos on quartzitic, sandy soils derived from Table Mountain Sandstone, and Elim Ferricrete Fynbos on the clay-rich, gravelly soils derived from Bokkeveld Shale, ironstone and granite. There are also isolated strips of Western Coastal Shale Band Vegetation, while Hangklip Sand Fynbos and Overberg Dune Strandveld occur on the coastal plain (Figure 4).

In the Onrus catchment, large areas of natural vegetation have been transformed by agriculture in the Hemel en Aarde valley, and by urban development on the coastal plain. Apart from on the steeper mountain slopes and in the municipal Fernkloof Nature Reserve, most of which lies within the catchment area, only disturbed fragments remain.

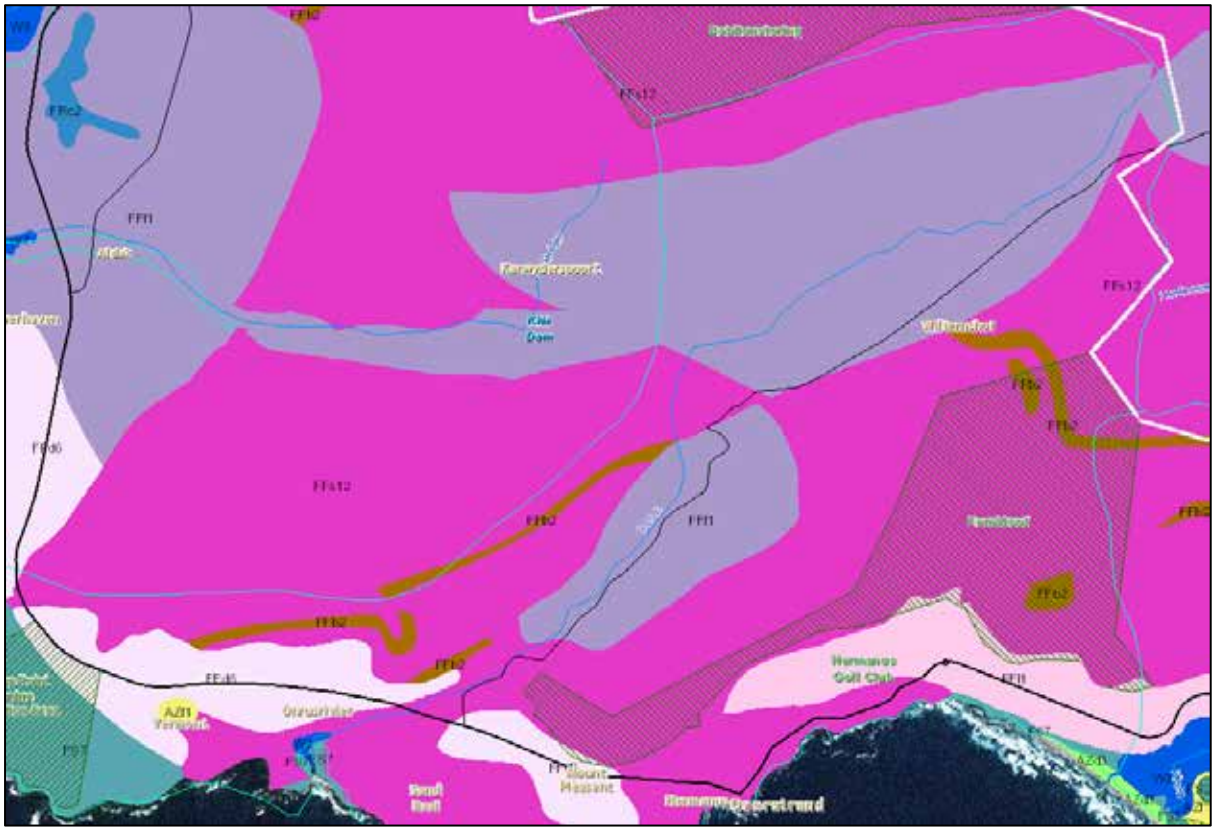

Figure 4 **Historical distribution of vegetation types in the Onrus River catchment. FFs12 (pink) = Overberg Sandstone Fynbos; FFf1 (grey) = Elim Ferricrete Fynbos; FFb2 (olive green) = Western Coastal Shale Band Vegetation; FFd6 (white) = Hangklip Sand Fynbos; FS7 (turquoise) = Overberg Dune Strandveld; FFl1 (pastel pink) = Agulhas Limestone Fynbos; hashed = nature reserves (*http://bgis.sanbi.org/ecosystems/project.asp*).**

Both Overberg Sandstone Fynbos and Elim Ferricrete Fynbos are listed as critically endangered in the National List of Threatened Ecosystems (2011), while Hangklip Sand Fynbos is listed as endangered. Overberg Sandstone Fynbos is listed under criterion D1 – 'threatened plant species associations', because 105 Red Data plant species occur in this ecosystem type. It consists of moderately tall, dense shrublands of mainly proteoid and ericaceous fynbos, with restioid fynbos also occurring locally. There are at least 114 endemic plant species. Some 86% of the original area (Figure 4) of 117 000 ha remains.

Elim Ferricrete Fynbos is described as open to closed dwarf shrubland with occasional scattered tall shrubs. It is a diverse ecosystem, with all structural fynbos types present, but with extensive areas of asteraceous fynbos dominated by low proteoid elements. When degraded, this ecosystem becomes dominated by renosterbos, *Elytropappus rhinocerotis*. At least 29 endemic plant species and 72 Red Data plant species occur in the ecosystem. Since only 29% of the original 67 000 ha

remains, the ecosystem is listed as critically endangered under criterion A1 – 'irreversible loss of natural habitat - remaining natural habitat ≤ biodiversity target' (Figure 6).

Hangklip Sand Fynbos is also listed under criterion A1 for irreversible loss of natural habitat, but in this case some 60% of the original area remains. The ecosystem is endangered because remaining natural habitat ≤ (biodiversity target + 15%). It occurs on sand dunes and sandy bottomlands and consists of moderately tall, dense shrubland. Proteoid, ericaceous and restioid fynbos are dominant, with some asteraceous fynbos also present. At least five endemic plant species and 32 Red Data plant species occur in the ecosystem.

Western Coast Shale Band Vegetation supports diverse renosterveld and fynbos shrublands of all structural types, as well as small patches of afrotemperate forest in gullies and on saddles. It is well-protected in nature reserves and mountain catchment areas. Overberg Dune Strandveld consists of evergreen, hard-leaved shrublands and coastal thicket in scattered patches. Some 30% is formally protected in the De Hoop, De Mond and Walker Bay Nature Reserves.

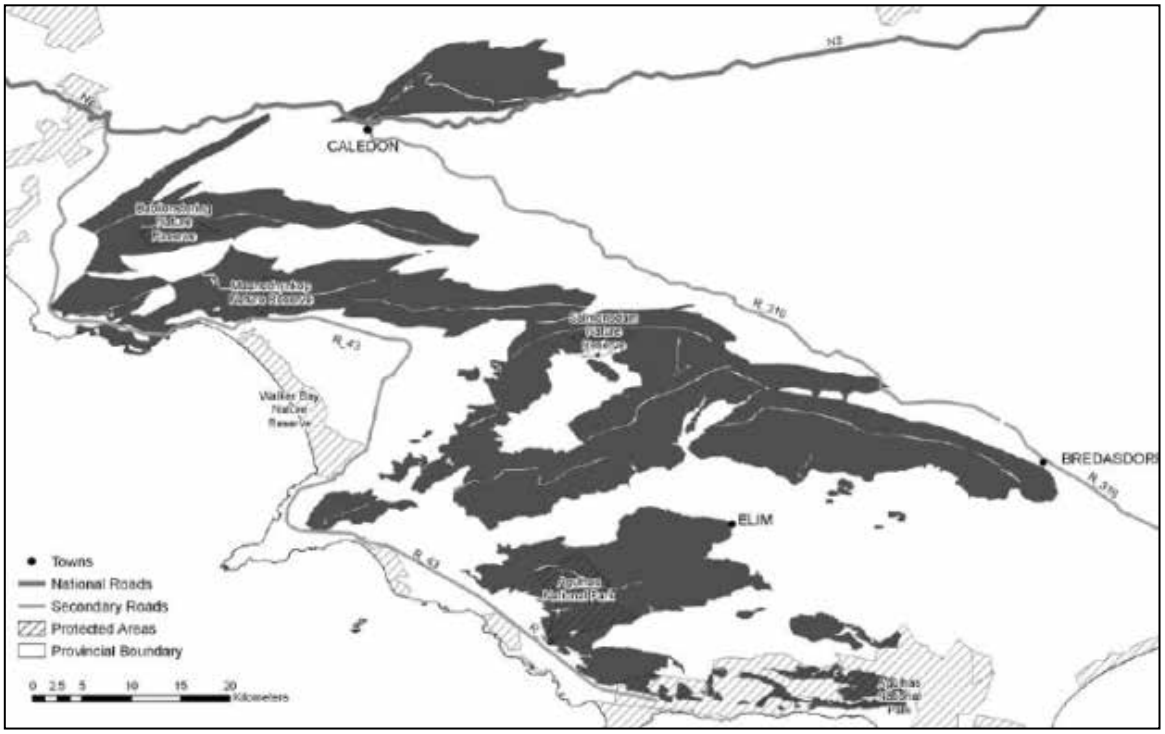

Figure 5 The original extent of the Overberg Sandstone Fynbos

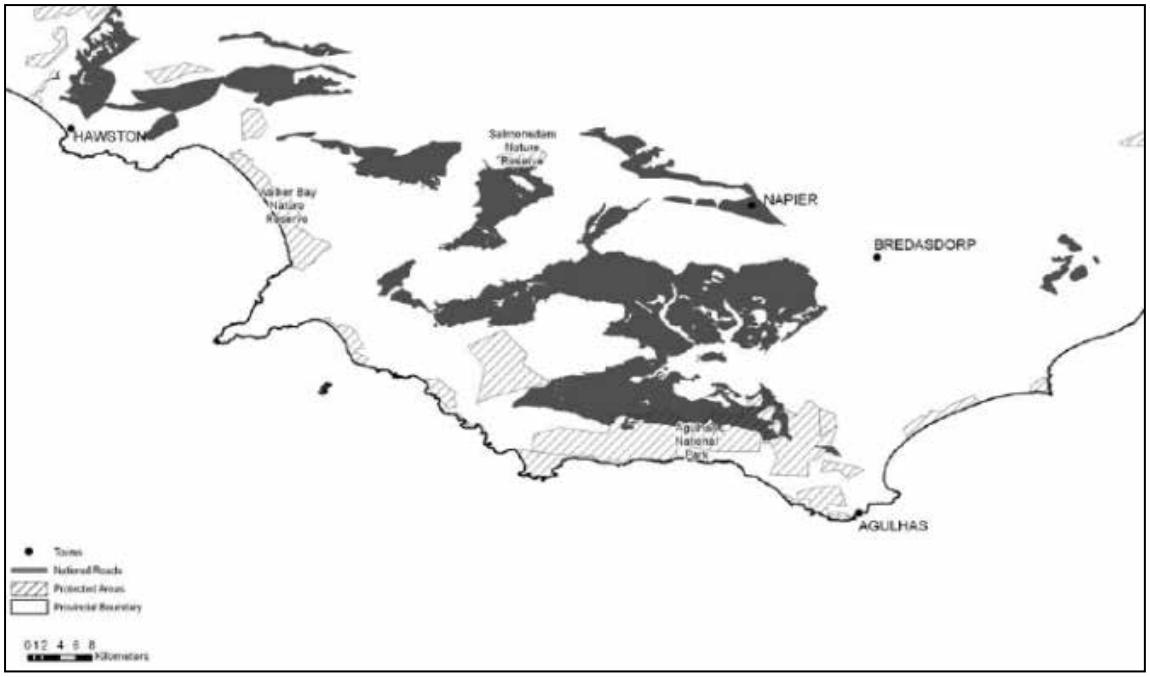

Figure 6 The original extent of Elim Ferricrete Fynbos.

2.3 Catchment Population, Land-use and economy

According to the most recent census, the population of the Overstrand municipal area increased from 55 012 in 2001 to 80 432 in 2011, representing a growth of 3.8% per year. Some 16% of the population is 60 years old or over, reflecting the area's popularity as a retirement destination. There are 28 010 households, of which 80.1% are formal dwellings, and 75.8% of households have piped water inside their dwellings. The official unemployment rate for youth aged 15 to 34 is 31.1%, and 27.7% of people over the age of 20 have a matric education.

The municipal area has a coastline of approximately 200 km, and its proximity to the greater Cape Town area and inland areas of the Overberg means that tourism is a major economic driver. A large percentage of residences are holiday homes, which results in a fourfold increase in the population over holiday seasons (Overstrand Municipality IDP 2012).

The suburbs of Onrus and Vermont, comprising Ward 13, lie in the immediate vicinity of the Onrus Estuary, and have a combined population of 5151. The Onrus catchment currently provides the main source of water supply to the greater Hermanus Area, which is home to almost 49 000 people.

Viticulture is the main agricultural activity in the catchment, but there are also orchards, olive groves and wheat fields, as well as livestock-farming. The first vineyards were established by Tim Hamilton Russell after he purchased land here in 1975, but there are now at least 22 wine-growers/producers and 300 hectares of vineyards. The Hemel en Aarde wine route has become a popular tourist attraction, supporting a number of wineries and restaurants, while the R320 road through the valley to Caledon is recognised as a scenic drive.

The Camphill School for special-needs children was opened in the early 1950s, and the Camphill Farm was subsequently established to create work for school-leavers. In the lower part of the

catchment, three properties owned by the municipality are leased as smallholdings or for commercial activities (amphitheatre, paintball, zip-lines and quad bikes).

The original farm in the lower valley was once called Attakwas Cloof, a reference to the Attaqua Khoi tribe that must have inhabited or visited the area. In 1817 the Governor of the Cape, Lord Charles Somerset, instructed the Landdrost of Swellendam to establish a confinement facility for leprosy patients, and the Attakwas Cloof farm was chosen for this purpose. A settlement of huts and food gardens was established, a hospital was built, and by the end of 1820 there were about 120 inmates, most of them Khoi. The colony was run by the Moravian Mission Society and known as the Moravian Leper Home. In December 1845, it was decided that the inmates should be moved to Robben Island, as there were regular visitors to the colony and increased isolation was needed to contain the disease. The following year, all the inmates were relocated. About 400 lepers who succumbed to the disease are believed to be buried in the valley.

3 ECOLOGICAL CHARACTERISTICS AND FUNCTIONING OF THE ESTUARY

3.1 Physical characteristics and dynamics

3.1.1 The De Bos Dam

The Onrus River catchment has a number of small farm dams, as well as the municipal De Bos Dam which was built in 1976 approximately 9 km upstream of the estuary mouth in the narrow Attacques Kloof. This dam constitutes the primary freshwater resource supplying potable water to the Overstrand region and has a storage capacity of 6 Mm^3 with an annual supply capacity of approximately 3.3 Mm^3 (Du Plessis 1995). The Municipality has been allocated 2.8 million m^3 (Overstrand IDF 2014, Ninham Shand 1973, Ninham Shand 1987) with an additional 0.47 Mm^3 reserved for compensation of downstream water users. To maintain normal river flow downstream of the dam, it was calculated that 0.23 Mm^3 per month would have to be released between October and April each year, totalling 1.6 Mm^3 (Ninham Shand 1987). While 0.47 Mm^3 was released annually for downstream users, the 1.6 Mm^3 annual compensation release to ensure normal river flow has not been implemented.

Taking into account the anticipated demand for water from the growing population in the Greater Hermanus Area, it was anticipated that the Municipality's annual allocation of 2.8 Mm^3 from the De Bos Dam would be reached by about 1997 (Ninham Shand 1991). The Overstrand Municipality submitted an application for a higher water allocation to the Department of Water Affairs and Forestry (DWAF now Department of Water and Sanitation). Permission to increase the municipal allocation was denied by DWAF, which instead assisted the municipality in initiating the Greater Hermanus Water Conservation Programme in November 1996. This included a water demand management component that relied on a block tariff system for water consumption, and the removal of alien vegetation carried out by the Working for Water programme.

Despite the implementation of the Water Conservation Programme, the Municipality was drawing 4 Mm^3 of water from the dam by 2006 (Overstrand 2010). From mid-2007 however, the surface water supply was supplemented by groundwater from the Gateway Wellfield. Subsequently, the Camphill and Volmoed Wellfields were established in the Hemel en Aarde Valley to augment the water supply from the De Bos Dam and the Gateway Wellfield in Hermanus. Consequently, the Municipality has not exceeded the permitted allocation of 2.8 Mm^3 since 2011 (P. Robinson, *Pers Comm*.). The reduced dependency on the dam in future raises the possibility of higher water releases from the dam for the environmental reserve. It is important to note that groundwater abstraction is not anticipated to have any impact on the baseflow of the Onrus River, as the Peninsula Aquifer is not directly connected to the river (SRK Consulting 2011). Similarly, groundwater seepage into the Onrus Lagoon will also not be affected, as this is sustained by the sandy (primary) aquifer on the coastal plain.

3.1.2 Flow patterns

The Mean Annual Runoff (MAR) reaching Onrus Lagoon has been significantly reduced by water use in the catchment, mainly for agricultural activity, and the construction of the De Bos Dam. In 1996 the Department of Water Affairs calculated that the natural MAR for the entire catchment was 14.5 Mm^3 but this had already been reduced to 8.2 Mm^3, representing a 56.6% decrease in MAR for the estuary. More recently, the present-day MAR has been estimated at 5 Mm^3 (Van Niekerk & Turpie 2012).

The annual 'compensation water' released from the dam should amount to 0.47 Mm^3 for downstream water users and additional environmental release of 1.6 Mm^3 per annum, which equates to 66 ℓ/s. However, there is no gauge measuring outflow through the outlet pipe, which can be opened or closed with a valve. In April 2013 the flow rate was crudely estimated (using a 20 ℓ bucket and stopwatch) at 8 ℓ/s, which translates to an annual release of approximately 0.25 Mm^3. It is therefore unlikely that enough water is released for the environmental reserve downstream of the dam.

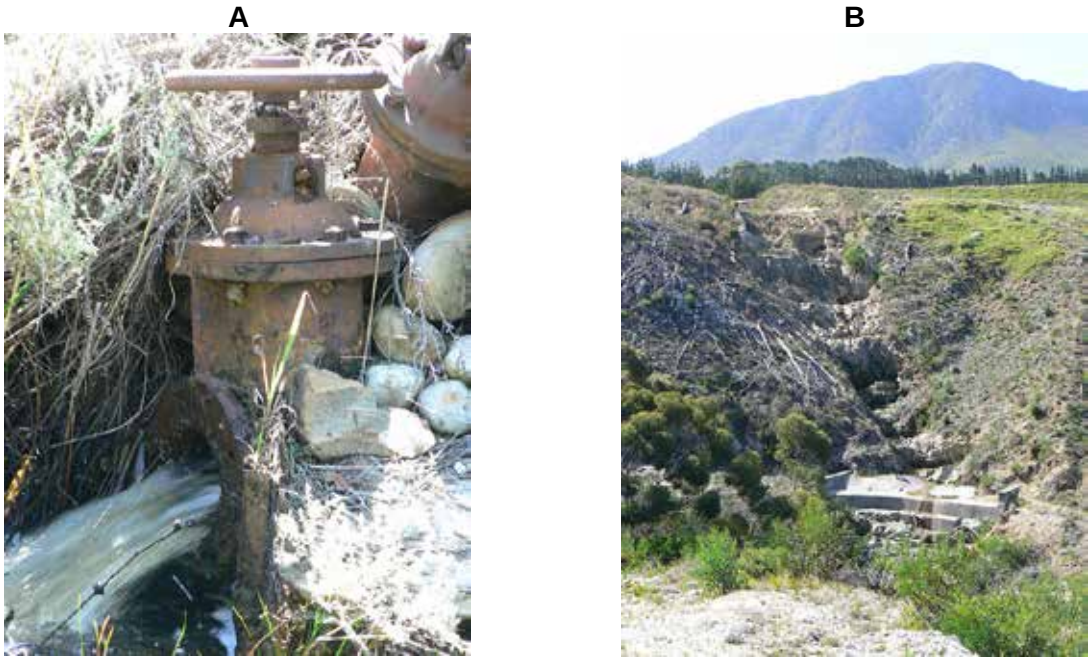

Figure 7 **(A) The outflow from the De Bos Dam into the Onrus River in March 2013, and (B) the spillway down which water flows when the dam overflows. The dam overflowed in October 2012, after reaching the 100% water level for the first time in three years.**

According to the DWAF (1996) estimates, the portion of the Onrus River catchment below the De Bos Dam contributes some 42% of the natural MAR. The Antjies River tributary and a number of small streams flow into the Onrus River below the dam, while groundwater from the sandy (primary) aquifer is also believed to help sustain water levels in the estuary. However, the dam clearly attenuates flood flows to some extent, and may thus reduce the frequency at which the sandbar (berm) separating the estuary from the sea is breached. The lower flows would likely also result in the mouth closing sooner after breaching.

An overlay of graphs depicting river flow above De Bos Dam (green line) and water level in Onrus Lagoon (blue line) for the period October 2009 - September 2010 shows how the estuary responds to rainfall events and seasonal flow in the upper catchment (Figure 8). Although this river flow is largely retained by the De Bos Dam, it can be expected that the flow pattern approximates that of streams flowing into the Onrus River below the dam. The estuary was relatively full in October, before a flood event caused the sandbar to break open. The water level dropped significantly as the estuary drained, but the mouth closed within about a week and the water level rose again to the pre-breaching level. The overflow channel then opened, which maintains the water level at approximately 1 m depth. At the end of January the overflow channel closed and the water level rose. Evaporation and seepage through the sandbar maintained the water level at about 1.45 m depth. It remained at this high level until the onset of winter rains, when higher flows in June and July re-opened the overflow channel.

Using the Mean Annual Runoff figures from the initial De Bos Dam Yield Study (Ninham Shand 1987), the CSIR (1991) estimated that the flood flow rates in the Onrus River for a 1:5, 1:20 and 1:50 year flood event were 75, 121 and 157 m^3/sec. If the extreme scenario was assumed, with the dam retaining all flow, the estimated flood flow rates from the remainder of the catchment would be 44, 71 and 94 m^3/sec. The authors concluded that the flow rates have been reduced by less than 40%. These findings would need to be re-evaluated in light of the revised estimates of natural and present-day MAR.

Overall, the hydrology of the Onrus Estuary is considered to be poor (Van Niekerk and Turpie 2012). It is recommended that management objectives take cognisance of the fact that since the construction of the De Bos Dam, flows have been reduced moderately. Although the frequency and magnitude of floods have been reduced significantly due to impoundment by the dam, it was concluded that larger floods still have the capacity to scour the estuary mouth.

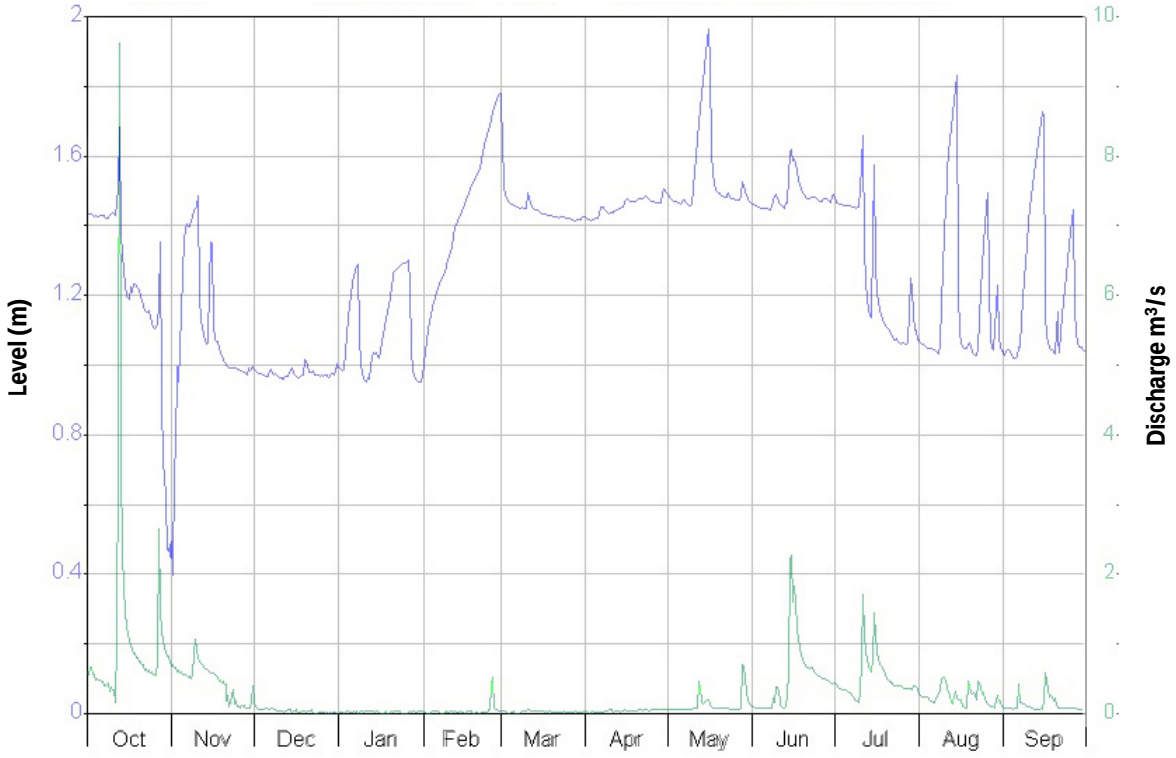

Figure 8 **The response of the Onrus Estuary water levels to rainfall events (measured in water level of the Onrus River above the De Bos Dam) for a period of once year starting in October 2009. River flow is depicted by the green line and estuary water level by the blue line (Source: Department of Water and Sanitation).**

3.1.3 Dynamic physical states of the estuary

The Onrus Estuary is one of 21 estuaries within the warm temperate biogeographic region and is classified as a temporarily open/closed (Van Niekerk and Turpie, 2012). Available information indicates that the mouth is mostly closed by a large sandbar with an average crest height of +2.8 m MSL (CSIR 1991). During the winter season following heavy rains, however, a narrow channel is formed in the western edge of the sandbar. This narrow channel serves as an overflow rather than a tidal inlet, and seawater only penetrates during high storm spring tides as evident from kelp in the lower reaches of the estuary. With the arrival of sufficiently large floods, the overflow channel scours deep enough to allow for a brief period of tidal fluctuations. The sandbar starts rebuilding on the seaward side as sand is deposited back on the beach by wave action and usually closes within ten days, reverting back to an overflow channel. The Onrus lagoon can therefore be regarded as being mainly supratidal (the sandbar is higher than the tidal reach).

Data from the Onrus Lagoon water level gauge, collected after the De Bos Dam was built, indicates that the sandbar is still regularly breached when floods are large enough. The estuary drained at least a dozen times between 1994 and 2011 (Figure 8). No breaching occurred during the 2010-2011 drought, but in October 2012 a deep channel was scoured open following a period of heavy rain that resulted in the De Bos Dam overflowing (Figure 9). The estuary breached again in April and June 2013. The estuary experienced tidal fluctuations in water level for a short period until the sandbar started rebuilding (Figure 10). The Onrus lagoon can therefore be regarded as being mainly

supratidal (the sandbar is higher than the tidal reach). During extreme storm events however, marine sediments may enter the lower part of the lagoon (Heinecken and Damstra 1983).

The De Bos Dam has attenuated flood flows to some extent and is thought to have reduced the frequency at which the sandbar (berm) separating the estuary from the sea is breached. The lower flows are likely to have resulted in the mouth closing sooner after breaching than prior to the commissioning of the dam. As a result, the state of hydrodynamics in the Onrus Estuary was rated as poor (Van Niekerk and Turpie 2012).

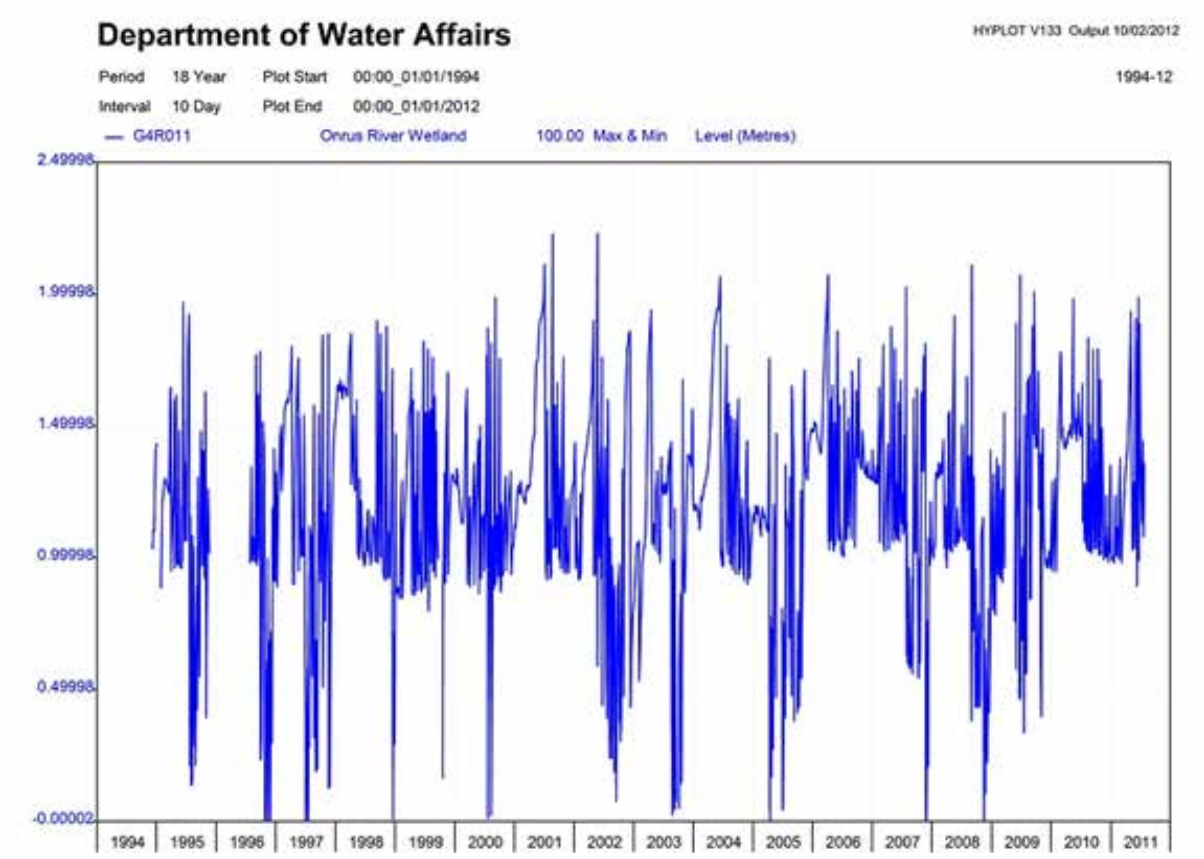

Figure 9 **Water level in the Onrus Lagoon for the period 1994-2011, indicating occasions when the estuary drained after breaching of the sandbar (Source: Onrus Lagoon water level gauge G4T011, Department of Water and Sanitation).**

Figure 10 **The estuary mouth on 23 October 2012, following the natural breaching on 19 October.**

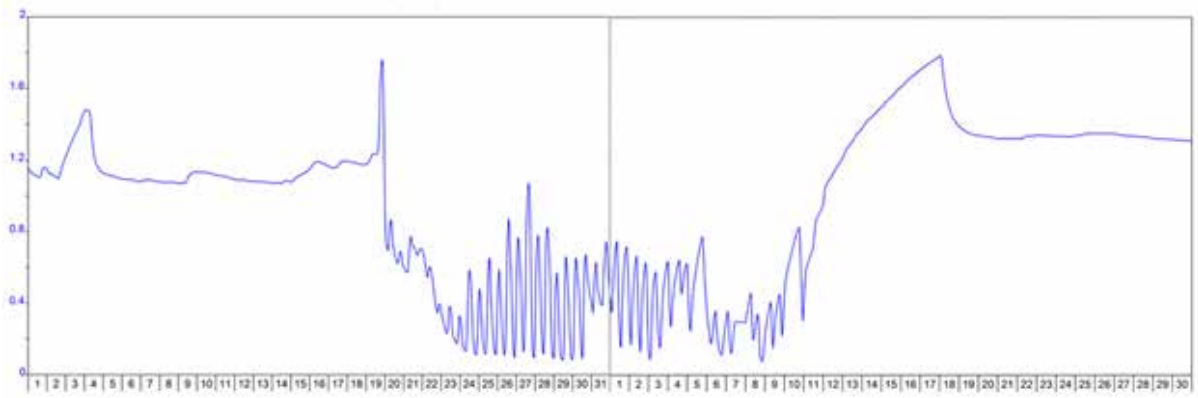

Figure 11 **Data from the Onrus Lagoon water level gauge plotted for one-hour intervals for the period 1 October to 30 November 2012. The lagoon breached naturally on 19 October2012 following heavy rainfalls. First the water level increased, then the lagoon drained, after which tidal fluctuations were evident for a short period before the mouth closed once more (Source: Department of Water and Sanitation).**

Marine sediments (coarse sand) may enter the lower part of the lagoon during extreme storm events but generally do not penetrate further than 100 m upstream of the estuary mouth (Heinecken and Damstra 1983). Beyond 100 m marine sediment is replaced by finer, catchment-derived sediment with a higher percentage of organic mud (CSIR 1991). Anecdotal information suggested that a flood following a fire in the late 1940s or early 1950s had resulted in the sudden silting-up of Onrus Lagoon, but more intensive farming activity in the catchment since that time would also have increased the sedimentation rate. Average deposition of catchment-derived sediment for the period 1940 to 1990 was approximately 1 200 m^3 per year (CSIR 1991). The de Bos Dam acts as a sediment trap and therefore most of the sediment deposits originate from the lower catchment below the dam. Over the past 20 years, agricultural development has remained relatively stable and sedimentation rates are not expected to have increased substantially in this period.

The shape of the estuary, together with the relatively low inflow and the reduction of winter spates by the De Bos Dam should result in very little scouring or flushing of accumulated sediment (Heineken & Damstra 1983). However, simulation of scenarios for flow rates under natural conditions as well as for impoundment of all inflow by the De Bos Dam indicated that flow rates for 1:5, 1:20 and 1:50 year flood events was reduced by less than 40% (CSIR 1991). It was concluded that this would have not significantly impacted on siltation or scouring of the estuary. These findings would need to be re-evaluated in light of the revised estimates of natural and present day MAR, though.

In 1991, most of the lagoon was above mean sea level (MSL) and only about 1 m deep, but there was a basin of approximately 1.5 m depth opposite 'the peninsula'. It was proposed that the estuary be dredged to restore open water in the Onrus Estuary, which had been severely invaded by the common reed *Phragmites australis*. The aim was to remove 45 000 m^3 of sediment to create channels 40-60 cm wide and 1.5 m deep to increase flow velocities during floods and hence reduce sedimentation rates (CSIR 1991). It was also anticipated that some deeper holes excavated to -2 m MSL would aid in trapping sediment (CSIR 1993).

The dredging was conducted in 1993, and succeeded in removing about 30 000 m^3 of sediment. A bathymetric survey conducted immediately after the dredging was completed indicated that the -1 m MSL level was reached in only a few areas. Subsequent surveys in 1994 following a major flood (by Department of Water and Sanitation) and in October 2002 (by Pieter Badenhorst) both revealed that very little infilling had taken place since 1993 (Figure 12). Most of the deposition had occurred in the northern channel (Badenhorst 2002).

Onrus Lagoon discharges into a small cove with a steeply sloped pocket beach on an exposed, high-energy coastline. The net annual longshore sediment transport is considered to be minimal due to the rocky coastline on both sides of the short beach (CSIR 1991). An analysis of shoreline change using a series of aerial photographs from 1938-1991 showed no apparent long-term erosion or accretion trend and was therefore identified to be in a dynamically stable state (CSIR 1991). Accretion at one end of the beach was usually accompanied by erosion at the other end, indicating that sand was moving alternatively from one end of the beach to the other, with the beach acting as a closed system. Consequently, short-term seasonal variation in shoreline position occurs, with the beach accreting in summer and eroding during winter storms (CSIR 1991). The south-easterly wind in summer may remove and deposit up to 3000 m^3 of sand per year from the beach into the estuary and a gradual accumulation of beach sand can be expected in the long term (CSIR 1991).

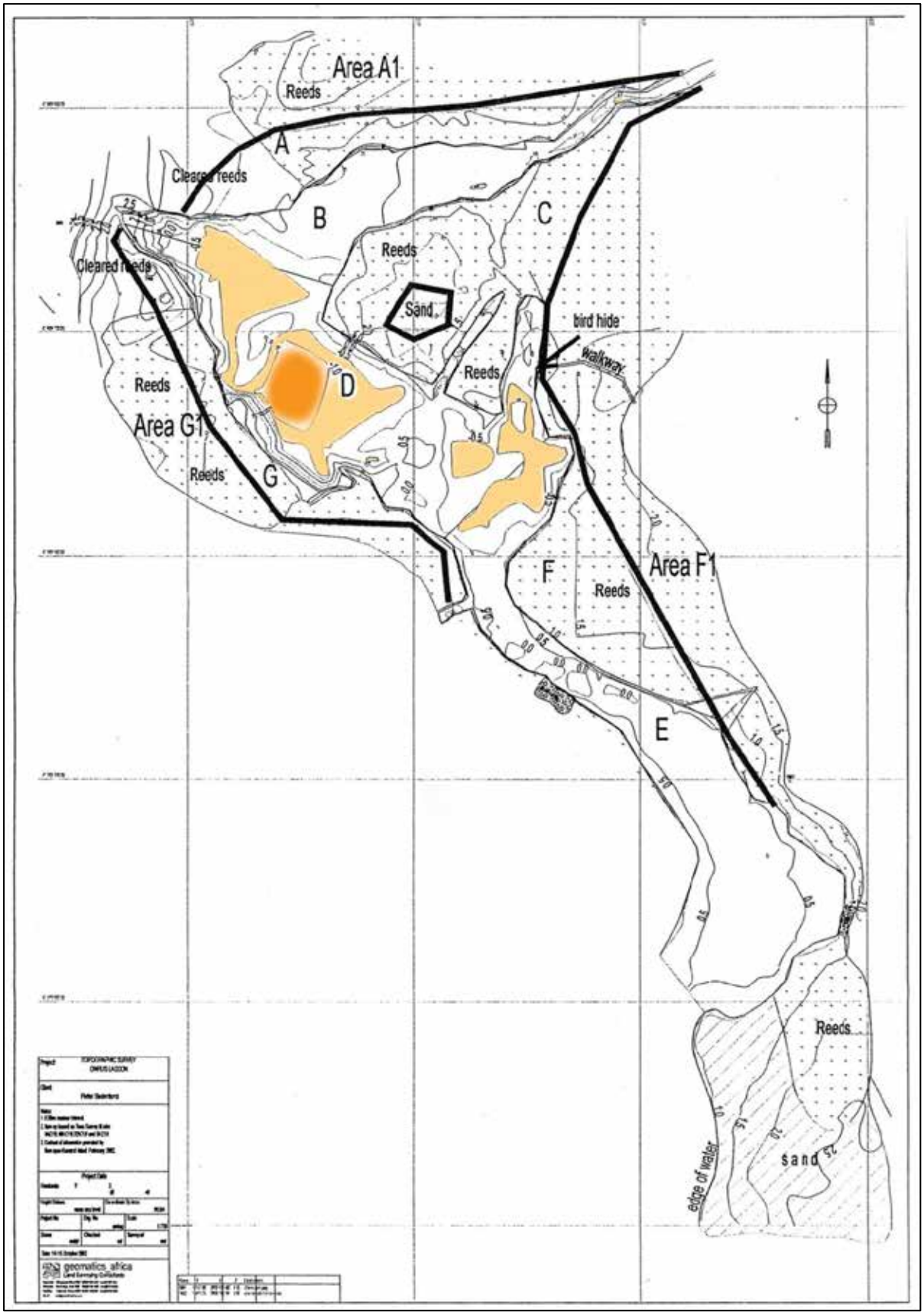

Figure 12 Bathymetry of Onrus Lagoon, according to the 2002 survey. The coloured areas are the deepest parts of the estuary, dark orange being -1 m MSL and light orange -0.5 m MSL (adapted from Badenhorst 2002).

3.2 Water Quality

Historical information suggests that the estuary has always been a freshwater-dominated system where instantaneous salinity measurements have varied from 0 to 4 ppt during the closed state (Heineken & Damstra 1983, S. Lamberth, *Pers. Comment*, Sue Matthews Overstrand Municipality 2013), rising up to 31.7 ppt when the estuary is open to the sea in 1994. Although no salinity data is available for the time prior to the commissioning of the De Bos Dam, it is unlikely that the system was significantly more saline than today. Without any significant seawater penetration into the estuary, salinity would be expected to increase slightly in summer due to evaporation and decrease with winter rainfall.

The inflowing water from the Onrus River has a relatively low pH (5.5-5.9 recorded at the R43 road bridge during the 2004-2005 River Health Programme monitoring, DWAF 2006) and a brown colour, typical of 'blackwater' rivers of the south-western Cape. In March 2013, pH in the estuary ranged from 6.5 in the river section to 7.3 in the mouth area. The dark water significantly attenuates light, limiting plant growth in deeper areas.

At the time of the 1979 survey, overall nutrient status of the estuary was reported to be low, with average concentrations as follows:

Nitrate = 29.02 µg/ℓ (range 8.26 – 79.80 µg/ℓ [0.59 – 5.70 µg ats/ℓ]),

Ammonia = 20.13 µg/ℓ (range 10.78 – 36.82 µg/ℓ [0.77 – 2.63 µg ats/ℓ])

Phosphate = 56.03 µg/ℓ (6.51 – 103.23 µg/ℓ [(0.21 – 3.33 µg ats/ℓ]).

The authors concluded that there was no evidence of eutrophication, of nutrient input from sewage or of excessive fertilisation (Heineken & Damstra 1983). More recent nutrient data is not available, but sewage spills are known to occur on occasion, and the generally high *E. coli* and *Enterococci* counts are indicative of sewage pollution. In addition, a private golf course on the north-eastern shore of Onrus Lagoon is likely increasing the nutrient load via runoff from fertilised lawns and overflow from water features. The river adjacent to the lawns had a fetid odour and high turbidity on 7 February 2013. Dissolved oxygen in this area was <45% in surface waters and <10% in bottom waters, compared to 75% and 35% respectively in the main body of the estuary. Overall, water quality in the estuary was rated as poor by Van Niekerk and Turpie (2012).

3.2.1 Sewage contamination

Sewage contamination in the Onrus Estuary has been a long-standing concern. Sewage spills have occurred on occasion, and bacterial counts (indicators for faecal contamination) are frequently high. For example in December 1999 only two pump stations were in working order and could not cope with the flows during the peak holiday season (*Pers. Comm.* Peter van Niekerk 2016). The estuary has had to be closed to swimming at times, often during the peak summer season. A monitoring study in 2007-2008 by Dr Vic Hamilton-Attwell at five sites on the Onrus River downstream of De Bos Dam showed that faecal bacteria levels were relatively low at the dam outfall and Camphill, and increased towards the estuary. Since December 2010, the Breede-Gouritz Catchment Management Agency has been testing water quality at the estuary mouth, which shows that *E. coli* and

Enterococci levels are very high with >185 and >500 organisms per 100 ml respectively, indicating that the chance of contracting gastrointestinal illness is greater than 8.5% (Table 3). In agreement with the monitoring study conducted by Dr Vic Hamilton-Attwell, the de Bos Dam has excellent water quality (in terms of bacteriological indicators) and is safe for recreational use (Table 3). Not enough data are available as yet to determine the water quality at the other four stations (ON2-5 Figure 13) as those have only been sporadically sampled since September 2015 (Refer to Appendix 2 for raw data).

Figure 13 **Aerial view of the Onrus River catchment showing six water quality sampling stations. Water quality samples for stations ON1-ON5 are collected by the Breede-Gouritz Catchment Management Agency. De Bos Dam water quality is regularly tested by the Preekstoel Water Treatment Plant. Red and green labels indicate high and low bacterial contamination respectively. Not enough data was available for the stations labelled in yellow.**

Table 3 **Receiving water quality guidelines for recreational use showing compliance level of the Onrus River at the Estuary Mouth (ON1 and ON1b) and at the De Bos Dam (RSA DEA, 2012)).**

Category	Estimated Risk Exposure	Enterococci (Count/100 ml)	E. coli (Count/100 ml)	ON1 – Mouth		ON1b – Lagoon from beach		ON – De Bos Dam
(Count per 100 ml)				*Enterococci*	*E.coli*	*Enterococci*	*E.coli*	*E.coli*
Excellent	2.9% gastrointestinal (GI) illness risk	≤ 100 (95 percentile)	≤ 250 (95 percentile)					16
Good	5% GI illness risk	≤ 200 (95 percentile)	≤ 500 (95 percentile)					
Sufficient or fair (minimum requirement)	8.5% GI illness risk	≤ 185 (90 percentile)	≤ 500 (90 percentile)					
Poor (unacceptable)	>8.5% GI illness risk	> 185 (90 percentile)	> 500 (90 percentile)	743	1510	1124	1828	

3.2.1.1 Sewerage line

A pipeline was constructed in 1996 to convey sewage from Kidbrooke Place, as well as any future development adjacent to the line, to the pump station on the northern shore of the Onrus Lagoon (Figure 14). This sewer line is located within the riparian zone, as well as the active channel of the river in places. Sewage spills from this pipeline consequently affect the lower reaches of the Onrus River and includes the zone of transition into the Onrus Estuary. V3 Consulting Engineers were contracted in 2000 to investigate the problem and found that the pipeline was in poor condition, with several dips, bends and holes, as well as root ingress and leaks. It was emphasised that parts of the pipeline did not comply with the requirements of the Guidelines for Human Settlement Planning and Design. As a result of these findings, a 280 m section of sewage line between the manholes on the western side of Mr Haumann's property (the first house below the R43 bridge) and the eastern side of Bosplasie was replaced in 2002. Continued reports of sewage contamination and generally high bacterial counts in the Onrus Lagoon, however, demonstrated that more needed to be done to fix this problem. A further investigation in 2010 by Trenchless Technology Specialists revealed more cracks, root ingress and grease deposits in another stretch of the pipeline. The Overstrand Municipality therefore established a task team in 2011 to investigate pollution sources and to identify appropriate remedial action for the entire system. For this purpose, Lyners Consulting Engineers were appointed in September 2012 to further investigate the sewerage line and subcontracted Jetvac to clean selected stretches of the sewage pipeline.

The report, submitted in April 2013, confirmed that the gradients of the pipeline were too flat in three sections of 160 mm diameter pipe totalling 134.8 m and two sections of 200 mm diameter pipe totalling 91.4 m. Together, this represented 14% of the pipeline's total length. Poor construction and the pipe's location in the riverbed have resulted in settling of sections and high ingress of water. Large quantities of fatty deposits, grit, sand and roots were removed during the cleaning process.

A 275 m section of the line could not be inspected or cleaned as some manholes could not be located. The consultants recommended that, in the short term, the pipe be surveyed and the manholes located, that defects, holes and fractures be repaired, and that two manholes and a rodding eye in the riverbed should be raised to reduce infiltration during high river flows. They also recommended that new, enlarged fat traps be installed at the Kidbrooke Place restaurant, while grit trap manholes could be constructed along the pipeline. Both would need to be regularly inspected and cleaned. In addition, a 117 m section of pipeline should be reconstructed or replaced to correct the unacceptable gradients. The entire sewer should be lined to prevent ingress of roots, but only if it is unlikely that the long-term recommendation will be implemented within the next few years. Lining would cost approximately R1 million, while the total cost of implementing all the short-term recommendations was estimated at R1.75 million. The long-term solution entails the replacement of the existing damaged pipeline and would cost approximately R2.56 million. Following the above recommendations, Guillaume Nel Environmental Consultants (GNEC) were appointed by the OLM to facilitate the Basic Assessment Report (BAR) procedure for the proposed upgrade of the existing sewer pipeline in Kidbrooke, Onrus River.

Environmental Authorisation was granted on 5 April 2016 for the upgrade the damaged and degraded existing sewer pipeline adjacent to the Onrus River below Bosplasie Crescent in the upper reaches of the Onrus Estuary (Reference: 16/3/1/E2/26/2091/14). This section of the pipeline will

be installed within the existing sewer pipeline via pipe cracking. The proposed pipe will follow the existing pipe for approximately 470 metres within the riparian area of the Onrus River and active river channel. This section will be rehabilitated in accordance with the Rehabilitation Plan and River Maintenance Management Plan (MacKenzie 2015). The replacement of this sewer lines also involves the construction of two new pump stations and two rising main sewer lines.

3.2.1.2 Sewage tanks

Houses in the vicinity of Onrus Lagoon were originally built with septic or conservancy tanks, but since the 1990s all but a few have been linked up to a small-bore sewage system. With this type of sanitation technology, the sewage sludge remains in the tank and needs to be pumped out periodically, while the liquid effluent that would normally flow into a soakaway is piped to the Hermanus wastewater treatment works. However, many of the tanks may be leaking, as most would be concrete or brick structures that are prone to cracking and crumbling with age. By contaminating groundwater in the primary aquifer, leaking tanks have the potential to pollute the estuary, particularly during rain events.

Although smaller developments and farm settlements typically rely on septic tanks with soakaways, the Camphill Farm and School complex approximately 4 km upstream from the mouth has its own sewage treatment facility comprising an aerator, settling tanks, sand filter and wetland, with discharge of the final effluent to the Onrus River.

During 2012 the Overstrand Municipality awarded a tender for an inspection programme of household sewage tanks in the vicinity of Onrus Lagoon. The successful bidder subsequently withdrew from the contract, and the tender had not been re-advertised.

Figure 14 Municipal sewage reticulation infrastructure in the vicinity of the Onrus Lagoon.

3.2.1.3 Sewage pump station

Sewage in the Onrus area is gravity fed to pump stations, from where it is pumped to the Hermanus wastewater treatment works. The main pump station, which receives sewage from the satellite pump stations along the seafront, is on the northern shore of the estuary. Sewage spills from the pump station have polluted the estuary in the past, as the emergency overflow is discharged through an underground pipe into the waterbody. However, a standby generator, telemetry system and daily inspections now ensure more consistent operation.

An investigative report written by V3 Consulting Engineers in May 2001 notes that the pump station, which was constructed in 1996, was designed for a total of eight submersible pumps with a future capacity of 180 ℓ/s. At that time, only two pumps were operating simultaneously, with a combined capacity of approximately 85 ℓ/s. The underground concrete sump has a capacity of 22 m^3, but there is no emergency storage capacity. Emergency storage capacity in the design of a pump station in an environmentally sensitive area is standard procedure and they recommended that underground emergency overflow tanks with a capacity of 1000 m^3 should be constructed next to the pump station to accommodate shorter operational interruptions. This, they suggested, would provide sufficient storage capacity to accommodate the 2000-2001 peak flow experienced during holiday seasons and rain storms for approximately 3.75 hours (reduced to 1.8 hours once the entire drainage area served by the pump station was developed). During off-peak flows, the storage capacity would allow for considerably more time for maintenance teams to address problems at the pump station.

The estimated cost to install these underground emergency overflow tanks was R1.45 million excluding VAT at 2001 prices, but the recommendation has never been implemented. Municipal officials have indicated that the telemetry system allows for the rapid deployment of 'honeysucker' sewage tankers at the pump station in the event of a malfunction. However, the report by V3 Consulting Engineers noted that the tankers would need to remove 270 m^3 of sewage per hour based on 2000-2001 peak flows, which would be an unrealistic undertaking.

Installation of emergency storage would be in line with the Guidelines for Human Settlement Planning and Design. The minimum emergency storage capacity should represent a capacity equivalent to four hours flow at the average flow rate, over and above the capacity available in the sump at normal top-water level (i.e. the level at which the duty pump cuts in). The Overstrand Municipality's Water Services Development Plan for 2012/2013 reflects that the Sewer Master Plan dated January 2011 recommends that the pump station be upgraded to a capacity of 120 ℓ/s, at an estimated cost of R0.5 million.

3.2.2 Stormwater and upstream pollution sources

There are a number of stormwater pipes discharging into the river and estuary, providing an additional source of faecal contamination in polluted runoff, particularly with the first rains after a dry period. Environmental authorisation has been obtained for the expansion of the Onrus Main Road stormwater system discharging into the river. This is projected to include polishing facilities in the form of landscaped ponds. In addition, a new, high-density development is planned close to the river course, which may increase the stormwater load. The land, known as the Sandbaai Common, was sold by the Overstrand Municipality in 2012 to finance capital projects. The development will include a retirement village, town houses and freehold homes, and a commercial area and business node close to Curro School (Hermanus Times 2012). Runoff from farmlands may also contribute to faecal contamination of the river.

3.3 Vegetation

3.3.1 Algae and aquatic vegetation

No information on typical micro-algal assemblages or chlorophyll concentrations is available for the Onrus Estuary. However, analysis of the dense detritus from an algal bloom collected from the shallows in June 2012 revealed a mixed assemblage of diatoms, with four species of blue-green algae present.

The filamentous algae *Cladophora* occasionally blooms in the system, forming dense floating mats. These mats constitute an unsightly sludge when they become stranded on the shoreline, and generate foul odours as they decompose. Furthermore, the stonewort algae *Chara* occurs with the fennel-leaved or sago pondweed *Potamogeton pectinatus* in the bottom mud of the upper parts of the estuary (Heineken & Damstra 1983), where water depths are sufficiently shallow for these rooted plants. These two species are the dominant macrophytes in the system and provide valuable sites for the attachment of aquatic fauna, while also providing food for Red-knobbed Coot.

The red water fern *Azolla filiculoides*, a floating alien invasive weed from South America, occasionally occurs in patches amongst the reeds, but tends to die back without the need for intervention. The indigenous blue water lily *Nymphaea nouchali* was recorded on the estuary in summer 2011. Small quantities of kelp get washed over the berm into the estuary during high seas, and rot in the shallows.

Based on the little information that is available at this point in time, the state of microalgae and macrophytes were rated as poor by the NBA 2011 (Van Niekerk and Turpie 2012).

3.3.2 Riparian Vegetation

The estuary is characterised by low gradients and extensive reed beds (*Phragmites australis*). The north western bank is dominated by alien vegetation or is contained within private residential gardens where riparian vegetation has been largely cleared or altered on the estuary banks. The south eastern bank does not have residential gardens and alien vegetation has been cleared recently (section 5.8.1.2) (MacKenzie 2015).

Reeds and sedges act as natural biological filters, they are important for bank stabilisation as they are rooted in soft intertidal or shallow subtidal strata (Adams *et al.*, 1999). Reeds and sedges contribute to the diversity of aquatic life, particularly the avifauna (Coetzee *et al.*, 1997). The common reed or fluitjiesriet *Phragmites australis* grows in dense stands on the margins of the estuary. Rapid encroachment by the reed from the 1950s resulted in an almost complete reduction in open-water area by 1993, when the estuary was dredged. Based on aerial photographs and satellite images, reedbeds have not expanded significantly since the dredging. Encroachment by *Phragmites* reeds is nevertheless an issue of public concern, and is covered in more detail in Section 5.8.1.1.

The 1980 survey recorded *Schoenoplectus triqueter* growing amongst the *Phragmites* reeds in shallow water, and *Juncus, Stenotaphrum secundatim* and *Ficinia nodosa* on the landward edge of the *Phragmites* beds. *Scirpus littoralis* had colonised an island that had suddenly developed near the head of the estuary, after which its rhizomes had extended northwards, completely closing the eastern channel. The bulrush *Typha capensis* also occurred in dense stands in localised areas (Heineken & Damstra 1983).

Following clearing operations over the past decade, *Scirpus littoralis* has formed a monospecific stand to the west of the canoe-launching area on the common, while *Phragmites* occupied the eastern side. However, the *Phragmites* stand was cut by local residents in early 2012, and arum lilies were then planted on the semi-solid marsh of reed rhizomes and old material that remained. By early 2013, a young stand of *Typha* had developed to the immediate east of the canoe-launching area, while the other half of the cleared area had been carpeted by the spiderwort *Commelina sp.* This had effectively repressed *Phragmites* regrowth.

Indigenous reeds that have a reputation of becoming problematic, including the common reed and bulrush, play very important ecological roles in estuarine and riparian habitats that should not be overlooked. These species stabilise and protect banks from erosion, and provide shade, important habitat in the form of cover as well as nesting sites, and act as extremely important nutrient sinks.

3.3.3 Terrestrial vegetation

The estuary would historically have been surrounded by Overberg Sandstone Fynbos, apart from Overberg Dune Strandveld on the western and eastern shores. These vegetation types have been completely transformed by residential development on the northern and western shores, but white milkwoods still occur between and in front of the houses. On the eastern bank, land donated to WWF (then Southern African Nature Foundation) in the early 1990s and demarcated a bird sanctuary still has a rich plant community with species representative of Overberg Dune Strandveld. The sanctuary was previously cleared of invasive vegetation by the Onrus Lagoon Trust and municipality, but follow-up work has not taken place for some time (section 5.8.1.2). This area is fenced off from the adjoining Habonim property, which is heavily infested with invasive alien acacias.

In the upper reaches of the estuary, the northern shoreline has been infilled with dredge spoil and builder's rubble to extend private golf chipping greens to the water's edge. Adjacent to this is a small grove of eucalypts, which also grow along the watercourse further upstream.

3.4 Fauna

3.4.1 Invertebrates

Invertebrates inhabiting estuaries can 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 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). No information is available on zooplankton and only limited information on some benthic and hyperbenthic species is available for the Onrus Estuary that was collected in the 1980s (Heineken & Damstra 1983). Based on the information available, the health condition of invertebrates in the Onrus Estuary was rated as fair (Van Niekerk and Turpie, 2012).

The 1979-1980 survey noted that the seaward end of Onrus Lagoon was inhabited by sandprawn *Callichirus kraussi* in the shallower water. Crown crabs *Hymenosoma orbiculare* were also caught in the seine net in slightly deeper water (Heineken & Damstra 1983). While the latter species has been recorded at salinities as low as 1 ppt in estuaries and even in the fresh water Lake Sibaya, *C. kraussi* cannot successfully breed in salinities below 17 ppt. Extended periods without saltwater intrusion will ultimately lead to local extinction of the species. The earlier surveys were conducted only three years after construction of the De Bos Dam. No prawn holes can be found in the lower reaches of the estuary today.

In the early surveys, the estuarine amphipod *Corophium triaenonyx* was also found near the mouth, together with the estuarine polychaete *Ceratonereis keiskamma*, the tanaeid crustacean *Tanais philetaerus* and various species of chironomid (midge) larvae.

In the upper part of the estuary, *C. triaenonyx* and *T. philetaerus* were found in low numbers in the muddy substrate, with *C. keiskamma*, the amphipod *Melita zeylanica*, the isopods *Pseudosphaeroma barnardi* and *Cirolana africana*, *corixids* (water boatmen) and *chironomid* larvae also present. Numerous mussels *Musculus virgiliae* were attached to submerged rocks and branches. The aquatic plants *Chara* and *Potamogeton* also provided an attachment area for small invertebrates.

The anoxic mud of the blind channel was found to be inhabited by *chironomid* larvae as well as low numbers of *C. keiskamma* and *C. triaenonyx*. The reed beds supported fewer estuarine fauna than the rest of Onrus Lagoon, but numerous chironomid larvae, *C. triaenonyx*, and the detritus-eating *M. zeylanica* and *P. barnardi* inhabited the reed bed detritus. Aquatic insects, especially whirligigs (Gyrinidae), were living among the submerged, decaying leaves, and spiders were found amongst the stalks (Heineken & Damstra 1983).

3.4.2 Amphibians and reptiles

Eighteen amphibian species have been identified that have either been recorded or are likely to occur in the area extending from Kleinmond to Hermanus and 6-12 km inland (A de Villiers, cited by Heineken & Damstra 1983). However, this area covers a diverse range of habitats and only some of

these species are likely to occur in the vicinity of Onrus Lagoon. Consequently, only eight of these species have been recorded in the area and are listed in Table 4. The earlier survey recorded two species of frog caught in a seine net, including the Cape river frog *Amietia fuscigula* and the western leopard toad *Amietophrynus pantherinus* (Heineken & Damstra 1983). Unfortunately, the western leopard toad may no longer occur in the Onrus area. According to the most recent IUCN Red List assessment (Measey 2011), it is Endangered ('considered to be facing a very high risk of extinction in the wild'), and its known distribution is limited to the Cape Peninsula and the Hermanus (Eastcliff) to Quoin Point area. Of the other species likely to occur in the area, the arum lily frog *Hyperolius horstockii* is considered to be of 'Least Concern' as it is relatively abundant within its range and can tolerate disturbance.

In total, three tortoise species, 21 snake species and 16 lizard species have been identified that have either been recorded or are likely to occur in the area extending from Kleinmond to Hermanus and 6-12 km inland (A de Villiers, cited by Heineken & Damstra 1983). No records of reptile species occurring in the vicinity of the Onrus Estuary are, however, available. This area covers a diverse range of habitats and only some of these species are likely to occur in the vicinity of Onrus Lagoon. Consequently, only four of these 40 species have been recorded in the area and are listed in Table 5.

Table 4 **Frog species for the area recorded by the 1:50 000 Sheet 3419 AC Hermanus (A de Villiers, in litt.). This area extends from Kleinmond to Hermanus and 6-12 km inland. Only species that have been recorded in the area or in the Onrus Estuary are listed here.**

Common name	Scientific name	Status (L=likely to occur, X=recorded, O=recorded in Onrus Lagoon)
Cape platanna	*Xenopus gilli*	X
Raucous toad	*Amietophrynus rangeri*	X
Leopard toad	*Amietophrynus pantherinus*	X, O
Cape river frog /Cape rana	*Amietia fuscigula*	L, O
Spotted rana	*Strongylopus grayii*	X
Cape grass frog	*Rana Montana*	X
Micro frog	*Microbatrachella capensis*	X
Arum frog	*Hyperolius horsockii*	X

Table 5 **Reptile species for the area recorded by the 1:50 000 Sheet 3419 AC Hermanus (A de Villiers, in litt.). This area extends from Kleinmond to Hermanus and 6-12 km inland. Only species that have been recorded in the area are listed here.**

	Common name	Species name
Tortoises	Angulate tortoise	*Chersina angulata*
	Padloper tortoise	*Homopus areolatus*
Snakes	Southern slug-eater	*Duberria lutrix*
	Spotted skaapstecker	*Psammophis notostictus*
Lizards	None	None

3.4.3 Fish

Estuaries provide an extremely important habitat for fish in southern Africa. The vast majority of coastal habitat in southern Africa is directly exposed to the open ocean, and as such is subject to intensive wave action throughout the year (Field and Griffiths, 1991). Estuaries in southern Africa are thus disproportionately important relative to other parts of the world, in that they constitute the bulk of the sheltered, shallow water inshore habitat in the region. Juveniles of many marine fish species in southern Africa have adapted to take advantage of this situation, and have developed the necessary adaptations to enable them to persist in estuaries for at least part of their life cycles. There are at least 100 species that show a clear association with estuaries in South Africa (Whitfield, 1998). Most of these are marine species that enter estuaries as juveniles, remain there for a year or more before returning to the marine environment as adults or sub-adults where they spawn, completing the cycles. Several other species also use estuaries in southern Africa, including some that are able to complete their entire life cycles in these systems, and a range of salt tolerant freshwater species and euryhaline marine species. Whitfield (1994) has developed a detailed classification system of estuary associated fishes in southern Africa. He recognized five major categories of estuary associated fish species and several subcategories (Table 6). Fish species in Categories I, II, and V as defined by Whitfield (1994) are all wholly or largely dependent on estuaries for their survival and are hence the most important from an estuary conservation perspective. These species need to receive most attention from a management perspective.

Table 6 Classification of South African fish fauna according to their dependence on estuaries (Whitfield, 1994)

Category	Description
I	Truly estuarine species, which breed in southern African estuaries; subdivided as follows:
Ia	Resident species which have not been recorded breeding in the freshwater or marine environment
Ib	Resident species which have marine or freshwater breeding populations
II	Euryhaline marine species which usually breed at sea with the juveniles showing varying degrees of dependence on southern African estuaries; subdivided as follows:
IIa	Juveniles dependant of estuaries as nursery areas
IIb	Juveniles occur mainly in estuaries, but are also found at sea
IIc	Juveniles occur in estuaries but are more abundant at sea
III	Marine species which occur in estuaries in small numbers but are not dependant on these systems
IV	Euryhaline freshwater species that can penetrate estuaries depending on salinity tolerance. Includes some species which may breed in both freshwater and estuarine systems

Table 7 **Fish species list for the Onrus Estuary (Sources: Harrison 1999, Heinecken and Damstra 1983, Turpie and Clark 2007).**

Category	Common name	Scientific name	Source
Ib	Silverside	*Atherina breviceps*	Turpie & Clark 2007
IV	Cape galaxias	*Galaxias zebratus*	Heinecken & Damstra 1983
Ia	Gilchrist's round herring	*Gilchristella aestuaria*	Harrison 1999; Heinecken & Damstra 1983; Turpie & Clark 2007
IIc	Southern mullet	*Liza richardsonii*	Harrison 1999; Heinecken & Damstra 1983; Turpie & Clark 2007
IIa	Flathead mullet	*Mugil cephalus*	Harrison 1999; Turpie & Clark 2007
Vb	Freshwater mullet	*Myxus capensis*	Harrison 1999; Turpie & Clark 2007
Ib	Knysna sandgobi	*Psammagobius knysnaensis*	Harrison 1999; Heinecken & Damstra 1983; Turpie & Clark 2007
IIc	White stumpnose	*Rhabdosargus globiceps*	Turpie & Clark 2007
IIa	Cape stumpnose	*Rhabdosargus holubi*	Heinecken & Damstra 1983
Freshwater	Cape kurper	*Sandelia capensis*	Heinecken & Damstra 1983
IV	Mozambique tilapia	*Oreochromis mossambicus*	Turpie & Clark 2007

Very limited data is available for the Onrus Estuary and includes data collected during the ECRU survey (Heineken & Damstra 1983), by Harrison (1999) in 1994 (as part of a project where data was collected for 67% of South Africa's estuaries) and by Turpie & Clark (2007) for a project where South Africa's estuaries were ranked based on conservation importance. In total, 12 species have been identified in the Onrus Estuary to date (Table 7). Of these 11 species, Gilchrist's round herring *Gilchristella aestuaria*, Knysna sand goby *Psammagobius knysnaensis* and Silverside *Atherina breviceps* live in estuaries, while southern mullet *Liza richardsonii*, flathead mullet *Mugil cephalus* and Cape stumpnose *Rhabdosargus holubi* are estuarine-dependent marine species. Juvenile white stumpnose *Rhabdosargus globiceps* occur in estuaries but are generally more common at sea. The freshwater mullet *Myxus capensis* in contrast breeds at sea, but uses estuaries as nursery areas and spends much of its adult life in rivers (catadromy). Both Cape galaxias *Galaxias zebratus* and Mozambique tilapia *Oreochromis mossambicus* are euryhaline freshwater fish, although the latter has expanded its range, being native to the more tropical waters of Kwa-Zulu Natal and Eastern Cape. The freshwater fish Cape kurper *Sandelia capensis* was only recorded in 1980.

In September 1994, the estuary mouth was open and salinity 200 m upstream of the mouth measured 31.7 ppt (Harrison 1999). Concurrently, the estuary had just been dredged and was likely to be a highly disturbed at the time. In these conditions, the estuary was dominated by mullet, where *L. richardsonii* and *M. cephalus* represented 96% of four seine hauls with 90% and 6% respectively. Interestingly, *M. cephalus* contributed the same biomass as *L. richardsonii*, together making up 91% of the total biomass caught. In comparison, *G. aestuaria* and *P. knysnaensis* were very scarce (Figure 15). The range of size classes of *M. cephalus* and *L. richardsonii* represented during this survey suggests regular recruitment of these species, indicating that the system was being utilised as a juvenile nursery area. The majority of specimens of *P. knysnaensis* were almost

fully grown, which indicates that the Onrus also serves a viable habitat for resident estuarine species.

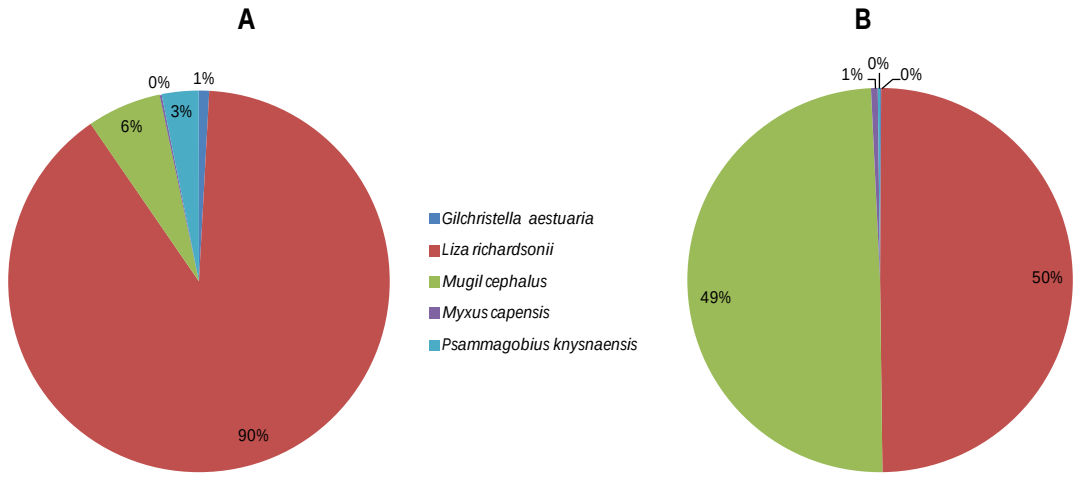

Figure 15 **Fish species composition of the Onrus Estuary in September 1994 during open mouth conditions. Figure A and B show relative abundance and biomass, respectively (Data source: Harrison 1999).**

Turpie & Clark (2007) sampled the Onrus Estuary in March 2006, most likely during closed mouth conditions and 13 years after the estuary was dredged for the purpose of combating reed encroachment. Consequently, the estuary had much greater open water area and the habitat would have had a chance to recover since 1993. In total, eight species were caught in four seine hauls (Figure 16). It is evident that compared to dredged and open mouth conditions in 1994, the species composition was dominated by estuarine resident species including *G. aestuaria* and *P. knysnaensis* making up 69% of the total abundance. *L. richardsonii* was also very abundant with 29% and represented 73% of the total biomass recorded. Catadromous *M. capensis* and freshwater fish *O. mossambicus* were not very abundant but represented 4% of the total biomass, which is much higher than in 1994.

Although not yet recorded, the alien invasive sharptooth catfish (barbel) *Clarias gariepinus*, carp *Cyprinus carpio* and largemouth bass *Micropterus salmoides* may occur in the Onrus Estuary (S. Lamberth, pers. comm.).

The mouth of the Onrus is predominantly closed, but usually breaks open for short periods after heavy rainfall several times during the year (Heinecken & Damstra, 1983). A narrow channel that mostly functions as an overflow from the estuary can scour deeper, resulting in brief periods of tidal influence before it closes again (section 3.1.3). More often than not, the seawater only enters the estuary via the overflow at spring tides and is washed out again by the river flow. When the mouth is closed, seawater may enter the lagoon when waves break over the sand bar particularly during storm conditions (Heinecken & Damstra, 1983). The fish composition described above demonstrates that even with limited interaction between the sea and the estuary, the Onrus Estuary does seem to play a role in recruitment of larval and juvenile marine fish. It is possible that the removal of large areas of the common reed *Phragmites australis* in 1993/1994 has improved nursery function of the Onrus Estuary (Harrison 1999).

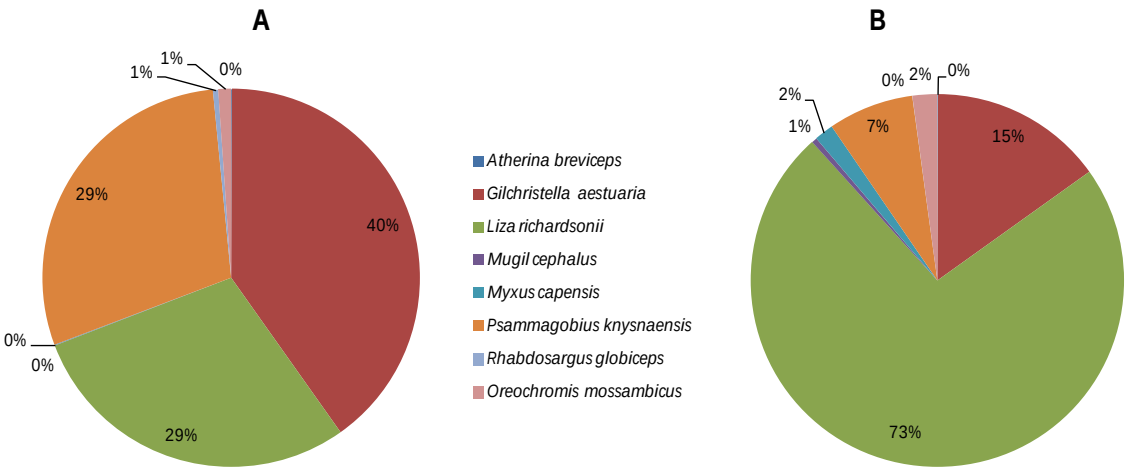

Figure 16 **Fish species composition (based on abundance) of the Onrus Estuary in March 2006 during suspected closed mouth conditions (Data source: Turpie & Clark 2007).**

3.4.4 Birds

The Onrus Estuary is classified as a small, black water, sandy estuary, where very few bird species would be expected to occur (Turpie and Clark, 2007). Due to the lack of tidal influence, the estuary is also not particularly important for wader species. The NBA 2011 rated the birdlife health condition in the Onrus Estuary as fair (Van Niekerk and Turpie, 2012), which is likely explained by the reduced flow rates resulting in a predominantly closed estuary mouth as well as poor water quality due to the sewage and stormwater entering the lagoon regularly (section 3.2).

Nevertheless, a total of 143 bird species have been recorded over the last two decades (Appendix A) of which 81 are considered water associated species. Sixty five water associated bird species are resident to South Africa, thirteen are migratory, and two are exotic species (Mallard and its hybrids). One rare vagrant, the little purple heron, was recorded in the estuary quite some time back.

The birds of the Onrus Estuary can be divided into 12 taxonomic orders (Table 8) the most species-rich being the Charadriiformes (waders, gulls and terns) and Passeriformes (warblers, wagtails, bishops, canaries, weavers etc.). Although bird abundance data is not available for the Onrus Estuary, several species have been identified as abundant or common in the estuary. For example, in 1980, the Hartlaub's Gull and Cape Weaver were listed as abundant, while Common sandpiper, Red-knobbed coot were identified as common (among others) (Heineken & Damstra 1983) (Refer to Appendix A for a complete species list).

The Onrus Estuary is home to species that are fairly difficult to find in many parts of the Overberg and that 'twitchers' come here to find include Little Bittern, Purple Heron, Black-crowned Night-Heron and African purple swamphen and Southern tchagra. Large numbers of Barn Swallows roost in the reedbeds in summer, while the many eucalyptus trees and other exotics along the Onrus River are used for breeding by a variety of raptors that include African Goshawk, African Harrier-Hawk, Black sparrowhawk and Little sparrowhawk. The presence of invasive alien Mallards on the estuary is a concern as they are breeding with Yellow-billed Ducks (Odendaal 2016). Such hybridisation is a

threat to biodiversity as it compromises the genetic integrity of indigenous species. A homeowner on the shore of the estuary also keeps domestic white ducks, which are often seen on the water.

Table 8 **Taxonomic composition of birds recorded in the Onrus Estuary (excluding rare vagrants) (Source: Damstra, 1980; Mike Ford & Lee Burman, 2013: Underhill & Cooper 1983).**

Common groupings	Order	Resident	Migrant	Exotic	Rare Vagrant
Birds of prey	Accipitriformes	2			
Cormorants, Darters, pelicans	Pelecaniformes	4			
Gulls	Charadriiformes	2			
Kingfishers	Alcediniformes	4			
Swallows, Swifts, Martins, Saw-wings	Apodiformes	3	1		
	Passeriformes	3	5		
Terns	Charadriiformes	1	1		
Waders	Charadriiformes	9	5		
Wading birds	Ciconiiformes	9			1
	Pelecaniformes	3			
	Phoenicopteriformes	1			
Wagtail, Longclaw	Passeriformes	3			
Warblers	Passeriformes	2	1		
Waterfowl	Anseriformes	9		2	
	Gruiformes	5			
	Podicipediformes	1			
Weavers, bishops, waxbills	Passeriformes	4			
Total		**65**	**13**	**2**	

3.4.5 Mammals

Documented information on mammals in the vicinity of the estuary could not be found, but a variety of rodents, including the vlei rat *Otomys irroratus* and the dune mole rat *Bathyergus suillus* are likely to be found. Mongooses and genets are probably present in the area, and insectivorous bats can be seen feeding over the water in the evening. A family of Cape clawless otters *Aonyx capensis* is believed to be living in the estuary.

4 ECOSYSTEM SERVICES

4.1 What are ecosystem goods and services?

Ecosystems can be viewed as natural capital which contributes to economic production. They provide goods, services and attributes, collectively known as ecosystem services that contribute to human welfare (Barbier, 1994):

- Goods are harvested resources, such as fish.
- Services are processes that contribute to economic production or save costs, such as water purification.
- Attributes relate to the structure and organisation of biodiversity, such as beauty, rarity or diversity, and generate less tangible values such as spiritual, educational, cultural and recreational value.

The Millennium Ecosystem Assessment (2003) recently re-categorized the services obtained from ecosystems as follows:

- Provisioning services such as food and water;
- Regulating services such as flood and disease control;
- Cultural services such as spiritual, recreational, and cultural benefits; and
- Supporting services, such as nutrient cycling, which maintain the conditions for life on earth.

The first three align well with the definitions of goods, services and attributes described above, while the fourth underlies these and need only be considered inasmuch as changes in these affect the values of the first three (Turpie, 2007).

4.2 Goods and services provided by the Onrus Estuary

The main types of ecosystem services that are associated with temperate South African estuaries are listed in Table 9. In comparison to what is likely to be expected, the estuary's ecosystem goods and services provided by the Onrus Estuary is dealt with in more detail below.

Table 9 **Ecosystem goods, services and attributes based on definitions by (Constanza *et al.*, 1997) that are likely to be provided by temperate South African estuaries (Turpie, 2007)**

	Ecosystem Goods, Services & Attributes	Description	Importance in Estuaries
Goods	Food, medicines	Production of fish and food plants; medicinal plants	High
	Raw materials	Production of craftwork materials, construction materials and fodder	Medium
Services	Gas regulation	Carbon sequestration, oxygen and ozone production,	Low
	Climate regulation	Urban heat amelioration, wind generation	Low
	Erosion control and sediment retention	Prevention of soil loss by vegetation cover, and capture of soil in wetlands, added agricultural (crop and grazing) output in wetlands/floodplains	Low
	Waste treatment	Breaking down of waste, detoxifying pollution; dilution and transport of pollutants	Medium
	Refugia	Critical habitat for migratory fish and birds, important habitats for species	High
	Nursery areas	Critical breeding habitat, Nurseries for marine fish	High
	Export of materials and nutrients	Export of nutrients and sediments to marine ecosystems	High
Attributes	Genetic resources	Medicine, products for materials science, genes for resistance to plant pathogens and crop pests, ornamental species	Low
	Structure and composition	Species diversity and habitats providing opportunities for recreational and cultural activities	High

4.3 Provisioning services

Onrus Lagoon is not an important site for subsistence or recreational fishing. The waterbody is very small and relatively shallow, so it is unlikely to support many large fish, and perceptions of pollution probably discourage fishing activity. Anglers tend to fish from the adjacent coastline or on the more productive Klein or Bot estuaries nearby. Bait collection is rarely practised here due to the absence of prawns. No harvesting of reeds by local communities for building materials (e.g. thatching) or craft production occurs in the estuary (mats, baskets).

4.4 Regulating services

Studies have shown that the high biomass production of *Phragmites* reed beds favours carbon sequestration but also enhances methane emissions, particularly in oligohaline (salinity 0.5-5 ppt) wetlands (Brix *et al.* 2001, Poffenbarger *et al.* 2001). The relative role of *Phragmites*-dominated wetlands as a source or sink of carbon over different time scales renders their importance to

greenhouse gas regulation unclear, but Onrus Lagoon's small size means that it would make a negligible contribution to climate regulation in any event.

According to Turpie (2007), temperate estuaries play little or no role in providing services such as flood attenuation, regulation of downstream flows and erosion control, since these systems are at the end of catchments and there is little in the way of downstream habitats that depend on them. The *Phragmites* reed beds do, however, help protect the estuary's shoreline from erosion during floods.

Wastewater effluent is not deliberately discharged into Onrus Lagoon for water purification purposes, although polluted water emanating from catchment practices and accidental sewage spills is likely cleansed to some extent before it flows into the sea. However, the marine environment has greater assimilative capacity than the estuary.

4.5 Cultural services

Onrus Lagoon and its beach together represent a popular recreational area, although its use is somewhat constrained by concerns about its pollution status. The shallow waters in the outlet channel provide a safe area for children to play and swim, while the main waterbody can be explored using craft such as lilos, pedalos, canoes and rowing boats. There is no demand for larger boats or kitesurfing due to the estuary's small size and sheltered location. The Onrus beach on the other hand provides youngsters and adults the opportunity to swim, body surf and surf in the sea. The Onrus Lagoon and beach therefore represent a recreational destination for all members of a family and poor water quality are likely to impact on the cultural service provided by both the lagoon and the beach.

The Onrus beach currently does not have Blue Flag Status, which is an international award that is given to beaches, boats and marina's that meet excellence in the areas of safety, amenities, cleanliness and environmental standards. The strict criteria of the programme are set by the international coordinators of the Blue Flag campaign in Europe, the Foundation for Environmental Education (FEE). Obtaining this status could improve recreational value of both the beach and the estuary, thereby also attracting a greater number of international visitors to the Onrus Town with economic benefits to the wider Hermanus area.

A zonation plan that provided designated areas for swimming, canoeing and a bird sanctuary was proposed by the CSIR in 1993. The zonation plan was adopted for a while but not enforced as it was considered unnecessary given the low level of recreational boating and the lack of user conflict.

Figure 17 Onrus Lagoon is a popular destination for families with young children.

Local residents have a sense of ownership over and responsibility for the estuary and it provides an important sense of place for holidaymakers, many of whom have a long family history of association with the area. A restaurant and beach bistro/kiosk overlooks the water (Figure 18). The estuary is used for adventure activities during Jewish Youth and Zionist summer camps held at the nearby Habonim Campsite and Conference Centre. In addition, it is occasionally used for African Zionist baptism ceremonies. Zwelihle is approximately 4 km walk along the coast, but there are also taxis operating between the township and Onrus Main Road.

Figure 18 The bistro next to the beachfront carpark overlooks the estuary.

The estuary is visited by birdwatchers, attracting 'twitchers' for species that are otherwise hard to find in the Overberg (A. Odendaal, pers. comm.). Following the demarcation of a bird sanctuary on the eastern shore in the 1990s, a bird hide was constructed at the northern end shore with funding by WWF through the Rowland and Leta Hill Trust. In 2002, the hide was repaired by the Onrus Lagoon Trust after being vandalised and partially burnt down in 1999. The Trust also constructed the boardwalk and path leading to the hide, and conducted alien-clearing on the property, which originally belonged to the municipality but was donated to WWF (see Section 4.3.1).

The hide was subsequently vandalised again, and today only the platform remains, while the wooden boardwalks to the hide are in a serious state of disrepair and are a safety hazard. The Onrus Lagoon Trust does not consider the structures worth repairing given that dense reed growth in the vicinity of the hide renders it obsolete for bird-watching, and has recommended that they be removed (R. Gaylard, pers. comm.).

However, the path to the bird hide offers scenic views of the estuary and passes through diverse strandveld that supports a rich birdlife. Apart from its recreational and environmental educational potential, this is an asset that has importance from a biodiversity conservation perspective. Maintenance work is needed to ensure that the path does not become overgrown and that the property is kept clear of invasive alien vegetation.

4.6 Supporting services

Turpie (2007) identified the export of nutrients and sediments to marine ecosystems as being of high importance. In the case of nutrients, however, this is more applicable to estuaries on the east coast, where levels tend to be higher than those of the naturally oligotrophic (nutrient-poor) estuaries of the Western Cape, especially in temporarily open-closed systems. Where anthropogenic activities elevate nutrient levels, these are usually depleted rapidly by algal or macrophyte production. Furthermore, unlike the nutrient-rich, upwelled waters of the Western Cape, the marine environment of the east coast is oligotrophic, so riverine nutrient input is more important there in sustaining primary production. Onrus Lagoon also plays a negligible role in terms of sediment export, given the small size of the estuary. Furthermore, sediment discharged during mouth breachings is thought to be retained within the bay to a large extent (CSIR 1991), and is deposited back on the beach to rebuild the sandbar within a week or two.

Estuaries are considered highly important in terms of habitat provision, as they provide refuge for migratory fish and birds, a breeding and roosting area for birds, and a nursery area for fish. Onrus Lagoon cannot support large numbers of birds or fish due to its small size. Nevertheless, the extensive reed beds surrounding a body of virtually fresh water do provide habitat for birds such as Cape Weaver, Red Bishop, Black-crowned Night Heron as well as migratory Barn (European) swallows in summer, while the beach is used as a roosting area by gulls and cormorants.

The fish fauna of Onrus Lagoon predominantly comprises freshwater and resident estuarine species. Although some euryhaline marine fish species occur, the estuary is not considered an important nursery area due to its small size. After breaching, the mouth generally remains open for only a short time, limiting recruitment, although larvae probably also enter the estuary via sandbar overwash during high seas.

4.7 Monetary value of ecosystem services

The monetary value of ecosystem goods and services is often estimated in environmental economics or natural resource economics studies. Turpie & Clark (2007) used a modified Total Economic Value framework to consider the tourism/recreation, subsistence, nursery, existence and property value of all 149 temperate estuaries in South Africa. They estimated that the estuaries had a combined value of approximately R2 billion in terms of annual turnover generated in the retail and tourism sectors. Total nursery value – the contribution of temperate estuaries to marine fishery production by providing nursery areas for commercially or recreationally valuable species – was estimated at R773 million. Subsistence value in terms of the number of fishers using estuaries and the nature of their catches ranged from zero to R800 000 per estuary, with an average of R70 000. Existence value, based on the willingness to pay to maintain the feeling of satisfaction that the existence of an estuary generates, totalled some R93 million per year for all South African estuaries combined.

While the Onrus Estuary has a fairly high recreational value (R1-5 million), the subsistence value is very low worth <R0.05 million. Due to its small size and predominantly closed state, the nursery value was estimated at R1-5 million per annum.

Property value is the premium paid for access to or views of estuaries, and represents the value or willingness to pay for that amenity. The total property value associated with all temperate estuaries was estimated to be at least R10.6 billion, which when converted to an annual value akin to the income generated in the property sector translates to a total of about R320 million per year (Turpie & Clark 2007). The property value for the Onrus Estuary, as evaluated in 2007, was estimated at 1.8 and 1.4 Million Rand for the front row and second row, respectively (Turpie & Clark 2007).

5 LEGISLATION AND MANAGEMENT ISSUES

5.1 The main threats and opportunities to be considered

There are a number of factors that threaten the future health of the Onrus Estuary and hence its biodiversity and capacity to deliver ecosystem services. The main threats to the system or areas of potential conflict identified in this Situation Assessment Report are as follows:

1. Water quantity and quality
    a. Reduction in freshwater inflows due to abstraction for agriculture and domestic use and storage in the catchment (De Bos Dam), and unknown volumes of environmental releases to maintain the ecosystem below the dam;
    b. Nutrient enrichment and bacterial contamination due to an aged and damaged sewage system. Parts of the damaged sewer line traverse through the riparian zone and the active channel of the lower Onrus River and upper Onrus Estuary; and
    c. Loss of open water area over time due to encroachment of the common reed *Phragmites australis* as a result of siltation and high nutrient levels in the water column and sediment.
2. Land-use and associated disturbance
    a. Potential for increased residential/resort development around the estuary leading to change in sense of place and existence value, increased human disturbance of biota, and damage or loss of estuarine habitat; and
    b. Unmanaged and non-strategic clearing of *Phragmites australis*

In addition to meeting the existing legislation governing the above activities, opportunities to protect the health and value of the system over the medium to long term include:

1. Continuation of conservation and rehabilitation efforts by the Onrus Lagoon Trust
2. Continuation of alien invasive clearing; and
3. Raising awareness and ensure public interest in the rehabilitation and conservation of the Onrus Estuary.

All of the above issues are discussed below in the context of the prevailing policies and legislation.

5.2 General policy and legislative background

This section provides an overview of legislation and policy applicable to management of estuaries in South Africa and specifically to the Onrus Estuary. More details on the legislative framework for estuary management including international and regional treaties and obligations, national policies and laws, and provincial and local policies and legislation is provided in Taljaard (2007).

The South African Constitution is the supreme law of the land, and provides the legal framework for legislation regulating environmental management in general. Section 24 of the Constitution states that:

"Everyone has the right:

a) to an environment that is not harmful to their health or well-being; and
b) to have the environment protected, for the benefit of present and future generations through reasonable legislative and other measures that –
    i) prevent pollution and ecological degradation;
    ii) promote conservation; and
    iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."

This lays the basis for environmental law in South Africa (Breen and McKenzie, 2001) and is a very important justification for the wise use of estuarine biodiversity. Because they are not freshwater, terrestrial or marine, estuaries have tended to be neglected in past legislation. However, the fact that estuaries contain freshwater, terrestrial and marine components, and are heavily influenced by activities in a much broader catchment and adjacent marine area, means that they are affected by a large number of policies and laws. Although the C.A.P.E. Estuary Conservation Plan identified estuaries which should be assigned Estuarine Protected Area (EPA) status (Turpie and Clark, 2007) there is still no specific legal provision for declaration of Estuarine Protected Areas.

South African policy and law as pertaining to estuaries has been summarised in detail elsewhere (Smith and Cullinan, 2000; van Niekerk and Taljaard, 2002) and only a brief summary of the most relevant policies is given here (Table 10 and

Table 11). 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 within estuaries (van Niekerk and Taljaard, 2002; Taljaard, 2007).

Estuary management falls mainly under three national government departments: (1) The Department of Water and Sanitation, responsible for water resources and sanitation (2) the Department of Environmental Affairs (DEA), responsible for land use and the coastal environment and (3) the Department of Agriculture, Fisheries and Forestry (DAFF) responsible for marine living resources (including estuarine resources). Environmental management in most instances is devolved to provincial level through whichever provincial department is responsible for environmental matters. Management and conservation of the coastal zone and marine living resources are exceptions in this respect, in that these are retained as a national competency, responsibility residing with the DEA branch Oceans and Coast and the DAFF respectively. In instances where provincial or local legislation are in conflict with national legislation, national legislation prevails. At a local (municipality) level, municipal councils pass municipal by-laws, which in turn, cannot conflict with provincial and national laws (Breen and McKenzie, 2001).

The Western Cape Government has also released a Coastal Management Programme in terms of section 46 of the ICMA, 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 Programme and are organised within five themes:

- Theme A: Governance and Capacity Building
- Theme B: Our National Asset
- Theme C: Coastal Planning and Development
- Theme D: Natural Resource Management
- Theme E: Pollution Control and Waste Management

A number of goals within each of these themes are of relevance to the management of the Onrus Estuary (Table 12). Draft Coastal Management Programmes for the Overberg District and Overstrand Local Municipalities have also been published for public comment and are currently being reviewed. These municipal programmes are revisited in more detail in section 5.3.3.

Table 10 **Summary of national policies which affect water quality and quantity in estuaries in general, land use, development and resource use in the estuarine environment. Policies in grey have been given legal status by the corresponding Acts.**

	White Paper (= Policy)	Bill or Act (= Law)	Lead Agent	Implications
Water quality &quantity	White Paper on National Water Policy for SA (1997)	National Water Act (Act No 36 of 1998)	Department of Water and Sanitation (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)	National Environmental Management: Waste Act (Act No 59 of 2008 as amended in 2014)	Department of Environmental Affairs (DEA)	Provides a legal framework for a management approach which aims to achieve pollution prevention, waste minimization, managing the environmental impacts associated with waste and pollution, remediating damaged environments and integrating the management of various sources of waste.
	White Paper for Sustainable Coastal Development in South Africa (2000)	National Environmental Management: Integrated Coastal Management Act (Act No 24 of 2008 as amended in 2014)	DEA and DWS	Provides for the protection of the marine environment (including estuaries, but in collaboration with the DWS in terms of the NWA) from pollution originating from land-based sources, 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.
	Operational policy for the disposal of land-derived water containing waste to the marine environment of South Africa (2004). AND National Guideline for the Discharge of Effluent From Land-based Sources into the Coastal Environment			
Land use & management	White Paper for Sustainable Coastal Development in South Africa (2000)	National Environmental Management: Integrated Coastal Management Act (Act No 24 of 2008 as amended in 2014)	DEA	The granting of coastal use permits for the purposes of construction on the sea-shore or in the sea (previously administered by DEADP in terms of the Sea-shore Act (Act NO21 of 1935).
		Environmental Conservation Act (Act No 73 of 1989 as amended)	Department of Environmental Affairs and Development Planning (DEADP)	Most of the provisions of this Act relevant to land use management have been repealed by NEMA, apart from the regulations past in terms of ECA Section 26 and associated regulations for Sensitive Coastal Areas,

	White Paper (= Policy)	Bill or Act (= Law)	Lead Agent	Implications
		National Heritage Resources Act (Act 25 of 1999)	South African Heritage Resources Agency (SAHRA)	Provides for management of national heritage resources (including landscapes and natural features of cultural significance, and for participation of communities in the identification, conservation and management of cultural resources.
	White Paper for Sustainable Coastal Development in South Africa (2000)	National Environmental Management: Integrated Coastal Management Act (Act No 24 of 2008 as amended in 2014)	DEA	Provides for integrated coastal and estuarine management in South Africa, and sustainable 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 Amendment Act (Act 7 of 2011)		White Paper on Spatial Planning and Land-use Management (2001)
		Spatial Planning and Land Use Management Act (SPLUMA) (Act 16 of 2013)	Department of Rural Development and Land Reform	Aims to develop a new framework to govern planning permissions and approvals, sets parameters for new developments and provides for different lawful land uses in South Africa. SPLUMA is a framework law, which means that the law provides broad principles for a set of provincial laws that will regulate planning. SPLUMA also provides clarity on how planning law interacts with other laws and policies.
	Mineral and Mining Policy for South Africa (1998)	Mineral and Petroleum Resources Development Act (2002)	Department of Mineral Resources	Deals with environmental protection and management of mining impacts, including sand and coastal mining.
Protected Areas, Including MPAs	White Paper on the Conservation and Sustainable Use of South Africa's Biological Diversity (1998)	National Environmental Management: Protected Areas Act (Act 57 of 2003 as amended in 2014)	DEA	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. Most recent amendments of this Act (Act No 21 of 2014) make provision for declaration of MPAs in terms of this Act, which was previously regulated in terms of the MLRA.
		World Heritage Convention Act (Act No 49 of 1999)	DEA	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 (Act No 10 of 2004 as amended in 2013)	DEA	Provides for the protection of South Africa's biodiversity, including the protection of species and ecosystems in need of protection through the establishment of the regulatory body on biodiversity – South African Biodiversity Institute.

	White Paper (= Policy)	Bill or Act (= Law)	Lead Agent	Implications
Use of living resources	White paper on Marine Fisheries Policy for South Africa (1997). AND Policy for the small scale fisheries sector in South Africa (2012)	Marine Living Resources Act (Act No 18 of 1998 as amended in 2014)	Department of Agriculture, Forestry and Fisheries (DAFF)	Provides regulating measures for the long-term sustainable utilisation and protection of marine living resources and access to exploitation, utilisation and protection of certain marine living resources.
	White Paper on the Conservation and Sustainable Use of South Africa's Biological Diversity (1998)	National Environmental Management: Biodiversity Act (Act No 10 of 2004 as amended in 2013)	DEA	Regulates sustainable use of indigenous biological resources and equity in bioprospecting.

Table 11 Provincial and local government legislation applicable to the Onrus Estuary

	Act/Ordinance	Lead Agent	Implications
Land use planning	Municipal Ordinance (Cape) (1974)	DEADP	Grants local authorities in the province of the Western Cape the power 'to drain storm water into any natural water course'.
	Western Cape Nature Conservation Laws Act (Act No 15 of 1998)	WCNCB	Provides for the establishment of the Western Cape Nature Conservation Board.
	Western Cape Land Use Planning Act (LUPA) staggered repeal of Land Use Planning Ordinance (1985) as amended and other older planning legislation.	DEADP	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. The Land Use Planning Ordinance, 1985 (Ordinance 15 of 1985)(LUPO) and various other old order legislation relating to various aspects of land use planning, will be repealed in a staggered manner as and when Municipalities are ready.
Other relevant By-laws	By-law on Municipal Land-Use Planning (July 2014)	Overstrand Local Municipality	To regulate and control municipal land use planning.
	Overstrand Municipality By-law relating to Stormwater Management 2009	Overstrand Local Municipality	The By-law provides for the regulation of stormwater management in the built-up areas of the Overstrand Municipality, and of activities that may have a detrimental effect on the development, operation or maintenance of the stormwater system. It stipulates that in the event of the discharge or entry of anything other than stormwater into the municipal system, the responsible person or owner of the property should immediately report the incident to the Municipality and take steps at their own cost to minimise the effects of the pollution and prevent its recurrence. Where stormwater systems occur on private land, the property owner has obligations to keep the system functioning effectively, and control vegetation that might obstruct the flow. The Municipality may recover the costs involved in rectifying any contraventions of the By-law. The By-law gives the Municipality the power to discharge stormwater into any watercourse, attenuated where appropriate. A number of stormwater pipes discharge into Onrus Lagoon or further upstream.
	Overstrand Municipality Water Supply and Sanitation Services By-law, 2009	Overstrand Local Municipality	The By-law deals mainly with service provision, but it stipulates that property owners must take measures to prevent the entry of substances that may be a danger to health or the environment into the water supply system, stormwater system, sewage disposal systems and the environment. If the Municipality suspects that a conservancy tank is not watertight, it may require the owner to test this at own cost, and then upgrade or replace the tank if necessary. The By-law also gives authorised officials the power to execute work, conduct an inspection, and monitor and enforce compliance.
	Overstrand Municipality By-law relating to the Keeping of Cats and Dogs, 2008	Overstrand Local Municipality	The By-law aims to regulate and control the ownership and general behaviour of cats and dogs. Among other issues it deals with the control of dogs in public places. It stipulates that dogs must be on a leash when in public places, and states that 'no person may, without reasonable grounds, incite a dog against a person, animal or bird, or allow a dog in his or her custody or control to attack or put fear into any person, animal or bird.' Dogs are not permitted on Onrus Beach, but they are walked on the 'common'. However, the reedbeds lining the estuary's shores provide an effective buffer against disturbance to birds. Dog owners are also required to remove and safely dispose of any defecation in public spaces.

Table 12 Goals and strategies in the Western Cape Integrated Coastal Management Programme with particular relevance to management of the Onrus Estuary.

Goal #	Goal	Strategies
Goal B3:	To preserve, promote or protect archaeological, historical and cultural resources and activities of the coast	B3.1.1: Implementation of section 38 of the National Heritage Resources Act B3.1.2: Encouragement of heritage conservation planning B3.1.6: Termination of inappropriate uses of places, illegal activities
Goal C1:	To promote the diversity, vitality and long term viability of coastal economies and activities, giving preference to those that are distinctly coastal or dependent on a coastal location	C1.7.1: Diversify tourism opportunities C1.7.3: Build capacity of communities to initiate and effectively participate in sustainable tourism ventures C1.7.4: Identify and address the limits imposed by natural and manmade environments when planning tourism (and other) initiatives
Goal C3:	To maintain an appropriate balance between built, rural and wilderness coastal areas in the Western Cape	C3.4.2: Ensure the protection and conservation of natural/wilderness areas
Goal C4:	To design and manage coastal settlements to be in harmony with the aesthetic, environmental and cultural attributes of the Western Cape Coast	C4.1.1: Determine adequate setback and buffer zones along the coast C4.1.2: Control the sitting of infrastructure in the coastal zone C4.1.3: Restrict non-coastal related land uses from being located in the coastal zone C4.1.4: Encourage appropriate forms of coastal settlement and building C4.1.5: Formulate design guidelines for all buildings and structures in the coastal zone C4.2.1: Develop regulations to restrict the alteration of landforms and vegetation cover in dynamic coastal zones C4.2.3: Manage pedestrian and vehicular access in coastal environments
Goal C5:	To plan and manage coastal development so as to avoid increasing the incidence and severity of natural hazards and to avoid exposure of people, property and economic activities to significant risk from dynamic coastal processes	C5.1.1 Protect and maintain dynamic coastal features that act as a buffer against natural coastal processes and hazards C5.2.1: Incorporate appropriate preventative and adaptive measures into all planning and management policies, plans and decision-making processes to account for projected changes in climate, particularly increases in sea level
Goal D1	To maintain the diversity, health and productivity of coastal and marine processes and ecosystems	D1.2.1 Identify and protect unique sensitive environments and habitats in the coastal and marine zones
Goal D2:	To establish and effectively manage a system of coastal protected areas	D2.1.3: Ensure proper management of protected areas that caters for ecological and human use requirements
Goal D3:	To ensure that the use of renewable resources and associated user practices do not compromise the regenerative capacity of coastal ecosystems	D3.1.2: Adopt holistic rather than single species management approaches D3.1.3: Set harvest levels that correspond to the regenerative capacity of coastal resources D3.1.5: Develop adequate strategies for monitoring and compliance D3.1.6: Promote participation of all stakeholders in management

Goal D5:	To rehabilitate damaged or degraded coastal ecosystems and habitats	D5.1.1: Identification of significantly degraded coastal areas and ecosystems and development of rehabilitation management plans D5.2.1: Put in place procedures to enforce rehabilitation of degraded coastal areas by those responsible
Goal E1:	To implement pollution control and waste-management measures in order to prevent, minimize and strictly control harmful discharges into coastal ecosystems	E1.2.3: Inclusion of pollution and waste management into land-use planning
Goal E2:	To manage polluting activities to ensure that they have minimal adverse impact on the health of coastal communities, and on coastal ecosystems and their ability to support beneficial human uses	E2.1.7: Reduce pollution entering rivers and estuaries by promoting catchment management

5.3 Land use and management of estuary margins

5.3.1 Legislative context

ICMA provides for a system of integrated coastal and estuarine management in South Africa, including norms, standards and policies to promote the conservation of the coastal environment and to ensure that the development and use of the coastal zone is socially and economically justifiable and ecologically sustainable. The Act provides for the establishment of a coastal protection zone to facilitate management, regulation and use of land adjacent to coastal public property (defined as all land below the high water mark including that in estuaries and the admiralty reserve), or that plays a significant role in the coastal ecosystem. The coastal protection zone extends to a distance of 100 m inland from the high tide mark in areas zoned for residential, industrial or commercial land use and 1 km for public land and land zoned for agricultural use. The Coastal Protection Zone also includes any sensitive coastal areas, as defined in terms of the Environment Conservation Act (Act 73 of 1989). The purpose of the Coastal Protection Zone is to:

I. Protect the ecological integrity, natural character, and the economic, social and aesthetic value of the neighbouring coastal public property;
II. Avoid increasing the effect of natural hazards;
III. Protect people and economic activities from risks and threats which may arise from dynamic coastal processes such as wave and wind erosion, coastal storm surges, flooding and sea level rise;
IV. Maintain the natural functioning of the littoral zone
V. Maintain the productivity of the coastal zone; and
VI. Allow authorities to perform rescue and clean-up services.

The Act also provides for the establishment of coastal management lines and coastal access land. Coastal management lines are designed to protect or preserve the coastal protection zone and will enable national government to prohibit or restrict the construction, extension or repair of structures that are wholly or partially seaward of the line. The establishment of coastal management lines is a provincial responsibility but the MEC can only declare such management line after consultation with municipalities and interested and affected parties.

Up until the promulgation of the ICM Amendment Act (Act No. 36 of 2014), Section 3.1 of the Sea-shore Act (Act No. 21 of 1935) remained in force and required that a lease be obtained from the relevant administering authority (in the Western this authority was assigned to CapeNature) before commencing construction activities on the sea-shore (the land between the low water and high water marks) or in the sea. Coastal leases and concessions regulated in terms of Section 3.1 of the Sea-shore Act were repealed and replaced with coastal use permits administered in terms of the ICMAA with the lead agency being the DEA. No guidelines for the evaluation of applications for coastal use permits are available at the time of writing and it is likely that the evaluation procedure followed by CapeNature in the past will be used in the interim:

- take into consideration whether the letting is in the interests of the general public and will not seriously affect the general public's enjoyment of the sea and sea-shore;
- consult with a local authority if the land adjoining the portion of the sea-shore is under the jurisdiction of that local authority;

- publish a notice in the Provincial Gazette, before granting a lease, to inform the public of the proposal and the inspection date and provide opportunity for objections. According to Section 3(6), any objection submitted in response to such advertisements must be considered by Cape Nature prior to entering into a lease agreement or issuing of a permit.

Development in the coastal zone will be strongly influenced by the planning that has to take place in terms of the Municipal Systems Amendment Act (2011). Under this Act, all municipalities have to undertake an Integrated Development Planning (IDP) process to produce integrated Development Plans (IDPs). These will supersede all other plans that guide development at local government level, and is the principal strategic planning instrument which guides and informs all planning, budgeting, management and decision-making in a municipality for a five year period. It is a very interactive and participatory process which requires involvement of a number of stakeholders. The process involves identifying a vision, objectives and strategies followed by the identification of projects to address the issues. Every municipality is required to produce an indicative plan, called a 'Spatial Development Framework (SDF)', showing desired patterns of land use, directions of growth, urban edges, special development areas and conservation-worthy areas. It must also produce a scheme, called a 'Land Use Management System (LUMS)' recording the land use and development rights and restrictions applicable to each erf in the municipality. The plan should be flexible enough to accommodate changing priorities, and the scheme has to conform to the plan. The plan (SDF) is a guide to development, and the scheme (LUMS) is binding.

Environmental issues are cross-cutting, which means that they have to be addressed in IDPs. It is important to note that estuaries are particularly cross-cutting, given their linkages with entire catchment areas and the inshore marine environment. Municipalities must incorporate a strategic environmental assessment (SEA) into their spatial development frameworks, forming part of their IDPs. Municipalities now also take the responsibility for EIAs, in theory to help resolve environmental and planning conflicts. IDPs are thus explicitly required to consider environmental issues and indicate how negative impacts will be resolved and/or avoided. The main opening for recognising the need for managing the Onrus Estuary in the IDP process is in the State of Environment Reporting during the Analysis phase. It is during this process that issues relating to estuarine values would be identified and included in the issues prioritization. It will be necessary to sensitise IDP planners to estuary values.

Thus, many key land-use planning decisions relating to the Onrus Estuary will be taken by the local municipality, in this case the Overstrand Municipality. Their plans have to fit in with broader scale plans of the district and province.

In addition, any major activities taking place on the banks of the Onrus Estuary, and/or development and use of the margins of the estuary are likely to fall within the ambit of the Environmental Impact Assessment (EIA) regulations promulgated under the National Environmental Management Act (Act No. 107 of I998). Regulations were first promulgated in 2006 and have been subsequently amended, with the most recent amendments being gazetted in December 2014 (GN R. 982, 983, 984 and 985). These regulations contain procedures and criteria for environmental impact assessment (EIA) and listed activities which are subject to basic assessment reports or scoping assessment and environmental assessment reports (referred to as Listing Notice 1-3 of 2014). Many of these listed

activities either directly or indirectly apply to development on the banks of the Onrus Estuary. The main listed activities relevant to this study include

A basic assessment is required in terms of Regulation 19 and 20 (GN R. 983) if the following activities are triggered in Listing Notice 1 (GN R. 983):

- The development or expansion of structures such as jetties, slipways, tidal pools, embankments, infrastructure exceeding 50 square metres in footprint etc. (Activities 17 and 53)
- The infilling/depositing or removing of material equating to more than 5 cubic metres into or from an estuary (Activity 19)
- The expansion of structures relating such as piers, inter- and sub-tidal structures for entrapment of sand, breakwater structures etc. (Activity 55)

A scoping and environmental impact assessment report is required in terms of Regulation 21-24 (GN R. 983) if the following activities are triggered in Listing Notice 2 (GN. R. 984):

- The development of structures relating such as piers, inter- and sub-tidal structures for entrapment of sand, breakwater structures etc. (Activity 24).

A basic assessment is required in terms of Regulation 19 and 20 (GN R. 983) if any of the activities in Listing Notice 3 (GN R. 983) are triggered.

If required, the basic assessment or EIA must be undertaken to assess potential impacts on the environment, socio-economic condition and cultural heritage, the results of which must be reported to the authority charged with authorizing, permitting or otherwise allowing the implementation of an activity (in this case DEA&DP).

Agricultural activities in and around the Onrus Estuary, including livestock grazing, cultivation of crops and husbandry involving invasive alien species (plants or animals), are all subject to the Conservation of Agricultural Resources Act (1983) which gives the Minister of Agriculture the power to prescribe control measures to achieve the objectives of the Act (viz. the maintenance of the production potential of land, by the combating and prevention of erosion and weakening or destruction of the water sources (including estuaries), and by the protection of the vegetation and the combating of weeds and invader plants).

5.3.2 Development planning pertaining to the Onrus Estuary

The Spatial Development Framework for the Western Cape Province is pitched at a very broad level, encapsulated in the vision “a home for all in the Western Cape”. It offers very little material guidance of specific relevance to the management of the Onrus Estuary, except to say that estuaries are unique ecosystems under serious threat both directly from human activities such as overexploitation, waste discharges, and through activities in the catchment.

5.3.2.1 Overberg District Municipality IDP and Sector Plans

A number of strategic objectives were identified in the Overberg District Municipality IDP (refer to Table 13 for the vision and mission contained in the IDP) one of which refers to providing efficient basic services and infrastructure in terms of disaster management and environmental management. Although this may seem like a broad statement, three Sector Plans directly relevant to the management of the Onrus Estuary serve the purpose to implement this strategic objective:

- Integrated Environmental Programme – Environmental Management Policy adopted on 8 December 2014 (Overberg District Municipality 2014)
- Spatial Development Framework – Approved (February 2014) (Overberg District Municipality 2013)
- Coastal Management Programme – Final draft published for comment (Overberg District Municipality (2015b).

Each of these Sector Plans is dealt with in the sections below.

Overberg District Municipality Environmental Policy

The Environmental Management Policy for the Overberg District Municipality was adopted on 8 December 2014 and ensures that all aspects of environmental management in the district are aligned with relevant environmental legislation. The policy also clearly defines the responsibilities that the ODM has in terms of implementation of environmental legislation some of which is relevant to the management of the Onrus Estuary (Overberg District Municipality 2014). The ODM is required to establish a Municipal Coastal Committee (MCC) to ensure effective communication with all coastal role players. Furthermore, the policy states that the ODM supports the Working for the Coast Programme as a national job creation initiative to assist in the implementation of the Coastal Management Programme (CMP) (Section 5.3.3). The Environmental Management unit is required to conduct regular coastal inspections to determine any changes or impacts on the coastline in terms of pollution, illegal structures, coastal access or processes (erosion and sand movement). Although the ODM will not act as a management authority pertaining to the implementation of Estuary Management Plans, the municipality nevertheless commits to supporting Estuarine Management Forums through the MCC and attend all forum meetings.

Other aspects of environmental management that will affect the management of the Onrus Estuary include the commitment of the ODM to conduct environmental education and awareness campaigns, and effective environmental governance.

Spatial Development Framework

A new Spatial Development Framework (SDF) was drafted in June 2013 in accordance with the strategies and objectives reflected in the national and provincial SDFs and IDPs (Overberg District Municipality 2013). It is consistent with applicable legislation on environmental management, agriculture and water, giving effect to national and provincial plans and planning legislation (refer to Table 13 for the vision and mission contained in the SDF). The SDF identifies Bio-Regions which form

the basis for the organisation of the SDF. The Onrus Estuary falls within the Bio-Region Urban Coastal Corridor for which policy proposals relevant to the management of the Onrus Estuary are as follows:

UCC4 Encourage conservancies to protect conservation priority vegetation (Walker Bay Nature Reserve) in the area and to support the Agulhas Biodiversity Initiative.

UCC5 Delineate in the local SDF the coastal management line in terms of the Integrated Coastal Management Act.

UCC7 The tourism potential of the Onrusberge and Kleinrivierberge should be promoted within the coastal reserves.

UCC8 Further development of this area should protect the character of the area, be aesthetically pleasing and contribute to the tourism quality of the area.

UCC9 Promote linkages and corridors between terrestrial and marine ecosystems particularly where coastal wetlands and estuaries are present. Promote the conservation of the mountain backdrop, the river valleys and coastal strip.

The SDF specifies several spatial planning categories for land use management and makes recommendations for management strategies. The Core 2 planning category is applicable to river and wetland corridors and estuaries. This planning category requires that bank side ploughing must be limited where possible. To limit further development close to water bodies, the 1:50 year floodline, or in its absence, a minimum of 32 m is proposed as the setback zone from the banks of all river and water bodies, unless a buffer area is otherwise delineated by flood lines and/or ecological set back lines. Costal management lines are applicable to estuaries and have already been developed for the Overberg District Municipality and can be used for planning purposes (section 5.3.6). Funding for continued clearing of alien vegetation for improving water quality and quantity should also be mobilised. Landowners must be encouraged to protect river and wetland corridors and estuaries via stewardship agreements or private conservancies in return for rates rebates and the appropriate use of land for eco-tourism and other income generating ventures. The spatial planning category should be changed to Core 1 (solely conservation purpose) and Buffer (portions containing infrastructure) for properties proclaimed as a conservancy or stewardship areas.

5.3.2.2 Overstrand Local Municipality IDP and Sector Plans

The Overstrand Municipality's IDP for the five-year period 2012-2017 was adopted by Council on 30 May 2012, and the latest annual review was published in March 2014 (Overstrand Municipality 2014c). The IDP includes a number of sector plans/policies, including the Spatial Development Framework, Growth Management Strategy, Environmental Plan and Water Services Development Plan, the latter being a requirement in terms of the Water Services Act (Act No 108 of 1997). The vision, mission and strategic objectives relevant to the management of the Onrus Estuary are detailed in Table 13.

The Overstrand Municipality published the 'Overstrand Towards 2050 – an Integrated Development Framework' (hereinafter referred to as Overstrand IDF) in March 2014 (Overstrand Municipality

2014a), which sets the strategic direction for the Overstrand's growth and development for the next 30-40 years. The Development Framework provides the strategic spatial direction for development and conservation in the long term by (1) consolidating the plethora of documentation into one user friendly summary document (2) ensuring that the current statutory required 5 year IDP cycle of planning is coordinated with achieving the long term objectives and (3) identifying and addressing gaps in the existing policy framework. The preparation of an Integrated Development Framework is not a legislative requirement in South Africa and is an initiative of the Overstrand Municipality based on a series of specific planning needs identified and not currently addressed within the existing spatial planning context.

The Overstrand IDF contains six spatial directives to achieve the overarching vision of *An accountable Overstrand Towards 2050*:

- Aliveable Overstrand
- An environmentally sustainable and resilient Overstrand
- A memorable and distinctive Overstrand
- An Overstrand that enables a prosperous and diverse economy
- Vibrant and exciting urban areas
- An accessible and connected Overstrand

Each spatial directive has several objectives, policies and implementation mechanisms and actions. Although all these spatial directives play a role towards achieving successful management of the Onrus Estuary, the directive "*An environmentally sustainable and resilient Overstrand*" undoubtedly is the most important of all six. This spatial directive aims to ensure that sustainability and resilience is integral to all developments and actions by 2050. In essence, this includes the protection of productive agricultural land and natural character of coastal environments through sensible and sustainable development. It is envisioned that a range of conservation areas have been established and at the same time urban areas are well integrated with internal and surrounding natural environments. New development is avoided in areas of known hazards (flooding, erosion, sea-level rise) and environmentally smart engineering is used to minimise environmental impacts, as well as energy and water consumption. Seven environmental objectives (EO1-7) are listed in the Overstrand IDF for achieving the long-term vision of an environmentally sustainable and resilient Overstrand. Several policies for achieving each EO have been identified, which in most part refer to existing spatial planning documentation (SDFs, Environmental Management Framework, Growth Management Strategy, etc.). Part 5 of the Overstrand IDF details Action Plans, which are continuously updated to achieve the Environmental Objectives (and objectives related to the other five spatial directives).

Geographically-specific Key Action Plans were also generated for the Overstrand IDF to achieve prioritised goals in the next ten years. Key Action Plan 20 for the Greater Hermanus (West) contains a selection of objectives applicable to all six spatial directives. Those directly relevant to the management of the Onrus Estuary are listed in Table 13. The Onrus Lagoon and the Onrus WWF Reserve were identified as special places in this Key Action Plan. The management approach aims to protect and manage the functioning of the Onrus River and Estuary as an ecological corridor and linear open space area. Furthermore, the Onrus Estuary Functional Zone is predominantly comprised of important heritage areas (western banks of the lower estuary) and CBAs. A heritage

management plan will be developed for the demarcated heritage areas containing appropriate guidelines for future development.

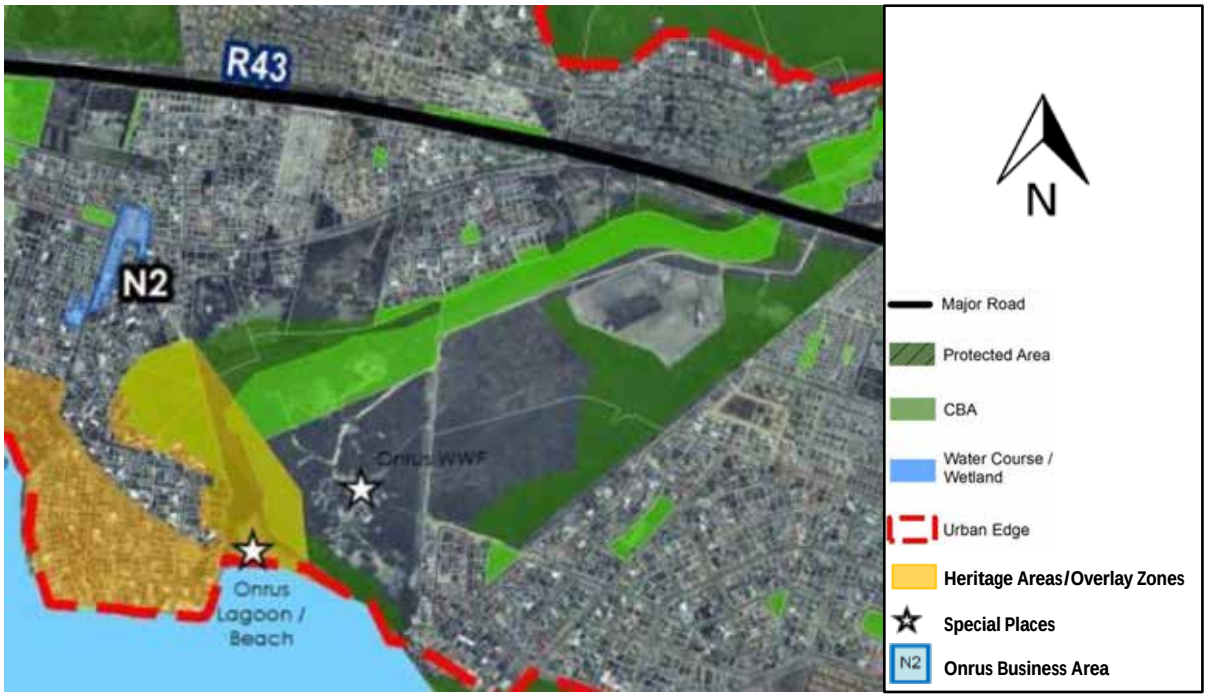

Figure 19 Key Actions Plan 20 for the Greater Hermanus Area (West) featuring the Onrus Lagoon and Estuary (Source: Overstrand Integrated Development Framework 2014).

The Environmental Management Framework (EMF) for the Overstrand Local Municipality was compiled as part of the Overstrand IDF and in terms of the Environmental Management Framework Regulations (EMF), 2010 (Overstrand Municipality 2014b). It has the purpose to function as a support mechanism in the evaluation and review of the Environmental Impact Assessments (EIA) and to inform decision making regarding land use planning applications. This document aims to help authorities to balance socio-economic and bio-physical environmental issues.

In summary, the objectives of the Overstrand EMF are to:

- Promote judicious management of natural resources;
- Support informed and integrated decision-making at all levels;
- Contribute to environmentally sustainable development;
- Support the undertaking of Environmental Impact Assessments in the area;
- "Red Flag" geographical areas within which additional specified activities may need to be identified in terms of the 2014 NEMA EIA Regulations;
- Support the process of delineating geographical areas within which activities listed in terms of the 2014 NEMA EIA Regulations may be identified and/or excluded
- Present the environmental attributes that inform the EMF in a spatial and electronic format that enables users to view and interrogate the EMF data at varying spatial scales.

Growth Management Strategy

The Growth Management Strategy that was approved by Council in January 2011 forms part of the SDF. The GMS uses densification as the main tool to redress and counteract the effects of urban sprawl. Most of the area surrounding Onrus Lagoon falls within Planning Unit 1, where no densification is proposed. The heritage overlay zone encompassing the estuary and the 'Point' coastal strip limits densification opportunities because spatial heritage development criteria would apply here. The limited capacity of the existing service infrastructure, particularly sewerage, is an additional constraint to further development. Furthermore, the Growth Management Strategy states that 'the green backdrop to the beach and estuary of Onrus contributes substantially to the environmental and visual significance of the area and should be conserved. No development which would impact on views from the beach and estuary should be permitted'. Some residential densification and mixed use opportunities are proposed for Onrus Main Road and upstream of the estuary.

Overstrand Zoning Scheme

A Zoning Scheme is a legal regulatory land use management tool that, amongst other, contains a list of zoning categories (Residential Zone, Business Zone, Public Open Space etc.) and the primary and consent land uses allowed per category. It also details the land use and development parameters applicable to each category, such as building lines, maximum height, coverage etc.

The 2013 Overstrand Zoning Scheme Regulations repealed the Zoning Scheme Regulations promulgated in 1988 in terms of section 7(2) of the Land Use Planning Ordinance, 1985 (Ordinance 15 of 1985). Revised zoning maps were published in terms of these new regulations in 2014 and land-use zones in the vicinity of the Onrus Lagoon are shown in Figure 20.

The Onrus Estuary Functional Zone is zoned primarily Public Open Space (dark green) in the lower estuary and agricultural zone (mint colour) in the upper estuary. The WWF owns the land on the eastern bank of the lower estuary, which is zoned Nature Reserve (light green) and lies adjacent to a large Resort Zone (Holiday Resorts, pink). The land westwards of the lower estuary is primarily zoned residential.

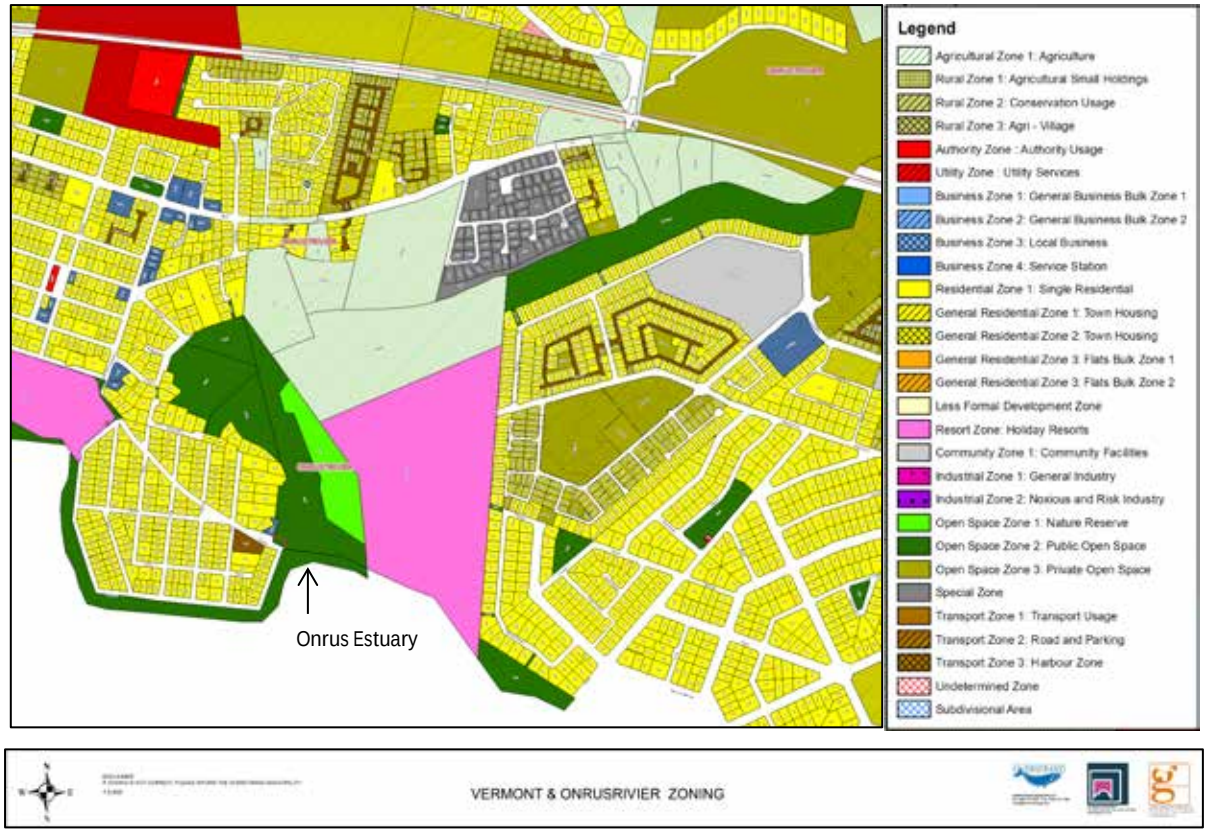

Figure 20 New zoning in the Onrus area for the Overstrand Municipality's Integrated Zoning Scheme of 2014 (Source: (Source: Overstrand Municipality 2014).

Spatial Development Framework

The Overstrand Local Municipality SDF is highly relevant to the management of the Onrus Estuary (Overstrand Municipality 2006). The vision and core ideas of the SDF directly speak to environmental issues including conservation, ecosystem services and environmental management (Table 13). The local planning proposals and strategies for the Greater Hermanus Area have several aspects that speak to the management of the Onrus Estuary. The Local Spatial Development Principles relevant to the Onrus Estuary aim to:

- Promote conservation of sensitive natural resources, including mountain backdrop and associated Fynbos reserves, a varied coastal strip and associated marine reserves and a series of river and estuarine systems;
- Promote conservation of cultural heritage resources, including the character of the historical fishing/holiday settlement areas of Hermanus and Onrus, the number of buildings of historical, architectural and social value [...];
- Promote Greater Hermanus as a tourism destination;
- Restrict industrial development [...];
- Maintain the open space corridors created by the Onrus River [...];
- Maintain the network of primary, secondary and linkage scenic routes [...] and
- Contain the urban footprint of Greater Hermanus within a well-defined urban edge.

The land use proposal at local planning level specifies that urban sprawl must be prevented and that an area specific densification policy should be compiled to ensure sustainable densification of residential areas. Sensitive areas of the biophysical environment should be managed with conservation objectives in mind. Wetland and vlei areas within the urban edge, open space linkages, coastline areas, dune systems, the Onrus River and estuarine environment were identified to be of particular importance.

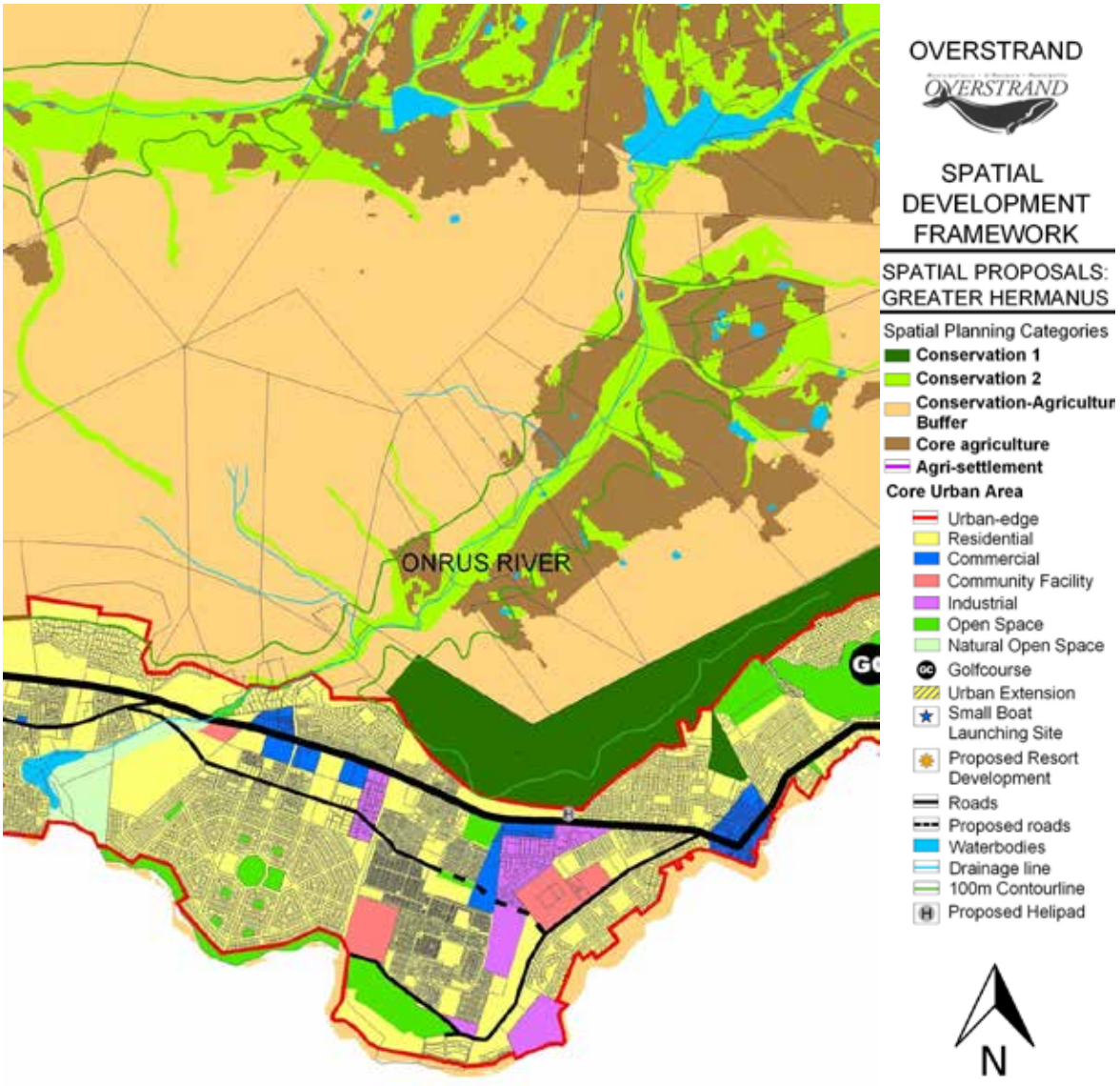

Figure 21 **The Spatial Development Framework 2006 for the Onrus Area (Source: Overstrand Spatial Development Framework 2006).**

Table 13 **The vision, mission (or goals/directives), objective and key strategies (or programmes/plans/policies) of the Integrated Development Plans (IDPs) and Spatial Development Frameworks (SDFs) of the Overberg District Municipality and Overstrand Local Municipality. Note that the vision, directives, objectives and policies of the Integrated Development Framework (IDF) are limited in applicability to the Key Actions Plan 20 for the Greater Hermanus Area (West) as detailed in Part 4 of the Overstrand IDF. Only those objectives and key strategies relevant to the management of the Onrus Estuary have been included here.**

	Vision	Mission/Goals/Directives	Relevant Objectives	Relevant Key Strategies/Programmes/Plans/Policies
Overberg District Municipality 2012-2017 IDP	*Totally committed to serve the Overberg*	*To render sustainable, client directed services and to be the preferred Provider of Shared Services within the Overberg*	Strategic Objective #1: To ensure the health and safety of all in the Overberg through the provision of efficient basic services and infrastructure in terms of disaster management, municipal health, environmental management.	• Operational effectiveness and efficiency of waste disposal services • Develop environmental planning management tools • Optimise stakeholder management approach
Overberg District Municipality SDF	*To optimize the rich and balanced mix of the Overberg's agriculture, tourism, heritage, conservation resources (including natural and scenic resources) and eco system services within their scenic setting which is contained by the Riviersonderend and Langeberg mountains in the north, descends across the rolling hills of the Rûens and the varied ecology of the Agulhas plain and culminates in the rocky headlands and long sandy beaches of the Atlantic and Indian oceans."*	*N/A*	The area's unique agricultural, environmental and urban qualities must be maintained	N/A
			Private conservation areas must continue to be promoted with careful consideration of appropriate development rights to mobilise the necessary resources for veld rehabilitation and management	
			Development and tourism efforts should take advantage of the district's close proximity to Cape Town as well as ensuring maximum benefits for local residents	
Overstrand Integrated Development Framework (IDF)	*An Accountable Overstrand Towards 2050*	*A liveable Overstrand*	Objective LO 7: The natural and built environments are well integrated, further contributing to the uniqueness and liveability of the Overstrand settlements.	(ii) Encourage the development of natural open space systems within urban and rural settlements
			Objective LO 8: The quality and attraction of the built environments are enhanced due to commitment to prioritising aesthetics and preserving	(i) Ensure that environmentally sensitive areas, significant cultural landscapes and heritage sites are protected and enhanced.

	Vision	Mission/Goals/Directives	Relevant Objectives	Relevant Key Strategies/Programmes/Plans/Policies
			its social and cultural attributes.	
		An environmentally sustainable and resilient Overstrand	Objective EO 2: Protect Biodiversity and agricultural resources.	(ii) Ensure that development is confined within urban edges and growth is managed based on sustainable densification principles.
			Objective EO 3: Overstrand's rural areas and settlements are integrated by natural environment or green corridors that connect ecosystems and contribute to biodiversity conservation.	(i) Encourage and support the development of networks of open space that sustain and enhance eco-system functioning, connect fragments of vegetation, protect waterways and regenerate the natural environment.
			Objective EO 4: Threats posed by climate change and natural disasters are reduced.	(ii) Encourage natural dune processes to occur where appropriate and pro-actively work towards reducing coastal erosion.
		A memorable and distinctive Overstrand	Objective MO 2: Overstrand settlements are well integrated with the natural elements from its surrounding areas.	(ii) Encourage and support the development of networks of open space that sustain and enhance eco-system functioning, connect fragments of vegetation, protect waterways and regenerate the natural environment.
			Objective MO 3: The identity, character, and history of the diverse settlements that make up the Overstrand are protected and celebrated.	(ii) Ensure that environmentally sensitive areas, significant cultural landscapes and heritage sites are protected and enhanced.
		An Overstrand that enables a prosperous and diverse economy	Objective ECO 1: Overstrand maintains and strengthens its tourism sector.	(i) Ensure that environmentally sensitive areas, significant cultural landscapes and heritage sites are protected and enhanced.
				(ii) Ensure that tourism destinations are accessible, safe and attractive by means of maintaining and developing

	Vision	Mission/Goals/Directives	Relevant Objectives	Relevant Key Strategies/Programmes/Plans/Policies
				new facilities.
Overstrand Local Municipality IDP 2012-2017	*To be the centre of excellence for the community*	*Creation of sustainable communities by delivering optimal services to support economic, social and environmental goals in a politically stable environment*	Strategic Objective #3: The encouragement of structured community participation in the matters of the municipality. → KPA 4 Good Governance	• Effective cooperative government within the Constitutional mandate • Effective communication and community involvement
			Strategic Objective #4: The creation and maintenance of a safe and healthy environment. → KPA 5 Safe and Healthy Environment	• Effective public safety and disaster management • Effective environmental management
Overstrand Local Municipality SDF 2006	*Overstrand Municipality is striving to be the most desirable destination to visit, stay and do business.*	*To implement an effective management system for the protection of biological diversity and ecosystems through the co-operation of all concerned*	Irreplaceable, threatened, highly dynamic and sensitive elements of the environment shall be protected	
			Adequate and effective measures shall be implemented to ensure co-ordination of environmental responsibilities by key role players and monitoring of usage in sensitive areas.	
		To develop and maintain a strong local economic base in rural areas, through the promotion of non-consumptive tourism and the role of agriculture in the municipal economy.	To develop a clear and appropriate tourism management/capture strategy based on natural and heritage resources of the rural areas	
		To protect and conserve the heritage resources of the area	To promote the conservation and inclusion of important heritage resources into a sub-regional tourism strategy	
			To improve and develop tourism related facilities.	
		To provide environmentally and economically sustainable bulk service infrastructure and road transport	To ascertain the overall carrying capacity of existing bulk services related to existing and future growth, and where appropriate, determine	

	Vision	Mission/Goals/Directives	Relevant Objectives	Relevant Key Strategies/Programmes/Plans/Policies
		network	flood lines	
			To improve and maintain the standard of bulk services with particular reference to bulk water supply, sewerage, and solid waste and sewage management	
		To promote the conservation and sustainable use of the natural resources in the Overstrand municipal area.	To protect, conserve, and restore where appropriate, all areas deemed to be conservation worthy	
			To ensure that the impact of existing and proposed development is adequately evaluated from an holistic environmental perspective, taking current and future generations into account	
			To promote the sound management of natural areas to ensure their sustainability	
			Rehabilitate and/or restore degraded and disturbed environments where necessary to meet conservation or environmental management objectives	
			To limit and control development and activities within environmentally sensitive and/or conservation worthy areas so as to ensure their sustainability taking into account effects on biodiversity.	

5.3.3 Issues of surrounding land use and development

A number of property erfs extend across the estuary, two of which are owned by the municipality, but there are also some belonging to private landowners or designated public open space when the area was developed (Figure 22). A portion of the municipal land was donated to the SANF (now WWF) in the early 1990s and designated a bird sanctuary, although it has no formal protected area status. The Onrus Lagoon Trust has managed the land on behalf of Overstrand Municipality, but support from the Environmental Management Services section is now warranted.

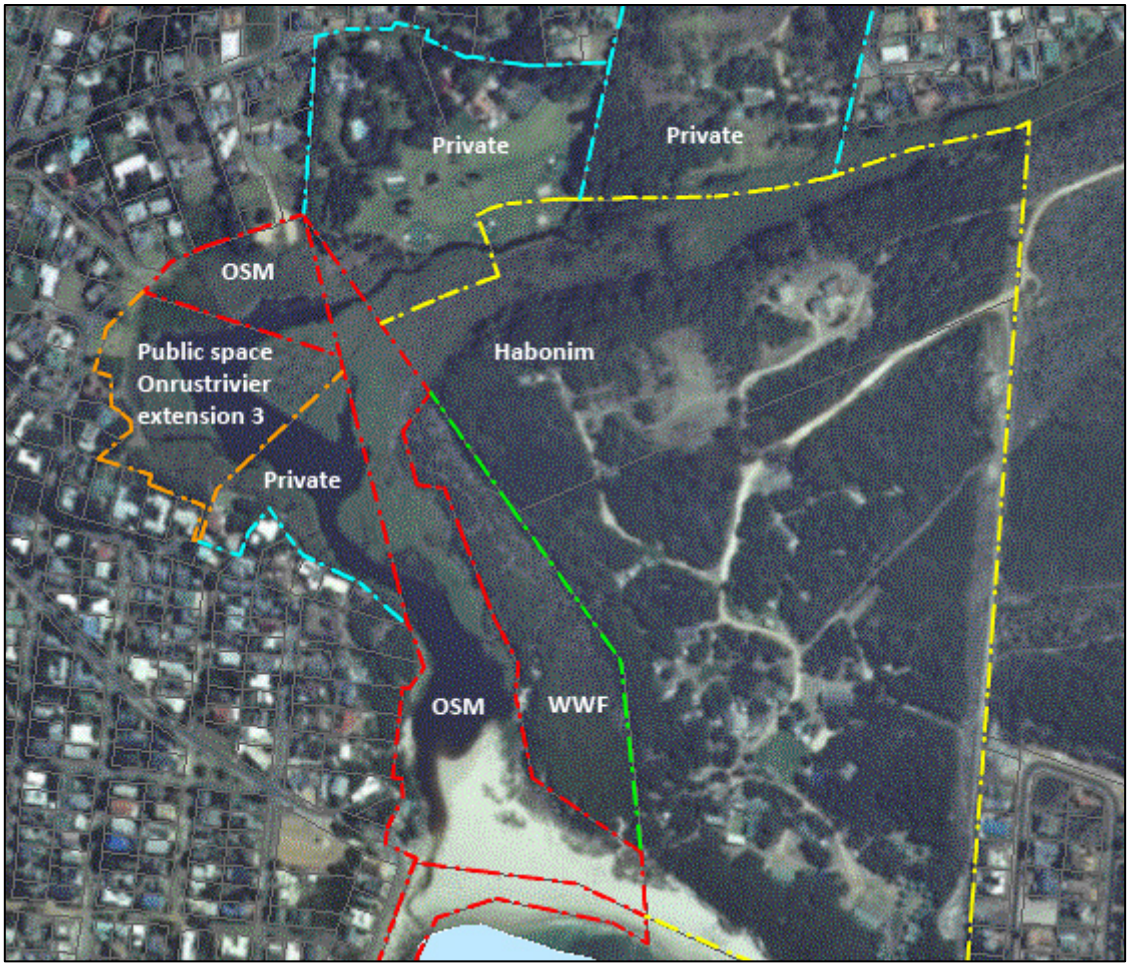

Figure 22 Land ownership around Onrus Lagoon

There is currently relatively little development and use of the margins of the Onrus Estuary and land ownership, current zonation as well as future planning indicates that not much more additional development will occur. The town Onrus has been identified to hold medium potential for development with very low social needs. Furthermore, the Onrus Lagoon and the Onrus WWF Reserve were identified as special places in the Overstrand IDF, which recommends a management approach that aims to protect and manage the functioning of the Onrus River and Estuary as an ecological corridor and linear open space area. The only land that could potentially be developed within and directly adjacent to the estuarine functional zone is the private land north of the upper

reaches of the estuary. This land is zoned agricultural and re-zoning would be necessary prior to development other than for agricultural purposes.

It is likely though that increased tourism related development in the Greater Hermanus Area as a whole may attract more people to utilise the Onrus Estuary for recreational purposes. This will have to be managed appropriately to prevent disturbance, pollution and degradation of the bio-physical environment. It is not anticipated that the cultural heritage of the area will be impacted by future land-use in the surroundings of the Onrus Estuary, as development planning goals consider important heritage sites.

5.3.4 Coastal Management Programmes

The draft Coastal Management Programme (CMP) for the Overberg District Municipality and the Overstrand Local Municipality were developed in accordance with the requirements of ICMA Chapter 6 (Section 48, 49 and 50). Given the different roles that district and local municipalities are expected to play in integrated coastal management; the Overberg District Municipality CMP forms the coastal management framework within which the accompanying components of the three local coastal municipalities - Overstrand, Agulhas and Swellendam – operate within the jurisdiction of the ODM. While CMPs at the municipal level are fundamentally operational in comparison to the national and provincial CMPs, the ODM CMP must be more strategic than its three accompanying CMPs. The focus of the supplementary CMPs for the three local municipalities within ODM is therefore explicitly operational and context-specific.

The overall vision is the same for both CMPs, but is worded slightly different. The Overberg District Municipality CMP vision reads:

"We, the people of the Overberg District Municipality, celebrate the diversity, beauty and uniqueness of our coast and its communities. We strive for a safe, accessible coastal environment that is sustainably managed and protected for the benefit of current and future generations."

Priority Areas, Objectives and implementation strategies have been identified in the Draft CMPs for the Overberg District Municipality and the Overstrand Local Municipality of which all are directly relevant to the management of the Onrus Estuary. These are presented in more detail in Table 14. For each of the implementation strategies, indicators and a budget (where appropriate) have been allocated. These numbers are not presented in the SAR but should be considered when allocating budget for the various action plans of the Onrus EMP.

Table 14 Priority Areas, Goals, Objectives and Implementation Strategies of the Overberg District Municipality and Overstrand Local Municipality Coastal Management Programmes.

Priority Areas	Goal	Objectives	Implementation Strategies/projects OBM	Implementation Strategies/projects OLM
1. Facilitating Coastal Access	*Provide reasonable and equitable access to the coast for all*	1. Ensure that the public has the right of physical access to coastal public property, and along the seashore on a managed basis, taking into account historic and cultural resources and activities 2. Ensure that the public has the right of equitable access to the opportunities and benefits of the coast on a managed basis 3. Ensure that the public has reasonable access to registered public launch sites for coastal recreation	· Coastal access inventory framework for ODM (link to ODM Environmental Management Plan) · ODM Coastal Access Management Plan (CAMP) including provision, maintenance and management of coastal access and addressing coastal management objectives (linked to ODM EMP) · Report to MEC on status of coastal access within the Overberg District	· Coastal access inventory framework for ODM (link to ODM Environmental Management Plan) · Boat launch site management
2. Compliance and enforcement	*Promote compliance and enforcement of legislation to facilitate protection of coastal resources within municipal mandate*	1. Improve compliance with coastal and other relevant laws and regulations 2. Ensure visible, effective and coordinated law enforcement as mandated	· Implementation of coastal management by-law along with local municipalities to ensure consistency · Coordination of other local municipality by-laws to ensure consistency with respect to coastal management issues, e.g. stormwater	· Implementation of existing OLM by-laws, including the CMP implementation by-law
3. Estuaries	*Ensure appropriate management and conservation of estuaries*	1. Develop and implement estuarine management plans for all estuaries 2. Ensure estuarine management structures are in place for all estuaries	· Coordinate development of outstanding estuary management plans by agencies designated in terms of the National Estuarine Protocol (CapeNature, DEADP, Local municipalities), including estuarine management structures	· Develop estuary management plans (EMPs) that are compliant with the National Estuarine Management Protocol for estuaries within the OLM.
4. Land and Marine-Based Sources of Pollution and Waste	*Minimise the impacts of pollution on the coastal environment*	1. Develop and implement pollution control and waste management measures to minimise and control harmful discharges into coastal ecosystems 2. Monitor and manage polluting activities (only ODM)	· Maintenance and management of bulk sanitation infrastructure including wastewater treatment works and sea outfalls · Water quality monitoring (link to Environmental Health by-0law), coordination and implementation of Waste Management Plans	· Local waste management initiatives to address litter and waste in the coastal zone (such as adequate and well-manged waste disposal facilities in designated areas)
5. Cooperative Governance and	*Promote integrated and cooperative governance*	1. Assess potential institutional arrangements for coastal management	· Formalise municipal coastal committee · Supporting/assisting local municipalities in	· Ongoing participation in ODM municipal coastal committee (MCC).

Priority Areas	Goal	Objectives	Implementation Strategies/projects OBM	Implementation Strategies/projects OLM
Local Government Support	*of the coastal zone and coastal planning/governance*	2. Promote partnerships to foster co-responsibility in coastal management	respect of coastal management functions including cooperative governance agreements/initiatives to address funding structures, areas of special management etc.	
6. Climate Change, Dynamic Coastal Processes and Building Resilient Communities	*Promote resilience to the effects of dynamic coastal processes and environmental hazards and natural disasters*	1. Ensure coastal development and planning provides for the effects of climate change, natural hazards and dynamic coastal processes 2. Develop a uniform approach in dealing with existing infrastructure at risk and areas of coastal vulnerability	· Implement the Coastal Management Lines (coordination of local municipalities) · Disaster management including coordination, incident reporting, and commenting on development applications from an environmental risk perspective	· Implement the Costal Management Line and Environmental Overlay Zone within OLM
7. Natural Capital and Natural Resource Management	*Promote conservation of biodiversity, ecosystem function and the sustainable use of natural resources*	1. Maintain and promote a network of coastal protected areas 2. Identify and rehabilitate damaged or degraded coastal ecosystems and habitats	· Assist Local municipalities in coordinating with CapeNature, SANParks, DEADP, DEA, etc. in terms of protected areas and potential rehabilitation projects.	· Management of local protected areas, parks and conservancies Rehabilitation of damaged and degraded coastal area to be prioritised (Environmental Overlay) · Development of mammal stranding policy/procedure in association with South African Whale Disentanglement Network/Dolphin Action& Protection Group
8. Social, Economic and Development Planning	*Promote sustainable local economic development*	1. Identify, develop and implement sustainable local economic development projects 2. Promote eco-tourism opportunities (OLM only)	· Provision of amenities and infrastructure that promote local economic development at resorts and comments/input on development applications, rezoning, etc. with a local economic development component	· Assess potential for new Blue Flag beaches in OLM · Assess potential and feasibility for local economic development (LED) initiatives in coastal areas that are dependent on a coastal location, e.g. aquaculture, coastal eco-tourism (non-consumptive), science and technology and education
9. Education and Capacity Building	*Promote coastal awareness, education and training*	1. Promote public awareness about the coastal zone 2. Assess training requirements for coastal managers and other stakeholders to ensure more effective coastal planning and management (OLM only)	· Implementation of National Strategy for Coastal Awareness, Education and Training in ODM	· Implementation of National Strategy for Coastal Awareness, Education and Training through local awareness and education programmes, including the provision of signage · Assessment of training requirements to boost coastal management capacity (potentially raise as agenda item at municipal coastal committee

5.3.5 Requirements for Estuary Management Plans

The National Estuary Management Protocol (NEMP) has been published in the in terms of the ICMA (GN R.314 published in GG 36432 of 10 May 2013) and is designed to provide guidance for the management of estuaries through the development of individual estuarine management plans including inter alia:

I. Determine a strategic vision and objectives for achieving effective integrated management of estuaries;
II. Set standards for the management of estuaries;
III. 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;
IV. Establish minimum requirements for estuarine management plans;
V. Identify who must prepare estuarine management plans and the process to be followed in doing so; and
VI. Specify the process for reviewing estuarine management plans to ensure that they comply with the requirements of the ICM Act.

The NEMP also outlines a national vision for estuarine management is as follows: "The estuaries of South Africa are managed in a way that benefits the current and future generations."

Objectives for effective integrated management of estuaries as outlined in the NEMP include the following:

I. To conserve, manage and enhance sustainable economic and social use without compromising the ecological integrity and functioning of estuarine ecosystems;
II. To maintain and/or restore the ecological integrity of South African estuaries by ensuring that the ecological interactions between adjacent estuaries, between estuaries and their catchments, and between estuaries and other ecosystems, are maintained;
III. To manage estuaries co-operatively through all spheres of government; and to engage the private sector and civil society in estuarine management;
IV. To protect a representative sample of estuaries (such protection could range from partial protection to full protection) in order to achieve overall estuarine conservation targets as determined by the National Biodiversity Assessment of 2011 and the subsequent updates.
V. To promote awareness, education and training that relate to the importance, value and management of South African estuaries; and
VI. To minimise the potential detrimental impacts of predicted climate change through a precautionary approach to development in and around estuaries and with regard to the utilisation of estuarine habitat resources.

The following management standards are prescribed under the NEMP:

I. Estuarine management must aim at best practice in terms of use, management and protection of estuaries based on principles of ecological sustainability and co-operative governance;
II. Estuary management planning must consider the predicted impacts of climate change and management of potential disasters including pollution events;

III. Integration of land use planning and natural resource management outcomes with estuarine management outcomes must be promoted;
IV. Management actions should be based on sound scientific evidence and where lacking, the precautionary approach should prevail;
V. An estuary must be managed to avoid, minimise or mitigate significant negative impacts that include but are not limited to reduced water flows and loss of habitat or species;
VI. An estuary must be maintained in its ecological category as determined in the 2011 NBA and subsequent updates in order to meet biodiversity targets, and to take into account the recommended extent of protection and recommended ecological health category; and
VII. The classification and setting of the Ecological Reserve and Resource Quality Objectives (RQO) of an estuary must take into account the current ecological health status, recommended extent of protection and recommended ecological category in order to meet the biodiversity targets as set in the 2011 NBA and the subsequent updates.

Responsibilities for the development of Estuarine Management Plans are prescribed in NEMP Regulation 5 as follows:

1. Where an estuary falls within the boundary of a single local municipality, the municipality must develop an EMP in consultation with the relevant government departments, except if the estuary is within the boundaries of a protected area or is identified as part of the protected area expansion strategy;
2. Where an estuary falls within the boundary of more than one local municipality, the district municipality must develop an EMP in consultation with the affected local municipalities, provincial and national government departments. The district municipality may in writing agree with the relevant local municipality/ies that the latter shall be responsible for developing an EMP. Copies of such agreements must be submitted to the relevant provincial environmental department for integrated coastal management within 30 days of them being concluded;
3. Where an estuary falls within the boundary of more than one district municipality, the provincial environmental department shall develop an EMP, in consultation with the affected district municipalities and the relevant national government departments;
4. Where an estuary crosses the boundaries between provinces, the Department must develop an EMP in consultation with Provincial Lead Agencies for the ICM Act and other relevant national government departments;
5. Where an estuary is within a protected area or is identified as part of a protected area expansion strategy, the management authority responsible for the protected area must develop an EMP in consultation with relevant government departments.
6. Where an estuary is in a harbour, the Department must develop an EMP in consultation with the NPA or other managing organs of state for a harbour and relevant municipalities; and
7. Where an estuary crosses a state boundary, the Department in collaboration with the responsible authority of the affected state/s must develop the EMP in consultation with relevant government departments of the affected states.

Regulation 9 of the NEMP further specifies that the responsible management authority (RMA) must review the EMP and consider any comments received during the public participation process. The RMA must then obtain approval for the EMP as follows:

(a) Where an EMP has been developed by local and/or district municipality, the MEC of the relevant provincial Department shall approve the EMP; and
(b) Where an EMP has been developed by the Provincial Lead Agencies for the ICMA, or a provincial conservation agency or provincial environmental Department or the National Conservation Agency, the Minister of the national department responsible for Environmental Affairs shall approve the EMP.

According to the NEMP and in the case of the Onrus Estuary, which is located wholly within the Overstrand Local Municipal area, Regulation 5.1 would prevail, implying that this municipality should be responsible for the development, approval and implementation of the EMP for this system. The Overstrand Local Municipality (OLM) should therefore submit the EMP to the Provincial Department of Environmental Affairs and Development Planning (DEADP) for approval (as per Regulation 9(a)).

However, at the time of writing, the Supreme Court of Appeal, in the case *Abott vs Overstrand Municipality* (99/2015) [2016] ZASCA 68 (20 May 2016), ruled that the OLM is currently not authorised to manage the Klein Estuary under the provisions of ICMA (i.e. the NEMP). The Supreme Court of Appeal Judgement found that: "[…] any powers which the municipality may wish to exercise with regard to the estuary have to be assigned to it by national or provincial legislation." According to this judgement, no powers or duties regarding the management of the Klein Estuary had been assigned to the OLM. This ruling has repercussions with regards to the management of all estuaries in the OLM, including the Onrus Estuary. Consequently, at this point, neither the OLM nor the Overberg District Municipality (ODM) can take responsibility to coordinate the function of the RMA for the Onrus Estuary until the mandate has been devolved to one of the municipalities.

The OLM or ODM will accept the mandate to manage estuaries in terms of the NEMP once the DEADP/DEA has devolved the responsibility to either authority and has allocated sufficient funds and capacity to the RMA to perform this function effectively. Therefore, defining the RMA for the Onrus Estuary will be a crucial step in the successful implementation of the EMP.

5.3.6 Overberg Coastal Management Lines

Historically, development in the coastal zone has been controlled largely through the EIA regulations published in terms of the NEMA, which require that an EIA be conducted for the development of any infrastructure within 100 m of the high-water mark. Recognising, however, that as well as being sensitive, vulnerable, and often stressed ecosystems, coastal areas are also highly dynamic in both space and time, and cannot be boxed within fixed boundaries, the approach to controlling development in coastal areas has changed dramatically in recent years. This is particularly pertinent in the light of climate change where rising sea-levels and potential increases in the frequency and intensity of storm events are upping the stakes even further. These changes are being implemented through the ICMA (as amended in 2014) which calls for coastal management lines to be determined for all coastal areas. Specifically, section 25 of the ICMA indicates the priority for coastal management lines to be established (or changed from existing locations), as follows:

25. (1) An MEC must by notice in the Gazette—
a. establish or change coastal management lines:
i. to protect coastal public property, private property and public safety;

ii. to protect the coastal protection zone;
iii. to preserve the aesthetic values of the coastal zone; or
iv. for any other reason consistent with the objectives of this Act; and

(1A) An MEC may, in regulations published in the Gazette, prohibit or restrict the building, erection, alteration or extension of structures that are wholly or partially seaward of a coastal management line.

(1B) When establishing coastal management lines in terms of subsection (1), the MEC must consider the location of immovable property and the ownership and zonation of vacant land.

The establishment of coastal management lines is to follow a participatory approach:

(2) Before making or amending a notice referred to in subsection (1), or making the regulations referred to in subsection (1A), the MEC must—

b. consult with any local municipality within whose area of jurisdiction the coastal management line is, or will be, situated; and
c. give interested and affected parties an opportunity to make representations in accordance with Part 5 of Chapter 6.

Coastal management lines are to be plotted on maps as part of zoning and made available to public, as indicated in the ICMA:

(3) A local municipality within whose area of jurisdiction a coastal management line has been established must delineate the coastal management line on a map or maps that form part of its zoning scheme in order to enable the public to determine the position of the coastal management line in relation to existing cadastral boundaries.

In response to the above motivation and legal requirements, the DEA&DP commissioned WSP Africa Coastal Engineers (Pty) Ltd to develop a methodology for defining and adopting coastal development management lines in the Western Cape. The final report entitled Development of a Methodology for Defining and Adopting Coastal Development Setback Lines in May 2010 (WSP Africa Coastal Engineers 2010a) guided the development of the Draft Costal Management Lines and Coastal Overlay Zones for the Overberg District Municipality.

A **Coastal Management Line**, as envisaged by the amended ICM Act, is informed by the projections of risk generated in the first phase of the study, information on ecological or other sensitivities adjacent to the coast, as well as the location and extent of existing development and existing executable development rights. The CML is intended as a clear guideline for the management of development within risk areas, and the protection of coastal public property. The Overberg CML therefore differentiates between areas along the coastline with existing development rights and/or part of future municipal development, and those areas that should be left undeveloped due to a high risk from dynamic coastal processes or as coastal public property. The CML also extends along estuaries, and in developed areas along the banks of the estuary is aligned with the lower (water side) boundary of properties with existing development or development rights. In rural areas, the CML runs along the 5m amsl contour around estuaries or landward of identified coastal (estuarine)

sensitivities (Figure 23). Where the watercourse is defined by cadastral lines as a linear property which is wider than the 5m amsl contour, the property boundary is used.

Coastal Management Overlay Zones on the other hand are collectively envisaged as the area close to the sea/estuary within which development should be managed in order to preserve coastal quality and protect property and lives. Development in these zones is possible under certain circumstances and after appropriate environmental and risk assessments have been undertaken. Restrictions in this area can be applied strictly and consistently, since it is informed by information on the level of risk emanating from coastal processes such as coastal erosion, storm surges, sea level rise and storm wave run-up that informed scientifically modelled hazard zones.

Three Coastal Management Overlay Zones are proposed for ***urban areas***:

- High risk zone→20 year horizon (i.e. short-term)→0m amsl to high risk line
- Medium risk zone→50 year horizon (i.e. medium-term)→ High risk line to medium risk line
- Low risk zone→100 year horizon (i.e. long-term)→ Medium risk line to low risk line

In ***rural areas***, the risk grading from low to high is not necessary, and hence only a single 'risk' zone is indicated as the entire area between the 0m amsl and landward boundary of the low risk (long term risk) zone. The risk zone is expanded in places where littoral active zones are present, as these contribute to the risk of exposure to possible future coastal erosion

With regards to ***estuaries***, the risk-based zoning needs to be amended in order to accommodate the limited availability of information on localised estuarine dynamics. Consequently, it is proposed that a similar approach be taken as for rural areas, i.e. a single risk zone. This risk zone is, however, determined on the basis of inundation levels rather than wave impact risk. The risk zone is therefore considered to be the area below the 10 m amsl contour around estuaries. Where a clearly defined contour is not available, the nationally accepted SANBI demarcation of the estuarine boundaries is used.

Together, these planning tools recognise existing development and development rights while directing development into the lower risk areas and informing how the development should be undertaken such that property, people and the integrity of the coast can be protected. The draft coastal management lines and overlay zones for the Onrus Estuary are shown in Figure 23 Future development in the Onrus Estuary will be guided by these spatial planning tools. Specific activity, building and design requirements must be fulfilled within the Estuarine General Risk Overlay Zone (Overberg Municipality 2015a).

Currently, this information is in preparation to be published in terms of ICMA (as amended) in the Government Gazette for public comment. It is important to note that this product is therefore subject to change if the outcomes of the formal public participation process should require such changes. Unlike the coastal management lines, the overlay zones have no legal standing under the ICMA and therefore the overlay zones are likely to be published in the Government Gazette in form of supporting documentation (DEA&DP, pers. comm., 2014). Once the notices have been promulgated/adopted, the overlay zones will be given effect by incorporation into the municipal planning schemes under Municipal Systems Act (No. 32 of 2000). In the interim, the coastal management lines and overlay zones have been used to inform decision making by the Overstrand

local and Overberg district municipalities (DEA&DP, pers. comm. 2015). To aid implementation of these management tools, the DEA&DP has developed a web-based viewer, where all the above information can be accessed for a chosen location[2].

Figure 23 **The green line represents the Coastal Management Line and the purple line the 10 m above mean sea level contour line that partially delineates the Estuarine General Risk Overlay Zone. The purple area shows the general risk zone in rural areas (1:100 year risk zone) that has been adapted for the Onrus Estuaries by incorporating the 10 m amsl line. The grey area outlines development islands within the 1:100 year risk zone. The red, orange and yellow areas represent the high (1:20), medium (1:50) and low (1:100 year) risk zones for the urban/developed areas respectively (Source: DEA&DP 2016).**

5.3.7 Overstrand environmental and heritage overlay zones

Overlay zones provide a mechanism for land use management, additional to the base zone controls of a property, whereby Council may give effect to specific guidelines in a spatial development framework or policy plan or address a specific management issue. Within specified areas these guidelines could promote development, require a limitation of land uses, define additional, stipulate more or less restrictive development rules, or identify specific development rules or administrative procedures. Overlay zones provide a mechanism for elevating specific policy guidelines to land use regulations.

Urban Dynamics (Western Cape) were appointed by the Overstrand Municipality to compile Environmental and Heritage Overlay Zones for inclusion in the Overstrand Municipal Zoning Scheme.

[2] Note that the website is still under construction and coastal management lines, hazard lines (overlay zones) and launching sites are still to be added to the web-based viewer. This information will be available at: http://gis.westerncape.gov.za/apps/DEADPCoastalManagementViewer/

The draft overlay zones are currently being refined for delivery and statutory approval is likely to be granted around the fourth quarter of 2016.

5.4 Water quality and quantity requirements

Estuaries have a limited capacity to assimilate effluent by virtue of their low volume and limited exchange with the sea. Estuaries are of high conservation value and serve as nursery areas for a range of fish and invertebrate species that are important in commercial, recreational and artisanal fisheries. A wide range of recreational activities including beach activities, boating, hiking and birding are common in estuarine environments. Estuaries are considered sensitive environments as they have high water quality and variable water quantity requirements to sustain ecological functioning and their aesthetic value (RSA DEA, 2014).

5.4.1 Legislative context for pollution control

Discharging of waste or water containing waste into a "water resource through a sea outfall or other conduit" is listed as a "water use" for which a "licence" is required in terms of the Act, unless such use was authorised through a "general authorisation" indicated by a notice published in the Government Gazette. General Authorisation No. 399 of 2004 exempted users from having to apply for water use licences for the discharge of water containing waste into a water resource provided that the discharge was within certain specified limits and conditions.

More recently, with the promulgation of the National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008) (ICMA) (as amended[3]), responsibility for regulating land-derived effluent discharges into coastal waters (including estuaries) was transferred to the Department of Environmental Affairs (DEA). In terms of Section 69 of ICMA, no person is permitted to discharge effluent originating from a source on land into coastal waters except in terms of a General Discharge Authorisation (GDA) or a Coastal Waters Discharge Permit (CWDP). A GDA can only be issued by notice in the Gazette by the Minister responsible for environmental affairs and in instances of discharge of effluent into an estuary, only after consultation with the Minister responsible for water affairs. The DEA is currently in the process of establishing a permitting system for such effluent discharges. For this purpose, the Assessment Framework for the Management of Effluent from Land Based Sources Discharged to the Marine Environment was recently developed (AEC, 2015b). Although all discharges into estuaries are currently operating in terms of the general authorisation or a licence issued by the DWS in terms of the NWA, future discharges into estuaries will be regulated by the DEA in terms of the ICMA.

In line with the National Guideline for the Discharge of Effluent From Land-based Sources into the Coastal Environment (RSA DEA, 2014) the Assessment Framework for the Management of Effluent from Land Based Sources Discharged to the Marine Environment (AEC, 2015b) recommends that

[3] ICMA was amended by the National Environmental Management: Integrated Coastal Management Amendment Act, 2014 (Act No. 36 of 2014) (ICMAA).

discharge of effluent originating from land-based sources into estuaries should only be permitted under exceptional circumstances:

I. Where inflows provided by effluent discharge are required to improve or maintain defined resource quality objectives for an estuary. In this case effluent quality must meet receiving environment water quality guidelines for the Natural Environment (RSA DWAF, 1995) and Recreational Use (RSA DEA, 2012) at the end of the pipe; or
II. Where the ecological functioning has been irreversibly modified (only applicable to systems identified in the National Biodiversity Assessment: Estuaries Component). In this case effluent quality must not lead to any further deterioration in water quality in the system.
III. Effluent discharged from existing outfalls should be required to comply with water quality guidelines for the receiving environment at pipe-end.
IV. Effluent discharges into estuaries should not be permitted in terms of a GDA.

The National Environmental Management: Waste Act (Act 59 of 2008) (NEMWA) also has, even though to a lesser extent, bearing on the water quality of an estuary, primarily by controlling and regulating terrestrial waste handling and disposal. This should reduce the amount of waste entering an estuary through stormwater outlets, uncontrolled runoff as well as leaching of pollutants into the estuary from surrounding lands. However, this discussion focuses on NWA and the ICMA as being the most pertinent to the development of the Onrus Estuary Management Plan.

5.4.2 Legislative context for water resource reserve determination

The NWA specifically recognised that protection of the quality of the country's water resources (including estuaries) is necessary to ensure sustainability of these resources. The NWA promotes efficiency, equity and sustainability in the use of water resources and explicitly recognises the environment as a legitimate user of water. Chapter 3, Part 3 of the NWA requires determination of Classification and Resource Quality Objectives for all water resources, including estuaries. A focal aspect of this strategy is defining the "Reserve" which provides the quantity and quality of water flow required to meet basic human needs and to protect the natural functioning of a water resource. The latter portion of the reserve is defined as the environmental Reserve and represents the quality and quantity of water required to maintain a desired level of structure and function, or quality, of a specific aquatic system.

5.4.2.1 The Classification Process

The extent to which an estuary's functioning is catered for is determined by the designated "class" (= future state of health) of that estuary, with some estuaries being assigned a low class to allow maximal water provision and others being assigned a high class in order to meet conservation needs. The decision as to the designated class of the estuary is thus a critical one and the procedure for the water resource classification is standardised in the Regulations for the Establishment of the Classification System, 2010 (Government Notice R 810 in the Government Gazette 33541 (17 September 2010)). This process entails consideration of the trade-offs in value generated by allocating water (or pollution rights) to off-stream users (e.g. irrigation agriculture), flow-reducing

activities (e.g. plantation forestry) and polluters (e.g. municipalities, farmers) versus allocating water to the environment for the provision of ecosystem services (e.g. fishing, tourism). The Catchment Management Agencies[4] will in future probably play the key role in this decision –making process, but until these agencies are operational, decisions are being made with the aid of water situation assessments known as Internal Strategic Perspectives (ISPs) that were developed as an interim aid.

5.4.2.2 The Reserve Determination Process

The Reserve determination process is laid out in the Regulations for the Establishment of the Classification System, 2010 and involves the following eight steps:

Step 1 Initiate the basic human needs and Ecological Water Requirements assessment;

Step 2: Determine eco-regions, delineate resource units, select study sites;

Step 3: Determine the reference condition, present ecological status and the ecological importance and sensitivity of each of the selected study sites;

Step 4: Determine the basic human needs and Ecological Water Requirements for each of the selected study sites;

Step 5: Determine operational scenarios and its socio-economic and ecological consequences

Step 6: Evaluate the scenarios with stakeholders;

Step 7: Design an appropriate monitoring programme; and

Step 8: Gazette and implement the reserve

The reserve determination study relies on the Resource Directed Measures methodology[5] in conjunction with considerations of the demand for water in the catchment and the classification process described above effectively standardises the way this is done. A Reserve Determination Study has not yet been initiated for the Onrus River System and estuary.

[4] Catchment management agencies (CMAs) are statutory bodies established by a notice in the government gazette in terms of Chapter 7 of the NWA, with jurisdiction in a defined water management area (WMA). A CMA therefore manages water resources and coordinates functions of other institutions involved in water related matters within WMAs. A CMA begins to be functional once a governing board has been appointed, and is then responsible for specified initial functions, as well as any other functions delegated or assigned to it.

[5] The objective of Resource Directed Measures (RDM) is to ensure the protection of water resources, in the sense of protecting ecosystem functioning and maintaining a desired state of health (integrity or condition) of aquatic and groundwater-dependent ecosystems (RSA DWA, 2010).

5.4.3 Implications for the Estuary

The estuary is degrading under the current flows, levels of nutrient input and bacterial contamination. The main consequences of maintaining the Onrus Estuary in an Ecological Category D through these flows are considered to be as follows:

- Repeated encroachment of the common reed *Phragmites australis* into open water over time. This is an anticipated long-term change that would reverse the positive effects of the dredging event in 1993/1994
- Reduced aesthetic value and health risk due to unacceptable bacterial contamination;
- A decrease in bird species that prefer open water habitat and other habitat than reed beds;

5.5 Exploitation of Marine Living Resources

5.5.1 Legislative Context

The exploitation of marine living resources in South Africa (which includes those in estuaries) is governed by the Marine Living Resources Act (Act No. 18 of 1998) (as amended). Objectives of the MLRA are as follows:

- to achieve optimum utilisation and ecologically sustainable development of marine living resources;
- to conserve marine living resources for present and future generations, to use marine living resources;
- to achieve economic growth, human resource development, capacity building within fisheries and mariculture branches, employment creation and a sound ecological balance consistent with the development objectives of national governments;
- to protect the ecosystem as a whole, including species which area not targeted for exploitation; and
- to preserve marine biodiversity.

The MLRA and regulations promulgated in terms of the Act define the species that can be exploited, and protection measures for those species, such as closed areas, closed seasons and size and bag limits. Various types of resource-use permit systems are also defined under this act.

5.5.2 Issues Surrounding Recreational Fishing

Compared to other estuaries along the southwest and east coasts, the Onrus Estuary is currently utilised by a relatively low number of recreational fishers who seem to catch negligible amounts of fish (see section on recreational angling). In the broader region, the most important exploited fish species include dusky kob *Argyrosomus japonicus*, white steenbras Lithognathus lithognathus, leervis *Lichia amia*, elf *Pomatomus saltatrix* and various mullet species (*Liza richardsonii, Liza dumerili, Myxus capensis, Mugil cephalus*). Of these important species, only the mullet species have been recorded in the Onrus Estuary. In accessible estuaries the high catchability of juveniles and sub-adults make the first four species extremely vulnerable to overexploitation. Nationally, the

stocks of *A. japonicus* and *L. lithognathus* are overexploited and in a collapsed state. Due to the absence of prawns in the Onrus Estuary, bait collection is rarely practiced here.

Due to the large number of participants, and associated expenditure (tackle, bait, accommodation, food, travel costs), recreational fisheries have been shown to contribute significantly to regional economies (Mann *et al.*, 2002; Lamberth and Turpie, 2003; Pradervand *et al.*, 2003). It has been shown that the demand for recreational angling is largely driven by a desire for relaxation and that the quantity of fish caught does not negatively affect the expenditure by recreational anglers (McGrath *et al.*, 1997).

5.6 Non-consumptive recreational use

5.6.1 Legislation

There is no legislation at present that specifically controls non-consumptive recreational use of the estuaries but specific activities can be controlled in terms of the NEMA, NEMPA or the ICMA. For example, zonation of recreational uses of legally protected estuaries (marine protected areas, national parks or nature reserves) is an effective tool to control activities that pose a significant disturbance to a system with conservation importance (NEMPA).

Furthermore, Section 10 of the Seashore Act (1935) is the most common means used to control recreational boating activities in estuaries with powers delegated to Provincial Authorities (in this case the Western Cape Provincial Government). Most of the provisions in this Act aside from some of those assigned to Provinces have been repealed with the proclamation of the Integrated Coastal Management Act (2009). Finally, Section 24(4) of NEMA, through the Off Road Vehicle Regulations (2001, amended in 2004) regulates the licensing and control of recreational boat launching sites as well as the use of recreational vehicles in the coastal zone. These regulations effectively banned any person from using a vehicle in the coastal zone unless the use is a listed permissible use, is authorised in terms of a permit or is authorised in terms of an exemption.

5.6.2 Management issues

The Onrus Estuary is used recreationally for fishing, bird watching and swimming. Although these uses have not been quantified in any way, these non-consumptive activities pose little threat to the estuary at present. However, with increasing tourism development in the area, fishing pressure and disturbance of wildlife is likely to increase and if applicable, other potentially more damaging recreational activities should be identified during the stakeholder consultation process. Appropriate management measures such as implementation of a zonation plan could be developed to guard against impacts associated with increased use.

5.7 Exploitation of non-living resources

5.7.1 Legislative context

The Minerals and Petroleum Resources Development Act (2002) makes provision for equitable access to and sustainable development of the nation's mineral and petroleum resources. The Act affirms the State's obligation to protect the environment for the benefit of present and future generations, to ensure ecologically sustainable development of mineral and petroleum resources and to promote economic and social development. Chapter 4 of the Act deals with Environmental Management principles as set out in section 2 of the National Environmental Management Act (1998). The holder of a prospecting or mining right or permit must abide by the general objectives of integrated environmental management as stipulated in Chapter 5 of NEMA and is required to conduct an environmental impact assessment and thereby manage all environmental impacts in accordance with the environmental management plan. The Act also stipulates that the holder of such a right or permit is responsible for any environmental damage, pollution or ecological degradation resulting within or outside the boundaries from the mining activity. On application for a mining right, an environmental management programme is required to be submitted to the Minister and on application for a prospecting right or mining permit, an environmental management plan (as prescribed) is required to be submitted. Only on approval of the environmental management programme or plan by the Minister, can such a mining or prospecting right or licence be granted. No mining occurs in the Onrus Catchment at present.

5.8 Potential and need for conservation and rehabilitation of the Onrus Estuary

The Present Ecological State of the Onrus Estuary banks and valley floor were determined as D and C/D respectively. It is likely that the estuary is on a stagnated or even negative trajectory of change due to changes in flow, pollution and habitat loss through alien invasive species, should the situation remain unmanaged (MacKenzie 2015). Increasing developmental pressures in the Onrus Catchment and Greater Hermanus Area resulting from growing coastal populations due to influx from rural inland areas as well as the increasing popularity as a holiday destination could have negative impacts on water quality and available water quantity for the ecological reserve. In light of its degraded state and low importance from an estuarine habitat perspective, Onrus Lagoon was not identified as either a national or regional priority for conservation. However, according to DWA's water resource protection policy, estuaries that are in an Ecological Category of C or D need to be managed towards achieving an Ecological Category of at least C (DWA 2010). Management action that will result in some level of rehabilitation of the estuary is therefore warranted.

The degree to which the various factors should be managed to restore the health of the system depends largely on the vision that is developed for the estuary during the process of developing the Estuary Management Programme in collaboration with all stakeholders.

5.8.1 Management interventions

5.8.1.1 Managing reed encroachment

The common reed *Phragmites australis* forms persistent and dense monospecific stands that outcompete other indigenous estuary-associated species and encroach into open water of the Onrus Estuary. This invasive indigenous species has characteristics that give it competitive advantages over other native riparian species, which has been enhanced through anthropogenic disturbances in the Onrus Catchment. The rapid and severe invasion and encroachment is likely to have, at times, disrupted the ecological functioning of estuary and has led to conflicts with users of the estuary.

Specific environmental factors both in-situ anthropogenic disturbance and catchment-wide unfavourable land use practices are generally thought to contribute to the rapid invasion of the common reed:

- Eutrophication from poor catchment management and point source pollution;
- Disruption of flow regimes from unsuitable catchment practices and estuary mouth management;
- Sedimentation from poor catchment management;
- *In situ* excavations and bank manipulation; and
- Over-grazing and other physical disturbances to indigenous riparian vegetation in the catchment

Historically, the Onrus Estuary is a temporarily open-closed system, which would open frequently and facilitate tidal influx of large volumes of seawater. However, water abstraction and impoundment of runoff from the upper catchment by the De Bos Dam are the cause of much less frequent natural breaching of the estuary mouth. As a result, the water quality of the lagoon has become less saline and is likely to have facilitated the encroachment of the common reed. Additionally, shallowing of the estuary through sedimentation and concurrent excess nutrient availability are thought to be the main facilitators for rapid expansion of the reedbeds in the past. The reeds in turn have been contributing to further sedimentation and shallowing, as the standing stalks trap particles in the water column, causing them to settle out, while the dead material forms a thick layer of litter on the bottom, resulting in accretion of organic matter and sediment.

Historical attempts to manage reed encroachment

Reed encroachment was first documented in the a study on the Onrus Estuary conducted as part of the Estuaries of the Cape Series published by the CSIR in the early 1980's (Heineken & Damstra 1983). It was found that in 1921 large open water areas were replaced with extensive reed growth in 1976. Aerial photographs from 1938, 1961, 1973 and 1989 confirm this trend (Figure 24). In 1938, reeds were confined to isolated patches on the northern shore. By 1961 the reedbed had spread along this shoreline, and by 1973, three years before the De Bos Dam was built, the main waterbody was largely covered by reeds. By 1989 the channels were being choked, and open water had been reduced to only 25% of the total estuary area, compared to 61% in 1938. It was concluded that in the absence of a good management policy, sedimentation would continue and that the

reedbeds would extend towards the mouth. Since then various rehabilitation methods have been evaluated by several organisations and are presented in more detail in Table 1.

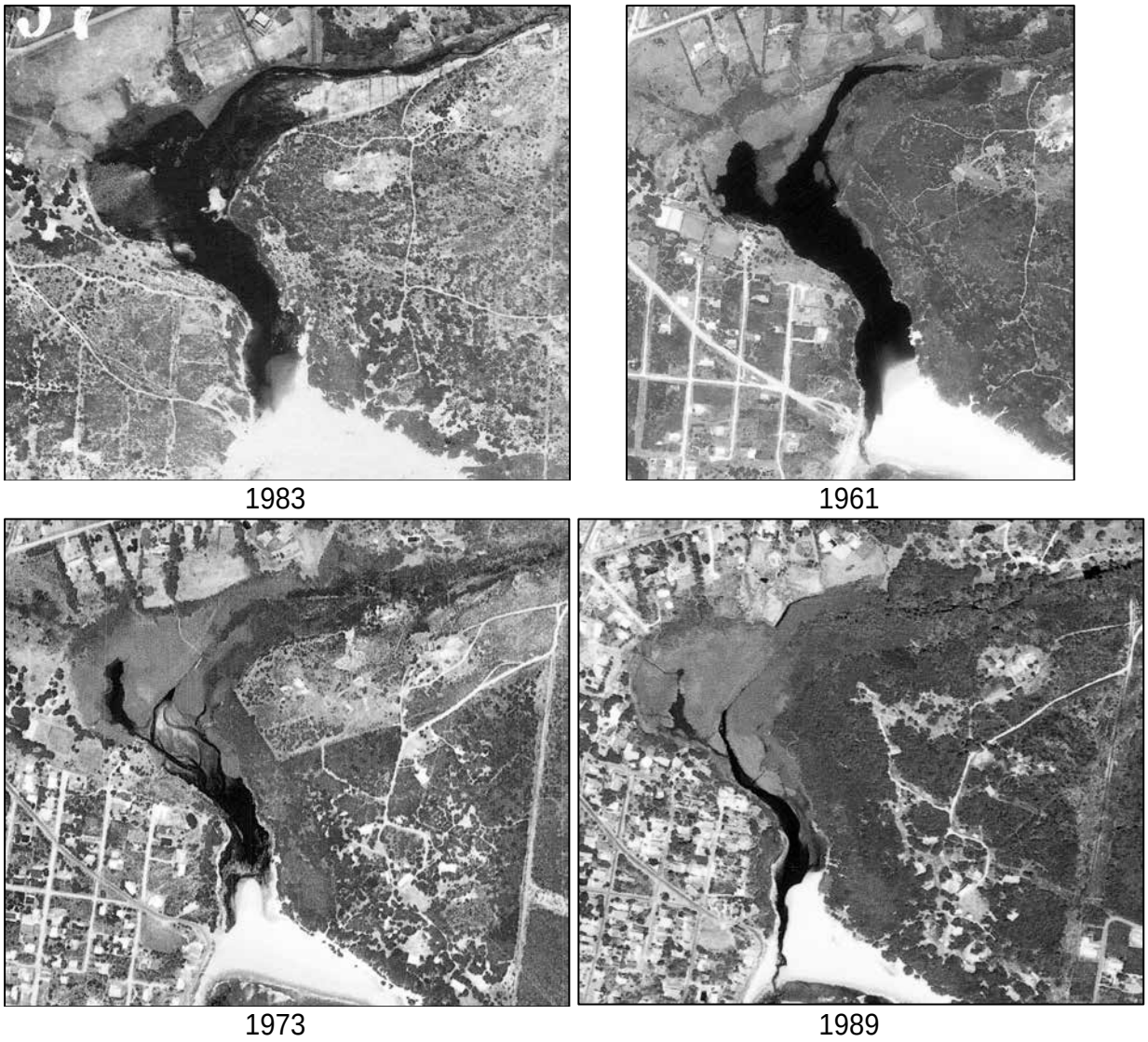

Figure 24 Aerial photographs of the Onrus Lagoon from 1938-1989 showing the change availability of open water.

In 1989, the first resolution was tabled that the estuary would be cleared should funds, in the region of R750 000, be made available. Two riparian property owners, Johann Rupert and Walter Loevendie, donated the money on condition that a portion of municipal land next to the estuary be transferred to the Southern African Nature Foundation (now WWF) (Du Toit 2002). No action was taken until the CSIR was contracted by the Save Onrus Lagoon Committee to review potential rehabilitation options in 1991. Various rehabilitation options were evaluated (see Table 15 for more details). It was concluded that chemical control of reeds through annual herbicide spraying was a viable option to increase open water, but that dredging was the only means of removing accumulated sediment in order to increase the estuary's depth. It noted that almost all life in the waterbody would cease in the short term, but recolonisation would take place with time (CSIR 1991).

By then only 1.2 ha of open water remained, while the reedbeds comprised 3.8 ha. It was proposed that approximately 1.7 ha of the estuary should be dredged, resulting in the removal of 1.5 ha of reeds and restoring the open water area to 2.6 ha. Dredging would take place to a depth of -1 m msl, with three holes of -2 m msl to act as sediment traps. This would entail removing 45 000 m^3 of sediment. It was recommended that a reed fringe should be maintained around the shoreline as a buffer between residential property and the estuary, in order to reduce disturbance to birds. Reeds in the upstream reaches of the estuary were also not to be removed as they filter nutrients and slow down sedimentation (CSIR 1993).

The CSIR also advised that a maintenance programme should be initiated after dredging to limit reed regrowth, and hence sedimentation. It was recommended that reeds be controlled by annual spraying with herbicide, conducted between February and July to minimise impact to birds, which mainly nest in spring (CSIR 1991, 1993). The herbicides registered for *Phragmites* control have been found to be safe to use as they do not bio-accumulate in aquatic food chains, exhibit very low toxicity and rapidly break down in the natural environment.

The dredging contract, amounting to R695 000, was signed on 16 October 1992. The dredging was completed by mid-1993, but problems were experienced due to the thick mat of rhizomes. The -1 m msl level was reached in one place only and the total amount of sediment removed was approximately 30 000 m^3 (Badenhorst 2002). Most of the sediment was deposited on the Sandbaai 'common', but some was used to create a small island, to provide additional habitat for birds. The main problems that were experienced during the dredging included (Badenhorst 2002):

- Seepage from the holding dams;
- Raised water table level in developed areas;
- Bad odours emanating from the holding dams causing public discomfort;
- Spreading of mud/sand on streets during removal of the reeds necessitating cleaning of the roads;
- Spreading of roots on the beach during sea dumping requiring regular cleaning of the beach;
- Clogging of the cutter head and delivery pipes;
- Water spillage in Habonim during flushing of delivery pipe;
- Breaching of the raised spit during high river flows causing inadequate water levels for dredging; and
- Noise from the machinery causing a public nuisance.

In 2002 the Overstrand Municipality commissioned a new report on the rehabilitation of the Onrus Lagoon from Pieter Badenhorst Professional Services CC. A survey revealed that no significant sedimentation had occurred since the lagoon was dredged in 1993, apart from some sudden sedimentation that was caused by a flood event shortly after dredging was completed. It was speculated that the sediment accumulation rate was reduced due to the lack of large floods between 1994 and 2002 as well as increased vegetation cover in the upper reaches of the lagoon. Costs for another dredging exercise were estimated at R4.5 million for removal of 75 000 m^3 of sediment and its disposal at sea, or R2.7 million for 35 000 m^3, allowing for price escalations to 2004 (Badenhorst 2002). EnviroAfrica was then commissioned to compile a Scoping Report on the dredging plan for submission to the provincial environmental authorities. A positive Record of

Decision was obtained (C. Bruwer, *pers. comm.*), but the dredging plan was not implemented due to cost constraints.

The Onrus Lagoon Trust was established in 1992 to remove reeds as per recommendations by the CSIR. Since then, clearing was only undertaken once on the eastern side of the channel area due to financial and logistical challenges (Ron Gaylard, *pers. comm.*). Cutting the reeds was time-consuming and difficult, and the intention to spray the regrowth had been thwarted by the rise in water level after mouth closure. The Onrus Lagoon Trust proposed purchasing a Truxor reedcutter to control the reeds, on condition that the Overstrand Municipality funds its operation and maintenance. This proposal has not been accepted, as the Municipal Finance Management Act prevents the municipality from spending municipal funds on matters that are outside its mandate. Local residents have however cleared reeds in front of the 'common' on the north shore on a number of occasions, often with the assistance of the municipality, to create a view over the water (Figure 25). Rehabilitation of the lagoon was further impeded by a request that was made by property owners on the northern shore to have sediment deposited in the reed fringe between their land and an existing island. This was historically the route of the main channel, but human interference had diverted it to the southern side of the island, although the river would still flow on both sides during extreme floods. The engineering contractors approved this proposal on the basis that the channel was expected to silt up with time, but the CSIR noted that this would be incompatible with the rehabilitation programme's aims to create more open water and restore natural conditions. They recommended against any infilling of the reed fringe. However, infilling of approximately 1 ha of the river course took place, extending a riparian property owner's land by some 60 m for use as a private golf course.

Figure 25 Reed clearing in front of the 'common' in autumn 2012.

More recently, Agrimentor was commissioned by the Van Graan family in 2010 to assess the status of the Onrus Lagoon. Using available maps, photographs, input from the local people and other background information, Agrimentor painted a dramatic picture of ongoing reed encroachment and a future scenario that would result in permanent and irreversible reed cover. Consequently, Agrimentor recommended the construction of an opening of 50 m at the mouth of the lagoon to facilitate constant flushing by seawater, or alternatively the pumping of large enough volumes of seawater to flush the lagoon. It was also recommended to eradicate the reeds through application of an approved herbicide. Only the first recommendation was novel (Refer to Table 15) and was rejected by Sue Matthews from the Overstrand Municipality, who correctly argued that the physical coastal characteristics of the site would only allow long-term artificial opening by means of a hard

structure. A permanent structure to keep the estuary mouth open is likely to result in unforeseen other bio-physical and socio-economic impacts. Changing the estuary from a temporarily open-closed system (as most systems are in South Africa) to a permanently open system via concrete structures would dramatically change the ecology of the estuary and also have an impact on the sense of place (i.e. lagoon character) impacting on property and tourism value of the estuary. At the same time, reeds can tolerate high salinities and previous studies have shown that it could take between 10 and 20 years for the gradual replacement of reeds by natural vegetation (Overstrand Municipality Sue Matthews, *pers. comm*.)

A sand trap system upstream from the estuary as an alternative option for future management of reed encroachment was investigated by Pieter Badenhorst Professional Services CC in December 2013. A functioning sand trap could reduce or even prevent ongoing siltation and shallowing of the estuary. A site visit in December 2013 helped to obtain a better understanding of the river configuration and dynamics upstream from the estuary. The river was inspected at a number of access points from the Onrus Lagoon up to the De Bos Dam. Badenhorst found little erosion along the banks of the Onrus River that could contribute to the sediment load. He pointed out that the river widens below the Dam and water flow velocities are greatly reduced, acting as a natural sand trap just upstream of the estuary. Indeed, Badenhorst found that sedimentation had increased in the upper reaches of the estuary between 2002 and 2014 (Figure 27). He concluded that although a sand trap could potentially aid in reducing reed growth in the estuary, implementation would be constraint by several factors. Firstly, detailed information on the sediment regime would be required to design a functional sand trap, including suspended and bed load sediment in the Onrus Catchment. Furthermore, the location of the sand trap would have to be chosen carefully and would require:

- A straight river stretch 50-100 m long with a stable edge;
- Large municipality owned land adjacent to the trap to accommodate an access road and room for the operation of heavy excavating equipment and large dump trucks;
- Proximity to a suitable waste site to stockpile spoils; and
- A stable, low level, gently sloped bank which can serve as working platform for an excavator to clean out the sand trap.

Finally, maintenance costs would be considerable due to the need of bi-annual sediment excavations. Overall, Badenhorst recommended against the implementation of a sand trap as a method to control reed encroachment in the Onrus Estuary.

As part of the same study, Badenhorst assessed the long-term effects of the dredging event in 1993 on the extent of the reed beds. He compared the reed edge in the Onrus Estuary from available aerial photographs for the years 1989, 1997, 2002 and 2014 (Figure 26). While little open water area remained in 1989, the dredging in 1993 had profound long-lasting effects on the open water areas of the estuary, resulting in little changes to the reed edge since then. The only apparent increase in reed cover occurred at the estuary mouth on the eastern bank (Figure 26). A comparative topographic survey of the Onrus Estuary showed that some sedimentation occurred in the upper estuary, while erosion took place closer to the mouth (Figure 27). Badenhorst concluded that reduced flood occurrence, sediment availability and/or trapping of sediment upstream of the estuary could be the reasons for a reduced sedimentation rate since 2002.

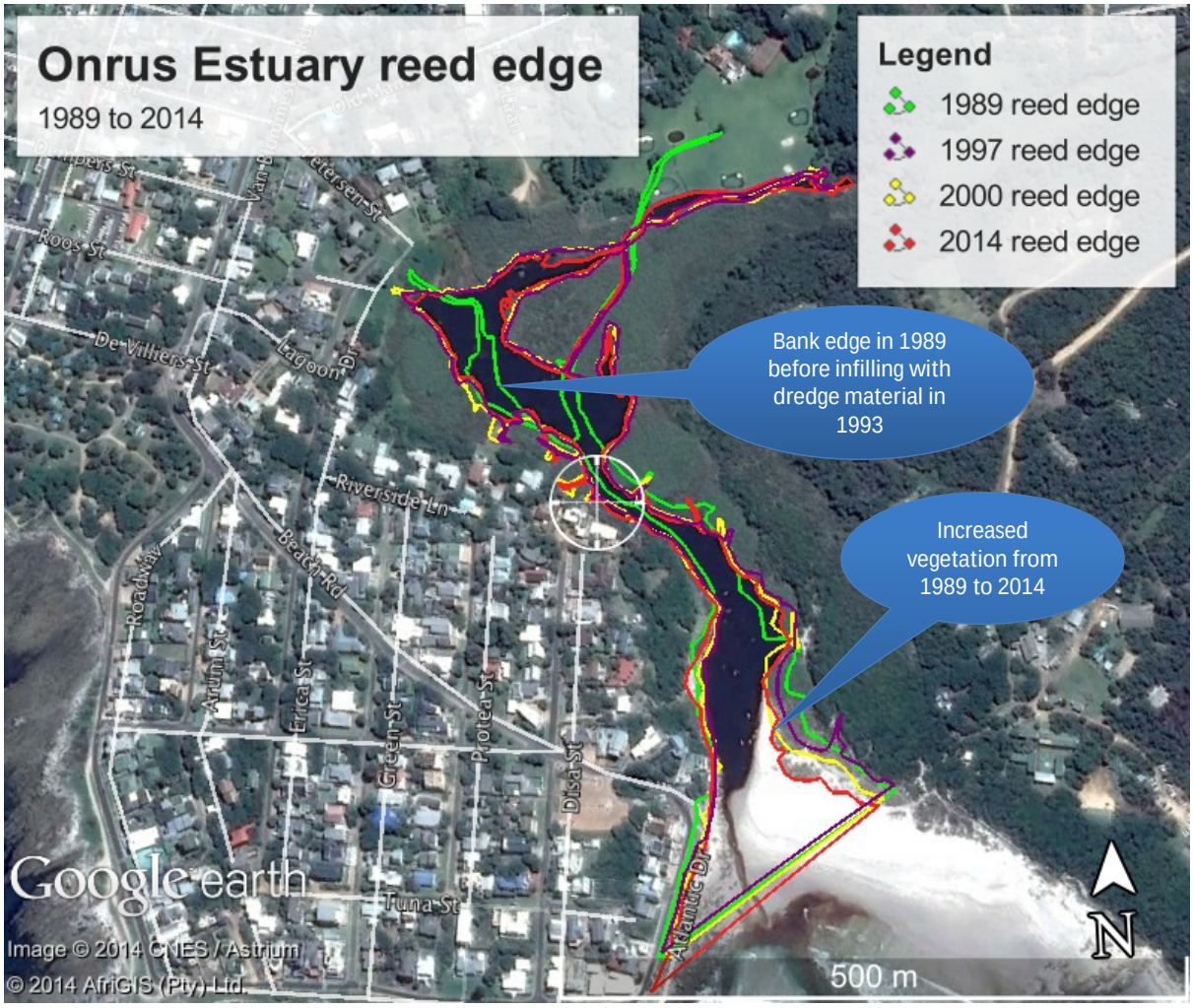

Figure 26 Onrus Estuary reed edge 1989 to 2014.

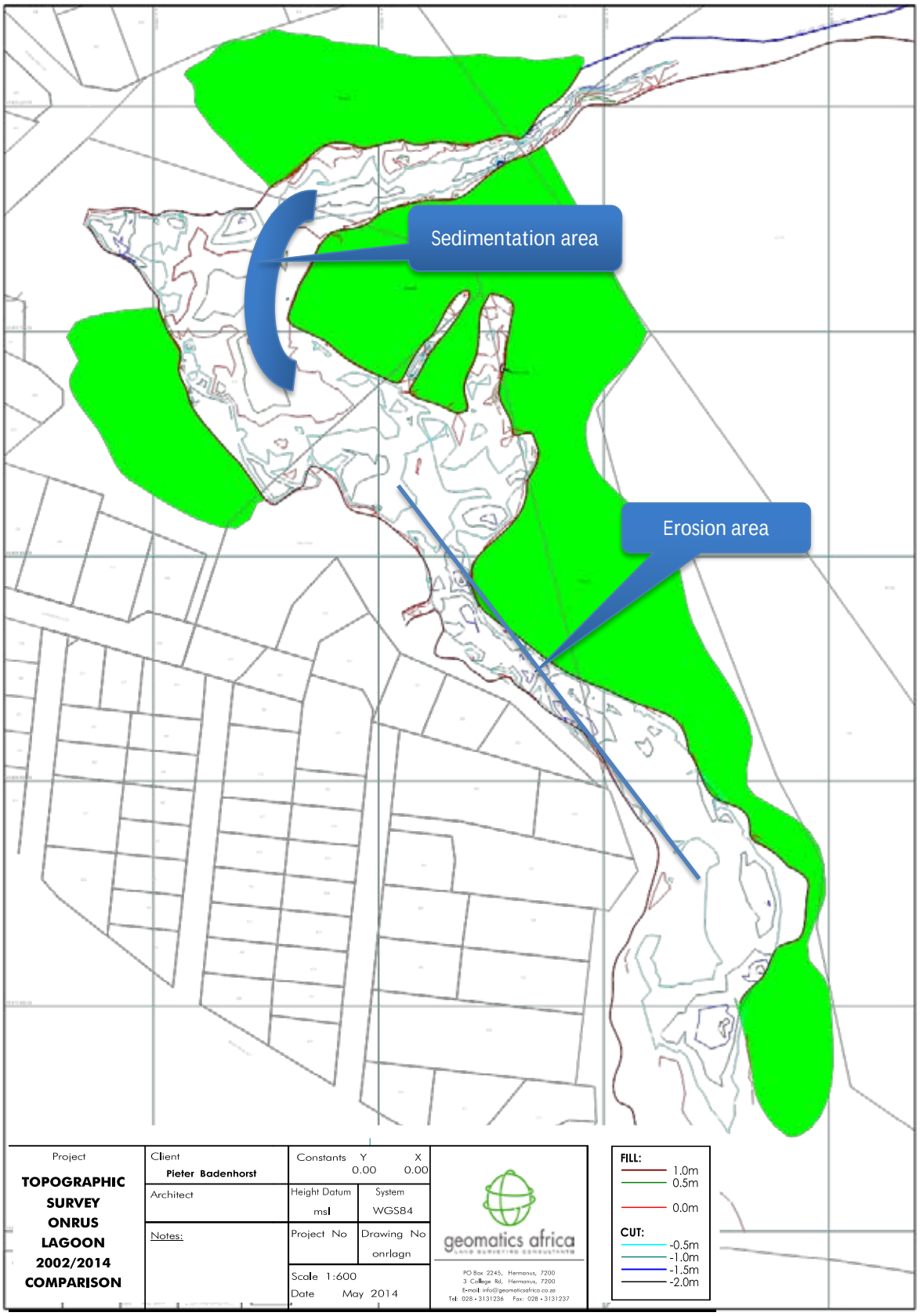

Figure 27 **Comparative contour lines for 2002 and 2014 showing areas where sedimentation and erosion occurred over time in the Onrus Estuary.**

Table 15 Rehabilitation options for managing reed encroachment of the Onrus Estuary. Reference has been made to various documents published since 1983.

Proposed rehabilitation option	Source	Purpose	Challenges	Recommendation
"Do nothing"	CSIR 1991	· None	· Reed encroachment and shallowing of the lagoon will continue · The probable fate of the lagoon is to become a swamp · Health and safety standards would be more difficult to control in a swamp compared with open water · Negative impact of this option on property values	Rejected
Chemical control of reeds using an approved systemic herbicide	CSIR 1991	· Ability to kill large sections of the reedswamp	· Reeds must be cut and removed off-site before herbicide can be applied. · Application of herbicide requires low water levels – timing is difficult due to low rainfall in summer leading to mouth closure which in turn leads to slow rise in water levels.	Possible but not recommended
Construction of a weir across the Onrus River mouth	CSIR 1991	· None	· Weir would not be able to maintain high enough water levels to prevent reed encroachment · Transformation of an estuarine system to a freshwater system	Rejected
Raise salinity levels by temporarily pumping seawater into the lagoon	CSIR 1991	· Increase salinity levels to control reed growth	· A large volume of seawater would have to be pumped for a prolonged period to affect the reeds. This would be too costly and impractical.	Rejected
Partial clearing of reeds - mechanical removal of sediment and reeds.	CSIR 1991	· To retain islands and a vegetated fringe to: · preserve some of the habitat for estuarine ecology of the Onrus · ensure continued absorption of excess nutrients	· Logistics for removing dredged sediment and organic material in an urban environment · Recovery of ecology slow after extensive disturbance	Recommended
Removal of all reeds - mechanical removal of sediment and reeds.	CSIR 1991	· Restore to the state of the Onrus Estuary in 1921	· More costly than partial removal of reeds · Logistics for removing dredged sediment and organic material is a challenge. · Recovery of ecology slow after extensive disturbance	Long-term recommendation
Open the estuary mouth artificially and permanently	Agrimentor 2010	· Induce flushing of the estuary to increase salinity levels to control reed growth.	· Opening the mouth artificially and permanently requires concrete structures, as coastal physical processes would facilitate mouth closure shortly after artificial breaching.	Rejected by the Overstrand Municipality 2011

Proposed rehabilitation option	Source	Purpose	Challenges	Recommendation
			· Concrete structures will negatively impact on the sense of place and therefore may influence property prices and tourism attraction · Existing reed stands have a high salinity tolerance and retreat would only be likely to occur after 10-20 years.	
Reduce nutrient input into estuary from Onrus Catchment	Overstrand Municipality 2011	· Address pollution at the source (i.e. run-off and outflow from the sewerage pump station) to reduce nutrient availability for excessive reed growth	· Requires co-ordinated actions from a variety of national, provincial, district and local departments as well as the catchment management agency. · Long-term solution - Sediments are saturated with nutrients and therefore reeds will take decades to respond to reduced nutrient levels in the water. Degrading reeds will continue contributing to nutrient load in sediments.	Recommended by Overstrand Municipality in 2011
Sand trap system upstream of the estuary	Pieter Badenhorst, 2013	· Trap sediment before it enters the estuary to prevent further shallowing of the lagoon and associated spread of the reed.	· Information on the sediment regime of the Onrus River is unavailable at present · It is challenging to find a suitable location for the installation of the sand trap (i.e. slope, bank stability, adjacent municipal land, proximity to suitable dump site) · High maintenance cost due to bi-annual excavation of sediment from the trap	Not recommended by Pieter Badenhorst

Legislative context for ongoing management of reed encroachment

The ongoing management of encroachment by the common reed *Phragmites australis* can involve the removal of indigenous vegetation, application of herbicides, as well as the excavation of sediment and organic matter from the estuary. The removal of more than 1 ha of indigenous vegetation and the infilling or depositing of material greater than five cubic metres (i.e. dredging) constitute listed activities in terms of the NEMA EIA Regulations. A basic assessment must be completed and environmental authorisation must be granted prior to commencement of the activities, unless an Environmental Maintenance Programme has been approved by DEA&DP. If herbicides are used as a management tool, the National Water Act (NWA, Act 36 of 1998) and the Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act (FFFARSR, Act 36 of 1947) is of relevance. In terms of this Act any person administering herbicides must be registered as a pest control officer or be in the presence and under the supervision of a registered pest control operator. The Act requires that:

- No person may use, or recommend the use of, any agricultural remedy (i.e. herbicides) or stock remedy for a purpose or in a manner other than that specified on the label on a container thereof or described on such container; and
- Any person administering agricultural remedies (i.e. herbicides) for the purposes for which they are intended, must be registered as a pest control officer or be in the presence and under the supervision of a pest control operator so registered (see the Act for details on how to register).

Furthermore, the National Water Act (NWA, Act 36 0f 1998) is relevant to situations where methods to control problem riparian and estuarine vegetation involve the use of herbicides that may pollute receiving waters. Section 19 of the Act states that:

1. An owner of land, a person in control of land or a person who occupies or uses the land on which
    a. any activity or process is or was performed or undertaken; or
    b. any other situation exists, which causes, has caused or is likely to cause pollution of a water resource, must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring.
2. The measures referred to in subsection (1) may include measures to-
    a. cease, modify or control any act or process causing the pollution;
    b. comply with any prescribed waste standard or management practice;
    c. contain or prevent the movement of pollutants;
    d. eliminate any source of the pollution;
    e. remedy the effects of the pollution; and
    f. remedy the effects of any disturbance to the bed and banks of a watercourse.

Recommendations going forward

The extent of the common reed in the Onrus Estuary has not expanded significantly since the last dredging event in 1993 and it is questionable whether active management of reed encroachment is required at this point in time. Extensive removal of reeds, roots and sediments by means of dredging has been identified as the only rehabilitation method that has shown positive results in the Onrus Estuary. However, dredging is very costly and causes intense medium-term disturbance to the estuarine ecology and must therefore be well justified. Should dredging be considered as a management method for common reed encroachment in future, the following factors should be taken into account when formulating an Environmental Maintenance Programme in terms of NEMA (AEC 2012):

1. Extensive removal of reed beds could have possible negative impacts:
    a. Reeds act as a nutrient sink and upon extensive removal the system could become more eutrophic;
    b. Another plant species capable of acting as an efficient nutrient sink could replace the species removed and become invasive;
    c. Toxic blue-green algal blooms could occur leading to hypoxia, the depletion of oxygen in the water, in turn leading to fish kills and knock-on effects in respect of other goods and services delivered by the estuary.
2. The aim of the management objectives should not motivate for complete eradication of reeds from the estuary and riparian zones as they provide essential ecosystem services;
3. The estuary should be classified into two broad categories based on morphometrics, including open areas and delivery channels:
    a. Reed cover in open areas and the riparian zone of an estuary could be removed in line with the vision for the particular estuary. Those plants in the middle of delivery channels should be removed. Those plants growing on the side of channels should rather be left to prevent erosion and act as nutrient traps. Reeds growing around amenity structures such as jetties, launch sites and boardwalks can also be targeted, should access to these facilities also be a management objective and part of the overall vision of the estuarine system.
    b. Areas where reeds should not be removed include those lining the sides of delivery channels as they perform a valuable function in reducing erosion, siltation and nutrient concentrations. In addition, those stands that harbour large colonies of breeding birds or species of special conservation concern should also be avoided, or their removal be guided by experts. Reed stands that comprise a mixture of other indigenous species that exceed 50% should rather be left.
4. Ensure that long-term management objectives simultaneously address the cause of the reed encroachment (i.e. control siltation through better land-use practices and restoration of riparian vegetation upstream, reduce nutrient input from agricultural runoff and sewerage, mouth management, etc.).
5. Damage to the environment has to be limited to the minimum:
    a. Removal of non-target plants must be prevented or minimised;
    b. Prevent or minimise possible chemical pollution of soil of water or any other threat to non-target organisms;

c. Use fire responsibly and ensure that flammable material does not accumulate in fire sensitive areas;
d. Prevent unnecessary or irresponsible disturbance of the soil, especially on riverbanks or slopes; and
e. Ensure that denuded areas are rehabilitated to prevent soil erosion and invasion by other undesirable species.

5.8.1.2 Clearing of alien invasive vegetation

Parts of the Onrus catchment are infested with invasive alien vegetation, such as black wattle, myrtle, rooikrans, pines and eucalypts. These tall, woody plants reduce streamflow as they use more water than the indigenous vegetation they replace. Working for Water first became involved in alien-clearing in the Onrus River catchment with the launch of the Greater Hermanus Water Conservation Programme in November 1996. Activities initially focused on the upper reaches of the catchment as a means of increasing runoff into the De Bos Dam, but since 2008, some clearing has taken place in the lower catchment too (Figure 28).

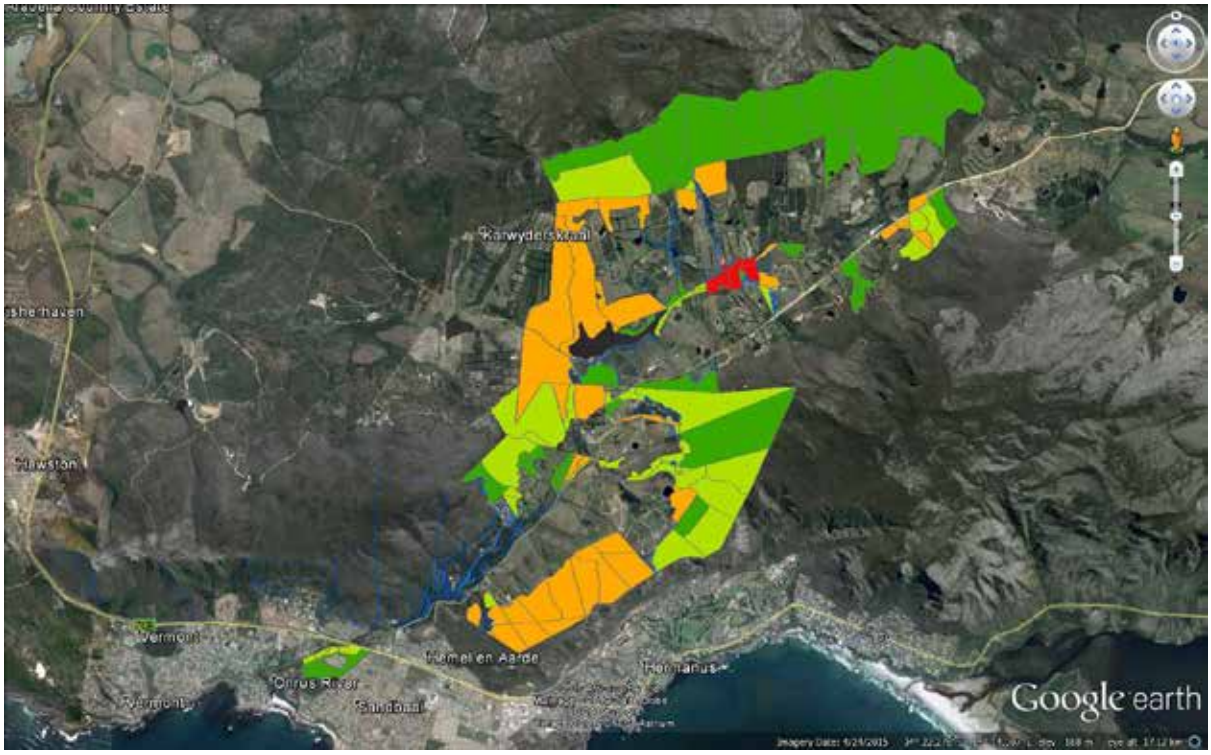

Figure 28 Alien-clearing status of Overstrand Working for Water in 2015. Very little clearing was done in light green areas, increasing in effort for areas in red (Source: Tarron Dry, Overstrand Municipality).

More recently, a new project was initiated to increase alien clearing efforts in the lower catchment. The project is funded by the Working for Water Programme to clear on private property within the project boundaries, and by the Overstrand Municipality from the Environmental Management Services budget to clear on municipal properties. The areas that were proposed for alien clearing

include the Habonim property on the eastern bank of the river and the riparian zone below the R43 bridge, the river course south of Camphill, as well as the mountainside above the suburb of Berghof (Figure 29). Some clearing has taken place on the Habonim property on the eastern bank, while clearing on the river course south of Camphill and the mountain side above Berghof have not yet begun (Figure 28).

There are currently no plans to clear the eucalypt plantations on leased municipal property between the R43 bridge and Camphill causeway. Rather, the intention is to incorporate these properties into the Fernkloof Nature Reserve and promote their use for recreational activities and commercial ventures.

Figure 29 Areas prioritised for alien clearing in the Onrus River Catchment below the De Bos Dam.

5.8.1.3 Flooding

Flooding is not a concern on this estuary as residences are above the 5 m contour, and generally set well back from the water's edge. In addition, the catchment is relatively small, and floods are attenuated by the De Bos Dam. The estuary is also small enough to respond quickly to high flows, and it breaches before back-flooding occurs upstream.

5.8.1.4 Managing erosion

Agricultural activities typically increase erosion compared to the natural state, but since the De Bos Dam acts as a sediment trap, most of the Onrus Lagoon's sediment input would originate from the catchment below the dam. In 1991 the CSIR estimated that 3 750 m^3 of sediment flowed into the estuary annually from the catchment below the dam, compared to 1 400 m^3 from the upper

catchment. The area of agricultural development in the lower catchment has remained relatively stable over the last 20 years, although some steep slopes at the head of the valley were cleared and planted with vineyards during 2010.

Afforestation of the steep slopes adjacent to the Onrus River was identified as a contributor to sediment input in the management plan compiled by the CSIR in 1993. Soils under eucalypts have water-repellent properties, attributed to a hydrophobic organic coating originating from soil microbes and fungal mycelia. By reducing wetting, water-repellent soils impede infiltration and percolation, and tend to cause gullying resulting from increased overland flow. The drier soils, together with allelopathic effects, inhibit the development of an understorey layer, increasing the potential for soil erosion. However, some studies have shown that erosion may not be a problem until the tree canopy and/or the eucalypt litter, which provides a dense groundcover, are removed. Eucalypts are in fact widely used throughout the world for slope stabilisation, and their removal from the steep slopes adjacent to the Onrus River would need to be done with extreme caution, involving gradual thinning and replanting with indigenous species. Rehabilitation of the riparian zone is considered to be of higher priority.

5.9 Potential for protected area status

5.9.1.1 Legislative Context

The *White Paper on the Conservation and Sustainable Use of South Africa's Biological Diversity (1998)* recognises the importance of estuaries and commits the government to a number of strategies to protect wetlands in general, such as facilitating the development of appropriate legislation to secure their conservation, promoting the establishment of a National System of Protected Wetlands, preventing inappropriate activities and development around wetlands, finding ways to recognise wetlands in planning and decision-making, determining the impact of fishers and developing guidelines for managing them.

Marine reserves were previously proclaimed under the under the Marine Living Resources Act (Act No. 18 of 1998) (MLRA, as amended), but are now under the mandate of the National Environmental Management: Protected Areas Act (Act No. 57 of 2003). The Protected Areas Act (2003) provides for the declaration and management of protected areas, and can also provide for co-operative governance, the sustainable utilisation of protected areas that preserves their ecological character, and the participation of local communities in the management of protected areas, where appropriate. A consultation and public participation process is outlined in the Act. It also contains the requirement that marine and terrestrial protected areas with common boundaries must be managed as an integrated protected area by a single management authority. It is also important to note that under this Act, commercial prospecting or mining is prohibited in any nature reserve.

Estuaries can also be protected within regular protected areas (see below), though the latter do not have jurisdiction over the use of estuarine living resources. Estuaries may also be protected within World Heritage Sites under the *World Heritage Convention Act 49 of 1999*.

The General Policy in terms of the E*nvironment Conservation Act – Terrestrial and Marine protected areas* (1994) categorises protected areas into 7 categories (based on IUCN and one additional

category). It prescribes the management objectives and criteria for selecting and managing each category. The policy suggests that estuaries, fish, spawning areas and seascapes should generally be treated as Category IV – Habitat and wildlife management areas, regardless of who owns those resources. In reality, estuaries could fall into any category. Those such as Kosi could be classified as Category V – Protected land/seascapes, while others could be classified as Category VI - Sustainable Use Areas. Each estuary should be classified on the basis of the management objectives of the estuary (Smith & Cullinan 2000).

The National Environmental Management: Biodiversity Act (Act No. 10 of 2004) (NEMBA, as amended) provides for the conservation of biological diversity. It requires identification of important landscapes, ecosystems, ecological process and species for biodiversity conservation, and promotes monitoring of these.

5.9.1.2 Potential for protection of the Onrus Estuary

The Onrus Estuary is one of South Africa's approximately 289 functional estuaries and is one of 21 estuaries within the warm temperate biogeographic region (roughly Cape Point to the Mbashe River) to be classified as a temporarily open/closed (Turpie *et al.*, 2012; Van Niekerk and Turpie, 2012). The Onrus Estuary is not considered particularly important for estuarine biodiversity on a national scale, ranking 94th of all South African estuaries in terms of its overall conservation importance (Turpie and Clark, 2007). The Onrus was also not included on the list of estuaries that require partial or full protection in order to meet South Africa's biodiversity targets for conservation of estuarine biodiversity (Van Niekerk and Turpie, 2012). Thus, while there is clear need for improved management of key physico-chemical drivers of estuarine health such as the quantity and quality of freshwater reaching the estuary, and protection of the estuary from encroaching developments and management of siltation, the establishment of a formal protected area on the estuary is probably not warranted at this stage.

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APPENDICES

Appendix A: Bird List

Common name	Damstra, 1980	Underhill & Cooper 1983 (Summer count)	Mike Ford & Lee Burman (CR = Common resident, UCR = uncommon resident, CSV = Common summer visitor)	Andrew Odendal 2015 (checklist)	Habitat (No = not water associated, Yes = water associated)
Apalis, bar-throated				X	No
Avocet, Pied	Rare				Yes
Barbet, acacia pied				X	No
Batis, Cape				X	No
Bishop, southern red			CR	X	Yes
Bishop, yellow	Rare		CR	X	Yes
Bittern, little	Present		UCR	X	Yes
Bokmakerie				X	No
Boubou, southern				X	No
Bulbul, Cape				X	No
Burchell's Coucal	Present			X	No
Buzzard, Forest				X	No
Buzzard, Jackal				X	No
Buzzard, Steppe				X	No
Canary, Bully				X	No
Canary, Cape	Present				No
Cisticola, Levaillant's	Present		CR	X	No
Coot, Red-knobbed	Common	5	CR	X	Yes
Cormorant, Cape			CR	X	Yes
Cormorant, Reed			CR	X	Yes
Cormorant, White-breasted			CR	X	Yes
Crake, Black			UCR	X	Yes
Crow, pied				X	No
Cuckoo, diederick				X	No
Cuckoo, Klaas's				X	No
Cuckoo, red-chested				X	No
Darter, African			UCR	X	Yes
Dove, Cape Turtle	Present			X	No
Dove, Laughing	Present			X	No
Dove, red-eyed				X	No
Dove, rock				X	No

Common name	Damstra, 1980	Underhill & Cooper 1983 (Summer count)	Mike Ford & Lee Burman (CR = Common resident, UCR = uncommon resident, CSV = Common summer visitor)	Andrew Odendal 2015 (checklist)	Habitat (No = not water associated, Yes = water associated)
Drongo, folk-tailed				X	No
Duck, African black			UCR		Yes
Duck, Hybrid			CV		Yes
Duck, Maccoa				X	Yes
Duck, Mallard			CV	X	Yes
Duck, white-faced				X	Yes
Duck, Yellow-billed	Present		CR	X	Yes
Eagle-owl, spotted				X	No
Egret, Cattle				X	Yes
Egret, Little			CR	X	Yes
Egret, yellow-billed				X	Yes
Falcon, peregrine				X	No
Fiscal, common				X	No
Fish-Eagle, African				X	Yes
Flamingo, Greater				X	Yes
Flycatcher, African dusky				X	No
Flycatcher, African paradise				X	No
Flycatcher, fiscal				X	No
Flycatcher, spotted				X	No
Godwit, bar-tailed				X	Yes
Goose, Egyptian			CR	X	Yes
Goose, Spurwinged				X	Yes
Goshawk, African				X	No
Grassbird, Cape				X	No
Grebe, Little			CR	X	Yes
Greenbul, sombre				X	No
Greenshank, Common				X	Yes
Gull, Hartlaub's	Abundant	3	CR		Yes
Gull, Kelp	Common		CR		Yes
Hamerkop				X	Yes
Harrier, African marsh				X	Yes
Harrier-Hawk, African				X	No
Heron, Black-headed			UCR	X	Yes
Heron, Grey			CR	X	Yes
Heron, little purple				X	Yes

Common name	Damstra, 1980	Underhill & Cooper 1983 (Summer count)	Mike Ford & Lee Burman (CR = Common resident, UCR = uncommon resident, CSV = Common summer visitor)	Andrew Odendal 2015 (checklist)	Habitat (No = not water associated, Yes = water associated)
Heron, Purple				X	Yes
Honeyguide, lesser				X	No
Hoopoe, African				X	No
Ibis, African Sacred			CR	X	Yes
Ibis, Hadeda			CR	X	Yes
Kestrel, rock				X	No
Kingfisher, brown-hooded				X	Yes
Kingfisher, Giant				X	Yes
Kingfisher, Malachite	Present		UCR	X	Yes
Kingfisher, Pied	Present		CR		Yes
Kite, black-shouldered				X	No
Kite, yellow-billed				X	No
Lapwing, Blacksmith			CR	X	Yes
Lapwing, Crowned				X	Yes
Longclaw, Cape				X	Yes
Martin, banded				X	Yes
Martin, brown-throated	Common		CR	X	Yes
Martin, common house				X	Yes
Martin, rock				X	No
Moorhen, Common			CR		Yes
Mousebird, redfaced				X	No
Mousebird, speckled				X	No
Neddicky				X	No
Night heron, Black-crowned			UCR	X	Yes
Oystercatcher, African Black				X	Yes
Pigeon, African olice				X	No
Pigeon, speckled				X	No
Plover, Kittlitz's				X	Yes
Plover, Three-banded			CR	X	Yes
Plover, White-fronted			CR	X	Yes
Prinia, Karoo				X	No
Rail, African			UCR		Yes
Raven, white-necked	Present			X	No
Robin-chat, Cape				X	No
Ruff				X	Yes

Common name	Damstra, 1980	Underhill & Cooper 1983 (Summer count)	Mike Ford & Lee Burman (CR = Common resident, UCR = uncommon resident, CSV = Common summer visitor)	Andrew Odendal 2015 (checklist)	Habitat (No = not water associated, Yes = water associated)
Sandpiper, common	Common			X	Yes
Sandpiper, Curlew				X	Yes
Saw-wing, black				X	Yes
Seedeater, streaky-headed				X	No
Shoveler, Cape			CR	X	Yes
Sparrow, Cape				X	No
Sparrow, house				X	No
Sparrow, southern grey-headed				X	No
Sparrowhawk, black				X	No
Sparrowhawk, rufous-chested				X	No
Spoonbill, African				X	Yes
Spurfowl, Cape				X	No
Starling, Common			CR	X	No
Starling, red-winged				X	No
Starling, wattled				X	No
Stilt, Black-winged				X	Yes
Sugarbird, Cape				X	No
Sunbird, amathyst				X	No
Sunbird, malachite				X	No
Sunbird, southern double-collared				X	No
Swallow, Barn			CSV	X	Yes
Swallow, greater striped	Common			X	Yes
Swallow, pearl-breasted				X	Yes
Swallow, white-throated	Common		CSV	X	Yes
Swamphen, African Purple			UCR	X	Yes
Swift, African black				X	Yes
Swift, Alpine				X	Yes
Swift, little				X	Yes
Swift, white-rumped	Present			X	Yes
Tchagra, southern				X	No
Teal, Cape			CR	X	Yes
Teal, Red-billed	Rare				Yes
Tern, Sandwich	Common				Yes
Tern, Swift	Rare				Yes

Common name	Damstra, 1980	Underhill & Cooper 1983 (Summer count)	Mike Ford & Lee Burman (CR = Common resident, UCR = uncommon resident, CSV = Common summer visitor)	Andrew Odendal 2015 (checklist)	Habitat (No = not water associated, Yes = water associated)
Thick-knee, Water	Rare	1	UCR		Yes
Wagtail, African Pied				X	Yes
Wagtail, Cape	Present	1	CR		Yes
Warbler, African reed			CSV		Yes
Warbler, lesser swamp	Common		CR		Yes
Warbler, little rush			UCR		Yes
Waxbill, common			CR		Yes
Weaver, Cape	Abundant		CR	X	Yes

Appendix B: Water Quality Data

ON1 = Onrus Mouth; ON1b = Lagoon from beach; ON2 = Old Bridge; ON3 = Camphill Bridge; ON4 = Volmoed; ON – BD = De Bos Dam; ON5 = Haygroven Haven (Source: Breede-Gouritz Catchment Management Agency; Overstrand Municipality).

	Total coliforms (Count/100ml)						Enterococci (Count/100ml)							E. coli (Count/100ml)						
Date	**ON1**	**ON2**	**ON3**	**ON4**	**ONDB**	**ON5**	**ON1**	**ON1b**	**ON2**	**ON3**	**ON4**	**ONDB**	**ON5**	**ON1**	**ON1b**	**ON2**	**ON3**	**ON4**	**ONDB**	**ON5**
02-Dec-10							630	350						260	49					
23-Dec-10							300	8						600	4500					
13-Jan-11							90	30						10	66					
03-Feb-11							380	44						760	53					
24-Feb-11							530	500						550	720					
17-Mar-11							126	330						230	370					
05-May-11							670	930						500	930					
02-Jun-11							500	910						30003	910					
30-Jun-11							0	0						1100	0					
20-Jul-11							0	0						0	0					
11-Aug-11							0	0						700	0					
31-Aug-11							0	0						1130	0					
22-Sep-11							0	0						108	0					
13-Oct-11							0	0						63	0					
03-Nov-11							0	0						2700	0					
23-Nov-11							20000	25000						128	25000					
15-Dec-11							500	600						60	600					
04-Jan-12							100	0						0	0					
26-Jan-12							0	0						49	0					
16-Feb-12							0	0						43	0					

	Total coliforms (Count/100ml)						Enterococci (Count/100ml)							E. coli (Count/100ml)						
Date	**ON1**	**ON2**	**ON3**	**ON4**	**ONDB**	**ON5**	**ON1**	**ON1b**	**ON2**	**ON3**	**ON4**	**ONDB**	**ON5**	**ON1**	**ON1b**	**ON2**	**ON3**	**ON4**	**ONDB**	**ON5**
15-Mar-12							0	110						61	110					
10-Apr-12							1300	1900						1000	1900					
03-May-12							6300	4900						83	4900					
31-May-12							540	280						88	280					
21-Jun-12							950	770						1734	770					
12-Jul-12							50	90						116	90					
02-Aug-12							220	530						353	530					
23-Aug-12							52	78						3000	78					
13-Sep-12							76	0						104	0					
11-Oct-12							109	127						99	127					
01-Nov-12							510	140						172	140					
22-Nov-12							45	0						62	0					
12-Dec-12							0	34						365	34					
14-Dec-12					70														4	
10-Jan-13							370	1540						1414	1540					
31-Jan-13							720	290						240	290					
21-Feb-13							480	6						26	6					
14-Mar-13							0	0						178	0					
16-May-13					0.5														0.5	
18-Jul-13					44														3	
17-Oct-13					80														4	
16-Jan-14					7257														2	
17-Feb-14					69														6	
10-Apr-14					158														16	

	Total coliforms (Count/100ml)						Enterococci (Count/100ml)							E. coli (Count/100ml)						
Date	**ON1**	**ON2**	**ON3**	**ON4**	**ONDB**	**ON5**	**ON1**	**ON1b**	**ON2**	**ON3**	**ON4**	**ONDB**	**ON5**	**ON1**	**ON1b**	**ON2**	**ON3**	**ON4**	**ONDB**	**ON5**
10-Jul-14					1120														25	
09-Oct-14					148														2	
15-Jan-15					0.5														0.5	
09-Apr-15					82														11	
15-May-15					23														1	
16-Jul-15					649														15	
03-Sep-15	140						140													
17-Sep-15	200	160	190	180		250	200													
15-Oct-15	800	3000	1600	3700		300														
15-Oct-15					0.5														0.5	
29-Oct-15							150							230						
12-Nov-15							85		68	6	1		59	120		21	530	9		34
26-Nov-15							500							150						
06-Jan-16							100		158					649		727				
06-Jan-16					2419														4	
11-Feb-16							200		200	60	40		45	20		70	7	16		18

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