ONRUS ESTUARY

Final Draft

Including Reassessment of 2002 proposed Rehabilitation and draft Situation Analysis

Onrus Estuary 2014

Prepared by:

Pieter Badenhorst

May 2014

Updated by:

Liezl Bezuidenhout

May 2015

Prepared by:
Pieter Badenhorst Professional Services CC
PO Box 1058
Wellington
7654

Date: May 2014

EXECUTIVE SUMMARY

PBPS was in late 2013 requested by The Lagoon Preservation Trust (LPT) (represented by John Loftie-Eaton) to undertake a re-assessment of the status of the Onrus Estuary and to recommend possible actions to remediate/reinstate the status. The overall aim should be to re-instate an open water body that could function as an estuary and will allow recreational activities.

During follow-up meetings between The Overstrand Municipality (represented by Liezl Bezuidenhout) and John Loftie-Eaton (representing LPT) in early 2014 it was decided that the report should aim to meet the requirements of an Estuarine Management Plan (EMP). The reason for this is that whatever is proposed for the estuary should be undertaken as part of such EMP.

The draft Step-By-Step Guide for the Development and Implementation of Estuarine Management Plans in terms of the National Estuarine Management Protocol, presents guidelines for the development and implementation of individual Estuarine Management Plans as required by the National Environmental Management: Integrated Coastal Management Act (Act No. 24 of 2008), as amended by the National Environmental Management: Integrated Coastal Management Amendment Act (Act No. 36 of 2014) (hereafter referred to as the ICM Act) and in accordance with the National Estuarine Management Protocol (Protocol). An estuarine management framework is provided, based on the minimum requirements stipulated in the Protocol, structured in terms of the three main phases, namely the Scoping phase, Objective setting phase and the Implementation phase.

The **Scoping phase** comprises a situation assessment to reflect on the current status of estuarine management in a specific estuary, conducted in collaboration with other relevant lead authorities and interested and affected parties, including estuarine scientists. The **Objective setting phase** entails the preparation of the Estuarine Management Plan, in accordance with the minimum requirements of the Protocol. The **Implementation phase** comprises the execution and monitoring of the estuarine management plan. A detailed review of an estuarine management plan needs to be conducted at least **every five (5) years** in accordance with the Protocol.

The process for the development of the Onrus EMP will also include the following:

1. Submission of the Final Draft Situation Assessment Report (SAR).
2. Stakeholder Meeting to discuss SAR and ensure that all required data are included.
3. Development of the Onrus Estuary Management Forum (OEMF).
4. Development of Vision and Objectives for the estuary.
5. Develop EMP to achieve vision and objectives.
6. Approval of EMP by the National Department of Environmental Affairs (DEA).
7. Implementation by the Management Authority.

This report therefore in its first draft included the findings of the re-assessment of the 2002 Report as well as include the available draft Situation Analysis and sections for stakeholder analysis and the Vision and Objectives for the management of the estuary.

From the section on the re-assessment of the 2002 Report the following can be concluded grouped as per the project deliverables:

1) Check on availability of other available data.
    - New available data has been incorporated with the information of the 2002 Report. This included a further assessment of available aerial photography and a survey

undertaken in May 2014 as well as a study by Agrimentor and the draft AR the (for latter see the next section).

2) Undertake an engineering assessment of the lower reaches of the Onrus Lagoon to check on sedimentation sources and possibility of introducing sedimentation traps to prevent sedimentation of the lagoon.
    - This has been undertaken and the finding is that the construction of a sediment trap is not a feasible option.
    - It is possible that a natural trap exists upstream of the estuary and management of this area might be a better solution.
3) Update the aerial photographic assessment as was included in previous reports.
    - The latest available aerial photography is for January 2014 and the reed bed edge was added to those for 1989, 1997 and 2000.
    - The comparision shows that few changes in the reed bed edge took place which seems to indicate that little sedimentation has taken place over the period.
4) Check on requirements of Estuarine Protocol for inclusion.
    - The undertaking of this report and completion of the Estuarine EMP to be implemented by the Management Authority after approval by DEA is a requirement of the protocol.
5) Arrange meeting with DWA to discuss their requirements.
    - This will form part of the next phase under stakeholder consultation.
6) Discuss with local community (Estuary Management Forum) and Municipality their requirements for management of the lagoon.
    - This will form part of the stakeholder consultation, development of Vision and Objectives, identification of Forum members, approval by DEA and implementation by the Management Authority.
    - The details will be included in section 4 as part of the next phase of this project.
7) Compile a technical report that is an updated version of the 2002 report.
    - This section of the SAR addresses the updating of the 2002 Report.
    - The overall findings can be summarised as follows:
        - The findings of the 2002 Report is still valid re possible rehabilitation solutions.
        - The aerial photographs show that few changes in the reed bed edge took place which seems to indicate that little sedimentation has taken place over the period.
        - The survey of May 2014 confirmed the above conclusion from the aerial photographs.
        - The survey quantified the present status compared with 2002 and indicate that overal the volume in the estuary has increased. It seems there was some sedimentation in the upper area of the estuary with erosion in the lower areas. (*Amend when info per section is available)*
        - It is therefore clear that the system retained itself for about a 20 year period after dredging in 1993/94. In addition the reeds also played an important role in maintaining water quality. Although the 2002 Report recommended that further dredging should be undertaken the question is now whether this should still be done. This is an aspect that should be addressed by the stakeholder consultation and final Vision and Objectives for management of the estuary.

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1 Introduction

PBPS was in late 2013 requested by The Lagoon Preservation Trust (LPT) (represented by John Loftie-Eaton) to undertake a re-assessment of the status of the Onrus Estuary and to recommend possible actions to remediate/reinstate the status. The overall aim should be to re-instate an open water body that could function as an estuary and will allow recreational activities.

The study would include the following:

- Assess the previous compiled reports and update the 2002 PBPS report including:
- Check on availability of other available data.
- Undertake an engineering assessment of the lower reaches of the Onrus Lagoon to check on sedimentation sources and possibility of introducing sedimentation traps to prevent sedimentation of the lagoon.
- Update the aerial photographic assessment as was included in previous reports.
- Check on requirements of Estuarine Protocol for inclusion.
- Arrange meeting with DWA to discuss their requirements.
- Discuss with locals (Estuary Management Group) and Municipality their requirements for management of the lagoon.
- Compile a technical report that is an updated version of the 2002 report.

During follow-up meetings between The Overstrand Municipality (represented by Liezl Bezuidenhout) and John Lofty-Eaton (representing LPT) in early 2014 it was decided that the report should aim to meet the requirements of an Estuarine Management Plan (EMP). The reason for this is that whatever is proposed for the estuary should be undertaken as part of such EMP.

The development of an EMP should include the following:

8. A Situation Analysis (SA).
9. Stakeholder Meeting to discuss SA and ensure that all required data are included.
10. Development of Vision and Objectives for the estuary.
11. Develop EMP to achieve vision and objectives.
12. Approval of EMP by DEA.
13. Implementation by the Management Authority..

For the Onrus Estuary a draft SAR is already available as shown in Appendix A. Steps 2 and 3 are still to take place. However, the previous 2002 Rehabilitation Report as well as the re-assessment undertaken in this report with possible rehabilitation options already identifies possible objectives for management of the estuary. These will, however, have to be assessed by stakeholders in context of the Vision and Objectives for the estuary. Other objectives could likely be added for inclusion in the EMP.

Discussions with Eldon van Boom (DEA&DP; Directorate Land Use Management) and Kobie Brand (Chief Director; DEA&DP: Directorate Sustainability) towards the end of 2013 (Estuary management falls under the latter) indicated that both supported the approach to involve all stakeholders to agree on remediation measures before commencing with any EIA process for environmental authorisation.

In Section 2 of this report the status of the lagoon is assessed, incorporating and commenting on investigations following the original assessment in 2002. Section 2 of this report also includes an updated photographic assessment of available aerial and satellite images. Section 3 provides a short discussion on the role of the catchment-generated sedimentation and the role of the reedbeds. Section 4 addresses the reviewed and updated proposed rehabilitation methods and provides estimated costing. Section 5 of this report addresses the findings of the desktop sediment assessment and the option of introducing a sandtrap stream up from the lagoon. The findings of the workshop as part of the public participation process are included where relevant.

2 Re-assessment of 2002 report

In this section the findings of the 2002 report is retained and available additional information added. In this section's conclusion the applicability of the previous findings and their re-assessment is discussed.

2.1 Previous studies on rehabilitation of the estuary

The rehabilitation of the Onrus lagoon has been under investigation since the early 1980s as indicated in the draft SA and by the following:

1. Estuaries of the Cape Report No. 24 – 1983
2. CSIR in Stellenbosch compiled a report in 1986 for the rehabilitation of the lagoon.
3. The CSIR produced another report in 1992.
4. The writer prepared a further report in 2002, and
5. Agrimentor produced a further report in 2010.
6. Comment on the Agrimentor Report was made by Sue Mathews and the Municipality of Overstrand (2011).

The 2002 study recommended dredging as a further rehabilitation measure since it was indicated that the previous dredging of 1993 was successful in creating open water areas to a depth of -1m MSL. Environmental Authorisation was obtained for the proposed work (as reported in the draft SA) but it was never undertaken due to a lack of funds.

2.1.1 Previous CSIR Reports

2.1.1.1 CSIR Report in the series Estuaries of the Cape – Onrus (1983)

The 1983 report describes the changes in the lagoon since 1921(Heinecken & Damstra, 1983). It shows the pristine state with large open water areas in a photograph of 1921 compared with extensive reed growth in 1976 (see Figure 2.1).

As part of the natural cycle rivers transport sediment from the catchment downstream until it is deposited when the flow rate decreases. This results in on-going sedimentation in lagoons and estuaries. During flood events the sediment is flushed to the sea to replenish the sediment requirements of the littoral zone. At the same time sediment is removed from the estuary or lagoon and the natural cycle starts all over again. In the case of the Onrus Lagoon the report states that human activity resulted in rapid increase of deposition, which changed from a seasonally-closed estuary with a relatively large open water lagoon to a shallow reed-choked lagoon. The human activity was mainly related to ploughing of farmland, clearing indigenous vegetation, afforestation and the building of bridges and dams. Building of the De Bos dam higher up in the catchment played an especially important role in reducing flood events that could flush sediment from the estuary. Once the sand in the estuary is stabilised by reedbeds it is unlikely to be flushed out either by tidal action or by river flow.

The report concluded that in the absence of a good management policy, sedimentation will continue and the reedbeds will extend towards the mouth. The report recommended that ecological management should strive to maintain a diversity of habitats where the estuary could act as a shelter for estuarine fish and support a marine invertebrate population near the mouth. It could have an area of reeds in the shallow water at the lagoon head with associated freshwater invertebrates, birds and small mammals and also provide a large expanse of deep water for recreational activities.

FIG. 10: Onrus Lagoon 1921, photographed from "Sleepy Lagoon", Protea Street. The wide lagoon is fringed with a narrow *Phragmites* bed. Islands in the lagoon are vegetated with a *Scirpus* species. (Photograph by courtesy of Mr Swingler.)

FIG. 12: Photograph illustrating the extensive reed growth that has taken place since 1921 (ECRU, 79-12-06)

Figure 2.1: 1921 and 1979 photographs of Onrus Lagoon

The final conclusion of the report states that the problem of the Onrus Lagoon lies not in the reeds themselves but rather in the sediment. This should be removed by mechanical excavation or dredging. It is further recommended that a transitional or ecotone zone should be maintained on the estuary banks.

2.1.1.2 A review of potential rehabilitation options for Onrus Lagoon (1991)

The 1991 CSIR report compiled for the Save Onrus Lagoon Committee provides a comprehensive overview of the status of the lagoon and discusses a number of rehabilitation options (CSIR, 1991). The report discusses *inter alia* Hydrology; Historical Changes; Substrata; Coastal Processes (Sea); Coastal Processes (Wind); Water Quality; Ecological Criteria; Recreational Needs; Rehabilitation Options and Recommendations & Summary.

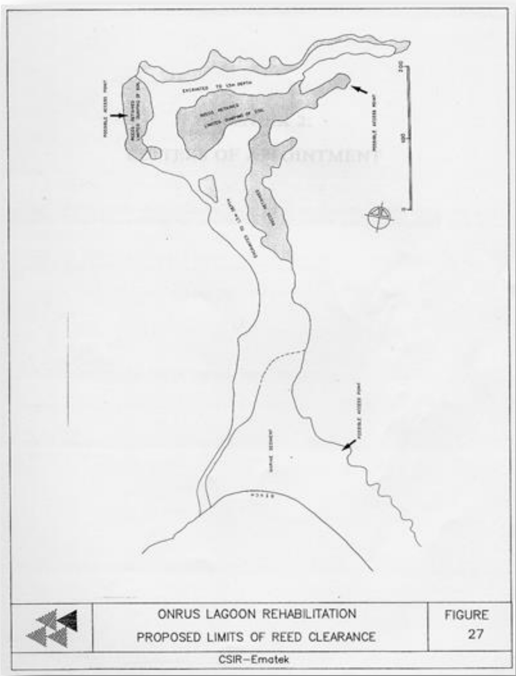
The report confirms the conclusions of the 1983 report that increased sediment deposition is the main reason for siltation. Increased irrigation abstraction might result in “no river flow” during the summer. The sediments are predominantly of riverine origin and the influx of sand from the sea over the spit play a minor role in increased sedimentation. There is no direct evidence of water quality problems in the past. The reeds are established following higher light intensities on the bottom that facilitates the rapid encroachment of the dominant reed *Phragmites australis*. The roots penetrate 60cm to 100cm with about 85% of the total root development in the 0cm to 60cm zone. The lagoon ecology is characterised by freshwater species although there are estuarine and a few marine elements, rehabilitation will not ultimately alter this status. With the increased population of reedswamp fauna it is not advisable to remove the reeds totally. Some of the reeds should be retained, especially in the upper reaches to function as a sediment and nutrient trap and to provide suitable habitat for birdlife.

The report listed six possible rehabilitation methods:

1. “Do Nothing” option – 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. The negative impact of this option on property values has been mentioned.
2. Chemical control of reeds – The reeds could be sprayed with a systemic herbicide. Although this would kill large sections of the reedswamp it would, however, not remove the reeds or sediments.
3. Construction of a weir across the Onrus River mouth – This option is rejected because the weir would not be able to maintain high water levels, remove existing

sediment from the system and would change the ecology to that of a freshwater system.

4. Raise the salinity of the Onrus Lagoon – To achieve this seawater would have to be pumped at considerable cost and retained for sufficient time to affect the reeds. This option was considered impractical.
5. Mechanical reed and sediment removal – Removal of about 45 000m³ of sediment. This would retain islands and a vegetated fringe as shown in Figure 2.2. This option was recommended. Two options for removal were discussed, namely, dredger or dragline. The dragline was seen as impractical due to the need for establishing an access road over the reeds and the ineffectiveness of dumping loads with high water content. It was also recommended that more detailed studies be undertaken to quantify the type of material to be removed.
6. Mechanical reeds and sediment removal – Removal of about 60 000m³ of sediment. This would entail completely clearing the lagoon leaving only a narrow fringe around the perimeter.



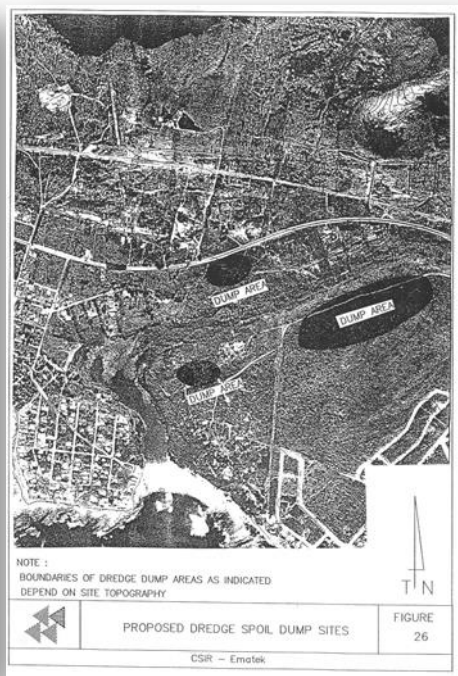


Figure 2.2: Proposed reed clearance (CSIR, 1991) Figure 2.3: Proposed spoil dumpsites (CSIR, 1991)

Three options for access to the site were discussed. The Petersen Road access would be easy but would cause a public disturbance. The road from Habonim over the beach or through the head of the estuary would require mitigation measures but would largely reduce the public disturbance aspect.

Three dumpsites were recommended as shown in Figure 2.3. It was noted that the dredge spoil would be black and give off quantities of marsh gas (methane) and hydrogen sulphide

(H_2S) which smells strongly of rotten eggs. Although neither of these gases is toxic they would constitute a public nuisance. On completion of dredging the dumped material would have to be capped with a layer of soil and then vegetated.

The report concluded *inter alia* that by implementing the preferred option of limited clearance of reeds and sediments, the source of fluvial sediments would not been removed and that a large flood may again deposit vast amounts of sediment in the lagoon. The sediment yield from the catchment can, however, be radically reduced by altered land-use practices and replanting of indigenous riparian vegetation to act as sediment filters.

The final recommendation states that between 30 000m^3 and 45 000m^3 of material should be removed. The motivation for not removing larger quantities include recreational requirements, narrow channels would increase flow velocities, cost of the operation, islands and banks could be used for dumping and the reduced netto riverine inflow would reduce the potential water area that can be sustained.

2.1.1.3 A management plan for the Onrus Lagoon and immediate environs (1993)

This report was compiled by the CSIR for the South African Nature Foundation (SANF – now WWF-SA) to design a management plan for the Onrus Lagoon and the 2,6ha on the eastern bank (CSIR, 1993). The management system was based on:

- A commitment by the Onrus Municipality and the SANF to be responsible for the management of the lagoon and environs.
- A policy to manage the lagoon and environs for the benefit of the inhabitants and visitors to Onrus, the natural environment and for low intensity recreation.

The management plan addressed the following aspects – natural environment:

- Establish a bird sanctuary on the 2,6ha to the east of the lagoon.
- Removal of alien vegetation.
- Re-establishment and encouragement of indigenous vegetation.
- Control and reduction of sedimentation.
- Control and reduction of reed growth.
- Need for an integrated catchment management plan.

The management plan addressed the following aspects – recreational environment:

- Maintenance of open water space.
- Ensurance of acceptable water quality.
- Development of the recreational value of the bird sanctuary through constructing a walkway, bird hide and vantage points overlooking the lagoon.
- Zoning of activities.
- Access points and recreational nodes.
- Environmental education.

The proposed zoning of the lagoon is shown in Figure 2.4. The report discusses each aspect of the management plan in detail. With reference to the reeds, the report confirmed that a fringe should be maintained. It also confirmed that an area of reeds in the upstream reaches of the lagoon should be maintained to act as a sediment trap and to remove nutrients from the water. It was also pointed out that ongoing lagoon maintenance would be required through follow-up dredging at regular intervals.

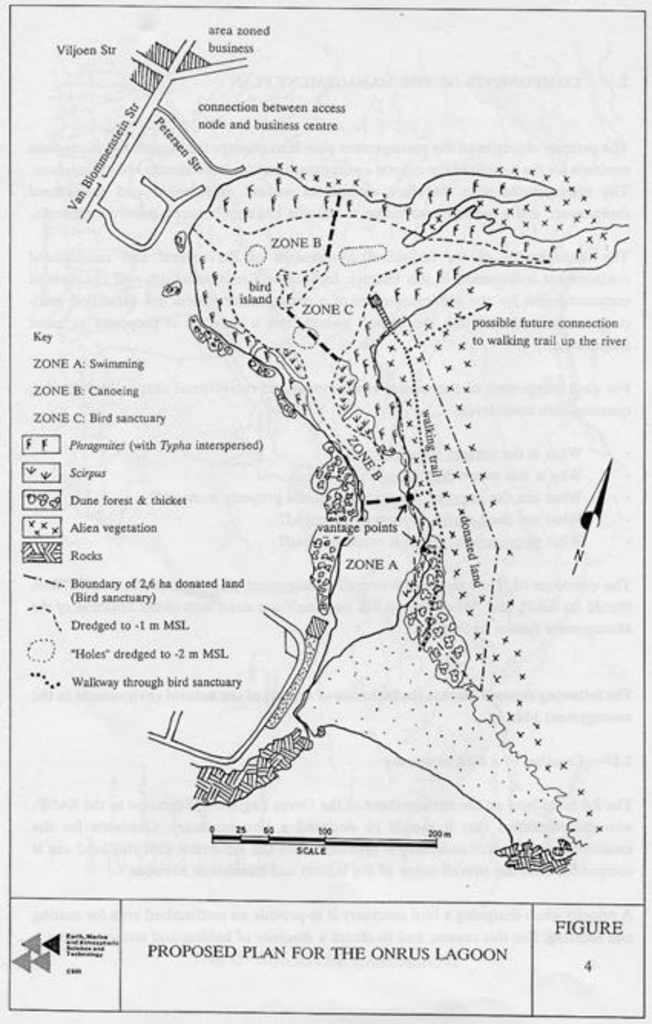


Figure 2.4: Proposed zoning (CSIR, 1993)

2.1.2 Comments on 1993 dredging as included in 2002 Assessment

Dredging of the Onrus Lagoon started towards the end of 1992 with reed removal and was completed by mid 1993. According to Alan Klaassen (pers. comm.) about 30 000m³ of material was removed. See Figures 2.5 and 2.6 for an overall view of the lagoon during dredging and a photo of the dredger.

Figure 2.5: View of lagoon and dredger

Figure 2.6: Dredger used in 1993

The main problems experienced included the following:

Dumpsites:

- The dump area near Sandbaai was hard (not sandy) and had to be broken with machines to find material to construct the holding dams.
- The holding dams were very porous and many problems were experienced with seepage.
- Seepage from the holding dams into the water table caused it to rise and problems were experienced with raised water levels in the adjoining developed areas such as Sandbaai and Habonim.
- Odours emanating from the holding dams.
- While pumping to the sea roots washed onto the beach and had to be cleared from time to time.
- It seems that on completion of the dredging the dredged spoil was partially covered with sand as required by the CSIR Management Plan (CSIR, 1993) and that some material was later removed as topsoil (Leon Geustyn, pers. comm.).

Pipeline

- The pipeline blocked regularly.
- Water released when the blocked pipe had to be opened caused flooding in areas of Habonim.

Reed removal

- The machine initially used to cut the reeds got seriously stuck in the mud.
- The reeds were then cut by hand and removed by truck from the lagoon to the dumpsite near Sandbaai.
- Trucks had to travel on streets in the Onrus area and this caused black mud/silt to spill on the road surface. This had to be cleaned regularly.
- The trucks caused many public complaints.

Dredging

- Many problems were experienced with cutting of the reed roots by the cutter head. Blocking often occurred causing delays.
- Many complaints were received re noise from the dredger.
- The raised spit in the mouth was often breached due to heavy flows in the river.

Volume removed

- The volume removed was in the order of 30 000m^3.
- The 1994 DWA survey of the lagoon immediately after dredging is shown in Figure 2.7. It seems that the –1m MSL level was reached in only a few areas.

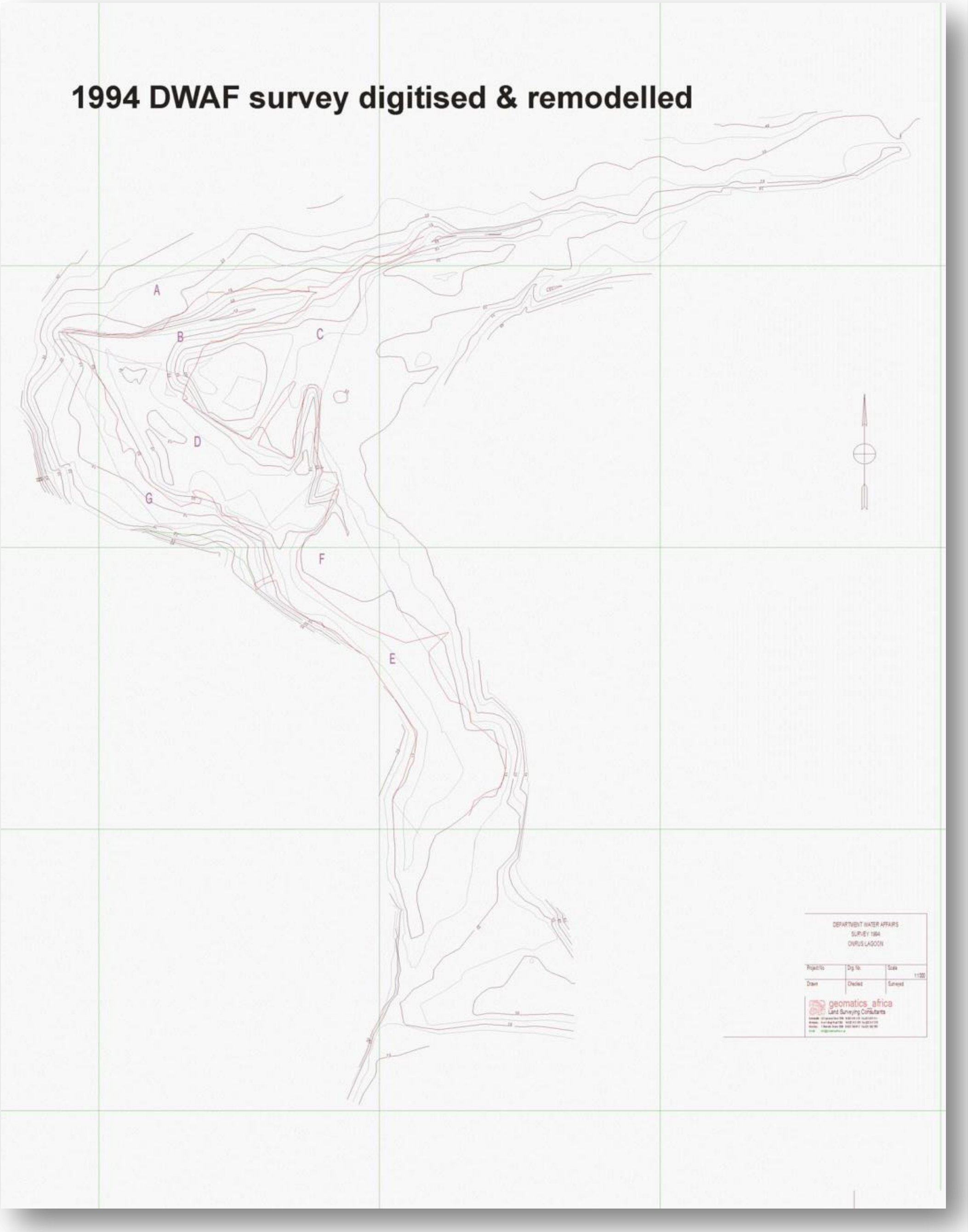


Figure 2.7: Survey after 1993 dredging

2.1.3 2002 Rehabilitation study – main findings

2.1.3.1 Report conclusions:

1. The main reasons for infilling of the lagoon are increased sedimentation from the catchment due to human influences – increased irrigation, construction of roads and bridges, sewerage pipeline construction along the lower river course and removal of natural and alien vegetation.
2. The De Bos Dam and farm dams in the lower reaches have reduced the frequency and magnitude of floods, which normally would have flushed the sediment from the lagoon to the sea.
3. The higher sediment levels with resultant shallower water depths have lead to the influx of reedbeds.
4. The lagoon would have been a reed swamp had dredging not been done in 1993.
5. It is unlikely that any major flood would be able to remove large volumes of sediments from the system, as would normally be the case. This is because the sediments have been stabilised by the reed growth.
6. The only practical way to re-establish open water areas would be mechanical removal of the reeds, roots and sediments. First removal took place in 1993.
7. The 1993 dredging experienced a number of problems including:
    - 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
    - noise from the machinery causing a public nuisance
8. About 30 000m³ of material was removed in 1993.
9. The motivation listed by CSIR for not opening large areas are largely subjective since flow velocities would be low in most cases; very little material can be dumped on the islands and banks and the inflow rate does not always control the water levels. Even in winter with an open mouth the water levels could be quite low.
10. The reed beds play an important role in removing nutrients and act as a sediment trap in the head of the lagoon.
11. The flood following dredging in 1993 caused some sedimentation as indicated by the 1994 survey. This could unfortunately not be quantified.
12. Since 1994 no further meaningful sedimentation took place. This is probably due to increased vegetation in the upper reaches of the lagoon and the fact that no major flood

occurred during this period. It is therefore a pity that more material was not removed in 1993. It might have prevented the need for additional dredging.

2.1.3.2 2002 Rehabilitation objective and requirements

It must be taken into account that open water areas in the lagoon with related bird and aquatic life would not only be an asset to property owners and the wider community but such a "natural" system would also contribute to the ecology of the area. With no further dredging it would only be a matter of time for the present system to return to a state similar to that of pre-dredging in 1993.

Therefore, should a system be required with open water areas that would be similar to that of a natural lagoon system and one that could be utilised for low-key recreational aspects (as listed in CSIR, 1993) then the following should be implemented:

1. Remove reeds and sediments mechanically.
2. Ensure that a reed fringe remains wherever practically possible to serve as an "ecotone" between the surrounding environment and the open water.
3. Maintain an island opposite the position of the old bird hide to serve as a bird habitat.
4. Maintain the reedbeds in the head of the lagoon to trap sediments and nutrients.
5. Ensure that a catchment management plan be implemented that will at least ensure the implementation and management of:
   - a natural vegetated fringe on the river banks and at the head of the estuary
   - farm and irrigation principles that will minimise erosion
   - adequate compensation releases from present and future dams to maintain water levels in the lagoon.

2.1.3.3 Rehabilitation areas and volume

CSIR (1991) recommended that a volume of between 20 000m^3 and 45 000m^3 be removed. Taking into consideration the cost to establish equipment together with the actual costs and indirect costs such as the public nuisance factor, it would be best to remove as much material as possible. Per unit volume over time this would not only be the cheapest method but would also remove adequate material so that the system remains functional for a long time. However, since this system is situated within a dynamic environment, there is a chance that a catastrophic flood could occur which would possibly introduce additional sedimentation. On the other hand with an open system there would be a better chance that sediments are flushed to the sea. There is, however, no guarantee on how long the lagoon will remain open and deep as per the recommended approach. Active implementation of a good management plan will ensure that all practical steps be implemented to ensure optimal maintenance of the dredged system. Maintaining the reedbeds and vegetation in the upper reaches of the lagoon would be critical to prevent sediments from reaching the lagoon itself.

The proposed area to be dredged is shown between the red lines in Figure 2.8. A small island will also be maintained as shown. The surveyed area and calculated volumes have been split into separate areas so that should a different area be selected for dredging fairly accurate assumptions on new volumes would be possible by adding prorata volumes of each area. Similarly as recommended by CSIR (1993), the volumes have been calculated for removal of material to a level of –1m MSL. The areas and volumes for each area are shown in Table 2 below:

Table 2: Surface areas and volumes for proposed dredging

	A	B	C	D	E	F	G	Total
Surface area (m^2)	4 080	4 915	7 020	9 633	10 488	4 654	2 981	43 771
Volume (m^3)	10 130	6 324	18 315	8 375	13 709	10 797	6 900	74 550

Areas A, C, F and G are covered by reeds giving a volume with reeds of about 20 000m^3 material with roots (assuming a root depth of 1m). The remainder would be clean sand (no roots). The area of reeds that would remain should the recommendation be implemented is shown in Table 3 below:

Table 3: Remaining reed area after dredging

	A1	F1	G1	Total
Reed area (m^2)	4085	4196	13063	21344

This means that the open water area would be roughly double that of the redd area.

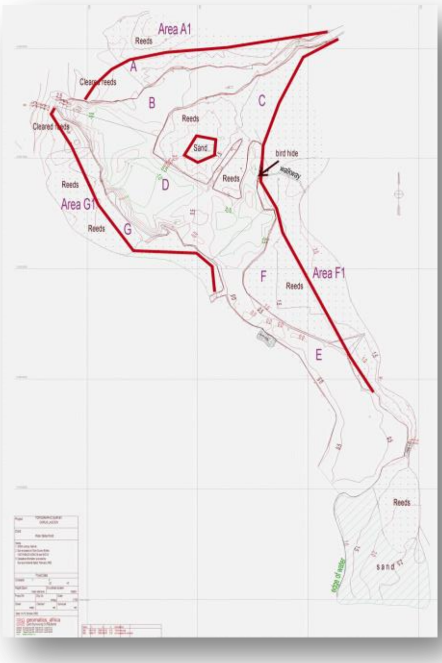


Figure 2.8: Area to be dredged

2.1.3.4 Reed removal

During the previous dredging activity the reed beds were mechanically cut and then transported to the dumpsite where they were used as "filters" in the holding dams. The problems experienced, such as spilling on the roads, will certainly reoccur. It is therefore strongly recommended that paths be cut by hand in the areas to be removed and that the remainder be burnt in small controlled burns. This will ensure minimal disturbance to the public. The following should be taken into account when planning the burns:

a) The burns could only take place towards the end of summer when no or few bird nests would remain.

b) The "burn paths" should be at least 7m wide and the material should be dumped on the other reeds.

c) Before a burn, people should walk through the reeds to chase all birds/animals from the area.

d) A calm wind day should be selected to ensure a "cool" burn.

However, should the excavator and trucking option be selected then the work should be undertaken during the dry summer months. In this case the reeds will have to be cut by hand as during the previous exercise.

2.1.4 Rehabilitation methods identified in 2002 report

From an engineering perspective, the following methods could be used to implement mechanical rehabilitation of the lagoon:

Figure 2.9: Dredger similar to 1993 exercise to on land dumpsite

Figure 2.10:Dredger similar to 1993 exercise to the sea

Figure 2.11: Dragline/Excavator and trucks to on land dumpsite

Figure 2.12: A combination of dredger and trucks

Table 1 below summarised the methodology, advantages and disadvantages of each method:

Table 1: Rehabilitation methodologies, advantages and disadvantages

	1. Dredger to on land dumpsite	2. Dredger to sea	3. Dragline or excavator & trucks	4. Combination
Method	• Use dredger during wet period with adequate water in lagoon to remove material – possibly from April through the winter. • Pump line from dredger to dumpsite (on land or to the sea). • Work during daylight hours to minimise noise inconvenience. • Pipelines to run through reed beds to minimise damage to natural vegetation and/or properties.	• Use dredger during wet period with adequate water in lagoon to remove material – possibly from April through the winter. • Pump line from dredger to dumpsite (on land or to the sea). • Work during daylight hours to minimise noise inconvenience. • Pipelines to run through reed beds to minimise damage to natural terrestrial vegetation and/or properties. • Roots to be removed from the beach using local labour and then trucked to dumpsite for burning.	• Use dragline or excavator on a constructed work base to remove material. • Transport material via haul roads to the dumpsite. • An alternative to haul roads through the lagoon would be to use urban streets – due to public nuisance value not considered feasible. • Work during daylight hours to minimise noise inconvenience. • Haul roads to be constructed on reed beds wherever possible to minimise damage to natural vegetation and/or properties.	• Use dredging and pumping for a short distance – say to an area east of the lagoon – and then truck the material from there to the main dumpsite. • The haul road could run around Habonim or alternatively through Habonim. This alternative not seen as feasible due to safety factor and public nuisance value.

Advantage	• Relatively easy to establish. • Remove roots and sediment at the same time (new technology will prevent clogging of cutter head). • Easier methodology compared with method 3 and 4. • No traffic hazard.	• Relatively easy to establish. • Relatively easy to change pump line from dumpsite to dumpsite on the beach. • Remove roots and sediment at the same time (new technology will prevent clogging of cutter head). • Easier methodology compared with methods 1, 3 and 4. • No traffic hazard. • Dump in sea during winter with high sea energy and few people swimming. • Dumping of sediment in the sea would also occur naturally during floods. • Less costly.	• Relatively easy to establish. • Remove roots and sediment at the same time. • Operates best with dry material and can therefore work during dry periods in the summer.	• Relatively easy to establish. • Shorter pipeline and haul road lengths compared with other methods. • No booster pump required.

Disadvantage	• Requires adequate water levels, which might mean artificially raising the spit. • Requires costly booster pump for on land dumpsite. • Noisy. • Pipeline and cutter head may clog.	• Requires adequate water levels, which might mean artificially raising the spit. • Roots must be removed from the beach in the case of sea dumping. • Noisy. • Pipeline and cutter head may clog. • A sand build-up will occur on the beach that will be removed naturally by the waves over time.	• Requires a constructed haul road while working on east side of lagoon. • The very muddy work environment would require a constructed work base for the machines to operate from. Within this environment this is not a feasible option. • The work base and haul roads would be very expensive to construct and maintain. • Difficult to load wet and muddy material. • Difficult to transport muddy material to dumpsite – waste along the way. • Working on the west side will require trucks to run through urban streets. This can be mitigated with a haul road through the lagoon. The latter not feasible. • Heavy trucks would pose a traffic hazard in urban streets	• Establishing costs would be nearly double. • Loading and transport of dredge “slush” would cause major problem since not enough holding area would be available to allow the material to dry out before transport. • Will cause a major public nuisance in Habonim area. • Will cause a rise in water table in Habonim area
Select	No	Yes	No	No

2.2 Dumpsites as identified in 2002 report

The lagoon is situated within an urban developed area, which makes operation and dumping of the material problematic. The only realistic on land site is the same site as was used during the previous dredging exercise (see Figure 2.9). Other sites further away would be more costly and only applicable to truck removal. Taking into account the type of material, truck haulage distances should be as short as possible.

The alternative to a land dumpsite is to dump directly into the sea (see Figure 2.10). This would not only be the simplest and cheapest option, and would have the additional benefit that sediment which should have been deposited in the sea during flood events would be placed in the marine environment where it should have been in the first place. The only negative aspect of this option would be roots that would wash up onto the beach and fine material that would be released into the sea. During the previous dumping to the sea, the roots were not a problem. The fines released directly into the sea would also have been washed into the sea during flood events. This option is therefore very close to what would have happened naturally during flood events. It should be implemented during the winter months when few people are swimming and the sea energy is generally higher due to winter storms. The additional turbidity caused by the dumping would therefore be inconspicuous.

The dumpsites should be on the "edge" of the pocket beach as shown in Figure 2.10 to provide the best opportunity for waves to move the sediment alongshore.

The advantages and disadvantages of dumping on land or in the sea is summarised in Table 2 below:

Table 2: Advantages and disadvantages of dumping on land or in the sea

	Dump on land	Dump in sea
Advantage	**1.** No silt or roots released into the sea. **2.** Dumped material could be used as topsoil.	**1.** Sediment deposited into the sea is part of the natural processes of lagoons and estuaries. **2.** No limit in quantity to be dumped. **3.** Pump lines are less intrusive compared with haul roads. **4.** Pump lines would be cheaper than haul roads. **5.** The pump line to the sea would be shorter than to a land dumpsite. **6.** Opening of pipe blockages would cause no problems. **7.** No drainage or water table problems. **8.** Total work time will be reduced. **9.** Few people are swimming in winter. **10.** During the winter the wave energy is generally higher and the water more turbid.
Disadvantage	• Holding dams without a liner would leak and cause the water table to rise.	• Roots will wash up onto the beach and will need to be removed. • Washed up roots will have to be

	• Holding dams with a liner would be impractical and costly. • The dumped material could have a bad smell. • Limited quantities could be dumped on land. • The dumpsite would cause the water table in the area to rise with negative impact on the local developments. • Opening of pipe blockages could cause problems to neighbouring properties.	transported to the on-land dumpsite and burned. • The fine material could cause turbidity in the sea similar to a flood event.
Recommend	No	Yes

2.2.1.1 Additional studies

The following additional studies would be required depending on which rehabilitation option would be selected:

Dumpsite on land:

Studies would be required to investigate the soil conditions and to design dams and outlets that will not cause water table problems as during the previous dredging exercise.

Haul roads

Studies would be required on the soil conditions in and around the lagoon to design appropriate haul roads and to define optimum alignments.

2.2.1.2 Costing

The costing provided allowed for the proposed removal of 75 000m³ and for 35 000m³. This clearly shows the advantage of removing the larger volume.

A summary of the total costs for each rehabilitation method is shown below in Table 3:

Table 3: Summary of rehabilitation costs

	Estimate in Rand for 2004 **35 000 m³**	**Estimate in Rand for 2004** **75 000 m³**
Rehabilitation method 1: Dredger to on-land dumpsite	4 204 320	7 676 760
Rehabilitation method 2: Dredger to sea	2 693 820	4 526 940
Rehabilitation method 3: Excavation and trucks to on-land dumpsite	2 935 500	4 830 180
Rehabilitation method 4: Combination of dredger and trucks to on-land dumpsite	4 065 240	6 537 900

The cheapest option was Method 2 followed by Method 3. As indicated previously Method 2 would not only be the easiest but would also have the least negative impacts on the public and the environment. It is strongly recommended that Rehabilitation Method 2: Dredging to the sea is selected for implementation.

[Note that 2014 cost could be 50% higher than those for 2004.]

2.2.2 Assessment by Agrimentor of the conditions at Onrus Lagoon

Agrimentor was commissioned by the Van Graan family in 2010 assess the status of the Onrus lagoon. Using available maps, photographs, input from the local people and other background information, Agrimentor concluded as follows (*Agrimentor*, 2010):

Historically, the lagoon was an open water body and the mouth would frequently be filled up with sand, which accumulated from sediment transport due to wave action of the sea. Subsequently, when the mouth was closed due to the embankment of sand, the large volume of fresh water, which flowed into the lagoon, resulted in a breach of the sand bank. Due to the above, the mouth of the lagoon would frequently be opened to considerable depth and subsequently the tidal influx of large volumes of seawater would occur. In addition to the above, the Onrus River would normally come down in heavy floods up to four times per year that would also result in scouring of the lagoon bottom level.

However, over the past 50 years, the inflow of fresh water from the Onrus River into the lagoon has been reduced significantly due to water extraction and the construction of storage dams upstream. Due to the above, the number of floods reduced to less than 5 percent of its former occurrence. Subsequently the mouth of the lagoon is permanently blocked, apart from a small drainage channel into the rocks on the beach. As a result of the above, the water quality of the lagoon changed from predominantly salt water to predominantly fresh water. Historically the reeds only occurred in the fresh water inlet of the lagoon, with their growth kept in check by the salt water. However, due to the change in water quality, the reeds started to dominate the entire area of the lagoon.

At present, the reeds are encroaching into the vertical cliff faced on the sides of the lagoon as well as onto the sides of the lagoon onto dry ground and into the tree line. Furthermore, the reeds are overgrowing the entire central channel of the lagoon.

Agrimentor concluded that the reeds in the lagoon will completely dominate all vegetation in and around the lagoon and the reed growth can be expected to occupy all the open space in the lagoon. The reeds also exhibit strong allelopathy, an aggressive negative action against certain other species, especially tree species. It is expected that the lagoon will silt up completely due to the lack of seawater influx and the absence of frequent floods in the Onrus River.

Agrimentor also concluded that once the encroaching progression of the reeds has been completed, the seawater could never be expected to penetrate into the fresh water body of the lagoon. Apparently the foothold of the reeds will be permanent and irreversible which would in turn also increase the elevation of the sand and list level in the lagoon. Should the above occur, the lagoon would develop into a grass wetland, dominated by reeds. Subsequently, this will result in an ideal breeding area for mosquitoes as well the build-up of a number of micro-organisms which could potentially threaten the livelihood of people in the surrounding areas.

According to Agrimentor's studies, the present condition of the water quality is such that it is no longer safe for leisure visitors to use the mouth of the lagoon and its surrounds. Sampling at the water outflow from the lagoon and counts of a number of bacteria species indicated that large numbers of organisms associated with human deceases were observed in the reed masses.

Agrimentor recommended the following mitigation measures to improve the present situation:

- Constructing an opening of about 50 metres at the mouth of the lagoon to create constant flushing;

- Introducing a low pressure pipe and pump system which would carry a large enough volume to flush the lagoon with seawater in order to limit the reed growth;
- Eradicate the reeds by means of a non-toxic herbicide combination (herbicide).

2.2.3 Response to Agrimentor's findings

Following the findings of the Agrimentor investigation, comments were made by Sue Matthews (*Matthews*, 2011), the estuary management coordinator. Her comments were supported by the Overstrand Municipality (*Overstrand*, 2011). Their responses to the Agrimentor report are briefly summarised below:

Matthews concurred that the Onrus lagoon is presently in a severely degraded state and that the lagoon has been rated an E for Current Ecological State in the National Biodiversity Assessment in 2010.

However, Matthews stated that the proposed mitigation measure as recommended by Agrimentor; to open a 50 metre stretch of sandbar is not feasible due to the physical coastal characteristics of the site. The opening will tend to close up quickly and will have to be kept open by means of a hard structure. Instead of facilitating the reduction of reeds in the lagoon due to flushing, such a permanent opening could result in an additional sedimentation problem, which in turn could simply drain the lagoon faster and allow the reeds to colonise in new areas of shallow water.

According to Matthews, the concept of increasing the salinity has been shown to cause a decline in reeds. However, since the reeds can tolerate high salinity, previous studies have shown that it could take between 10 and 20 years for the gradual replacement of reeds by natural vegetation by increasing the tidal action.

Matthews also raised concerns regarding Agrimentor's suggestion to spray the reeds with a non-toxic combination (herbicide) in order to kill the reeds. A spraying programme can only be conducted when the water levels decrease such that an area of reeds can be cut down. Following this, herbicide can be applied to the green shoots. It should also be noted that spraying herbicide with a helicopter is not feasible in a dense urban area and should this be accepted, the impact of tons of decomposing plant matter on the lagoon's ecology would be severe and physical removal needs therefore also to be budgeted for.

It should also be considered that the previous flood was believed to contribute to the reed growth, since large amounts of silt were deposited in the lagoon, causing shallowing and subsequently room for reeds to colonise. According to Matthews, a more proactive approach would be to clear away the Eucalyptus, which stands below the Camphill causeway, since this will help restore the riparian habitat and increase biodiversity.

Matthews also pointed out that pollution should be addressed at source and therefore the pollution due to the outflow from the sewerage pump station at the head of the estuary which sometimes overflows due to operational and capacity problems has to be addressed instead of trying to flush out the estuary during such conditions. The same accounts for the sewerage pipe which lies in the riverbed and raptures frequently, discharging raw sewage into the system. In addition to the above, nutrient-rich runoff from agricultural and residential properties further upstream also contribute to the water quality of the estuary.

Although Matthews state that the option to dredge the Onrus Lagoon could be feasible and has to be investigated, she pointed out that such an operation would be expensive and will require an EIA.

2.3 Basic Assessment report for river wall stabilising

During 2013 a Basic Assessment process was undertaken for a stormwater management project, which also included the stabilising, and rehabilitation of the northern embankment of the Onrus River, which extends along Private Erven 581/335, 581/360 and 5156.

The preferred option as approved for stormwater retention ponds is shown in Figure 2.13 and for embankment stabilisation as shown in Figure 2.14.

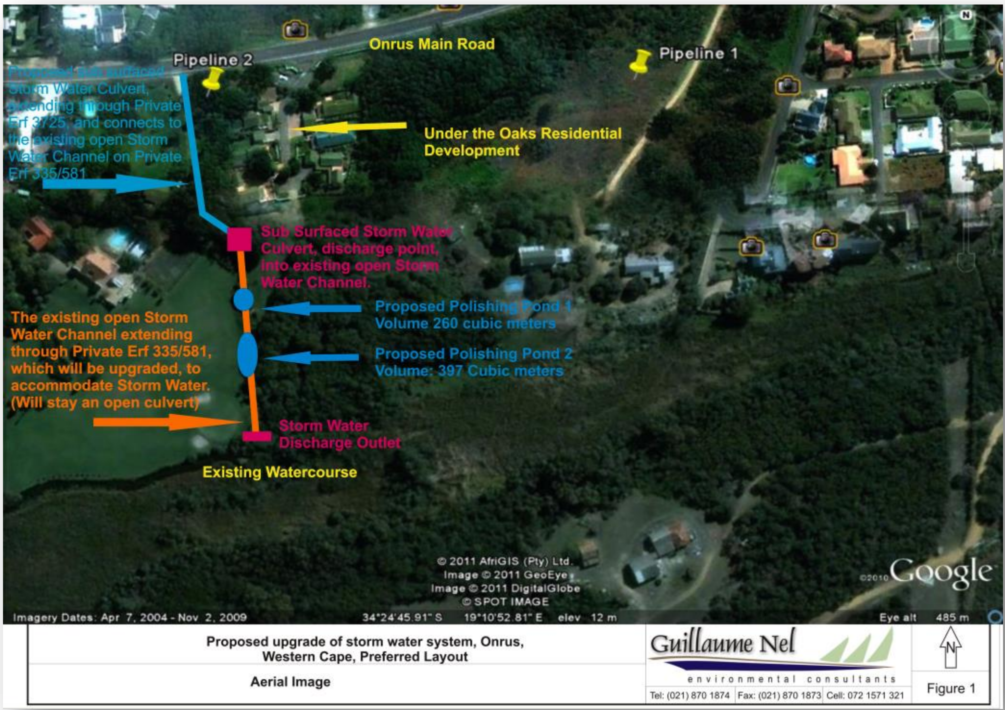


Figure 2.13: Proposed stormwater retention ponds

Figure 2.14: Proposed embankment stabilisation

The proposed embankment stabilisation is being implemented at present as shown in Figure 2.14a.

Figure 2.14a: Completed bank stabilisation

Although CSIR previously recommended that an ecotone fringe must be maintained it was not implemented likely due to erosion of the embankment that made such fringe impractical.

2.4 Investigation of sand trap system

In order to investigate an alternative option for future maintenance than physically removing the reeds, the feasibility to construct a sand trap upstream from the estuary was assessed.

In principle, a functioning sand trap in the system will assist in constraining the reed growth. A sand trap will accumulate fine sediment and silt upstream, which would otherwise be deposited in the estuary itself and which results in an increase of the bed level and subsequently the growth of reeds.

A site investigation was conducted in December 2013 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. The access points visited are shown in Figure 2.15 with examples of those sites in Figure 2.16.

From the investigation, the following was observed:

- The river is mostly contained along its edges, mostly due to either an adjacent road, rocky substrate, trees or cultivated lands (see below photos 2139, 2145, 2147-2149, 2151, 2153, 2156);
- Little erosion was observed, this is most likely due to the above; and
- High flow velocities were observed throughout the system, except in the area below the dam where the river widens; and
- It seemed likely that a natural sand trap is located downstream of the Onrus Bridge, in and just upstream of the estuary (see photo 2160). The main reason for this conclusion is that it seems the slope flattens below the bridge thereby decreasing flow velocities. In addition the comparive surveys of 2002 and 2014 show increased sedimentation in the upper ereached of the estuary.

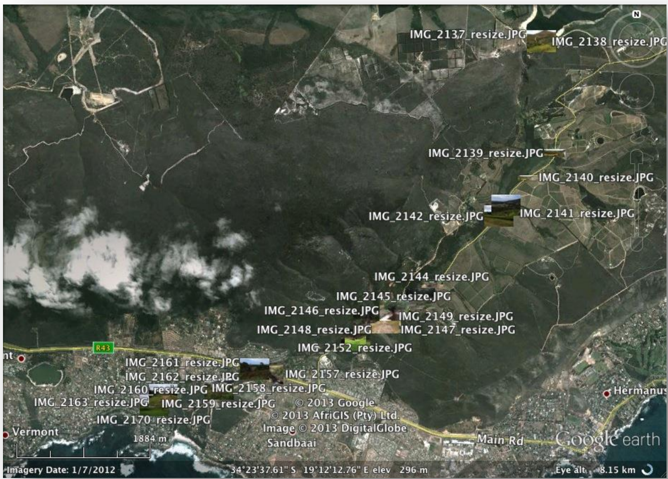


Figure 2.16: Photo positions

Photo 2139

Photo 2145

Photo 2147

Photo 2148

Photo 2149

Photo 2151

Photo 2153

Photo 2156

Photo 2160

Photo 2169

Although a sand trap could possibly assist to minimize the reed growth in the Onrus Estuary, a number of constraints were identified which affect the feasibility of such a solution. Possible construction and maintenance constraints are summarised below.

To date, there is no information on the sand volumes in the system. The suspended and bed load sediment will have to be quantified by means of sampling and sediment regime studies in order to design a functional sand trap. For a first estimate, it can be assumed that a proposed sand trap will have to be very large due to the steep river, which affects the velocities, and subsequently the sediment loads in suspension.

A significant constraint of a sand trap is the cost of maintenance. Normally, depending on the size of the sand trap and the sediment transport regime of the river system, a sand trap is excavated at least once to twice every year.

The location of the sand trap will be governed by a number of aspects, which will include (but not limited to) the following:

- A straight stretch of river more or less 50 to 100 metres long with a stable edge;
- Availability of large enough municipal land adjacent the trap to accommodate an access road and manoeuvrability room for heavy excavating equipment and large dump trucks;

- Proximity to a suitable waste site to stockpile the spoils; and
- A stable, low level, gentle sloped bank which can serve as a working platform for an excavator to clean out the sand trap;

From a first assessment, although a natural flat slope seems to be present below the bridge, taking the above into account, it seems unlikely that a suitable position is available.

2.5 Latest aerial photograph and comparison with earlier photos

The latest available aerial photography is for January 2014. A comparison of the reed edge for the years 1989 (pre dredge), 1997 (3 years post dredge), 2002 (8 years post dredge) and 2014 (20 years post dredge) is shown in Figure 2.17. This figure clearly shows that little of the estuary open water area was remaining in 1989. In 1994, 2000 and 2014 the open water areas as dredged in 1993/94 are clearly visible. A comparison of the surveys of 1994 and 2002 is shown in Table 4 (see Figure 2.8 for B, C, D and E). The table clearly shows that little sedimentation took place between 1994 and 2002. This seems to have indicated that the money spend on dredging was a good investment.

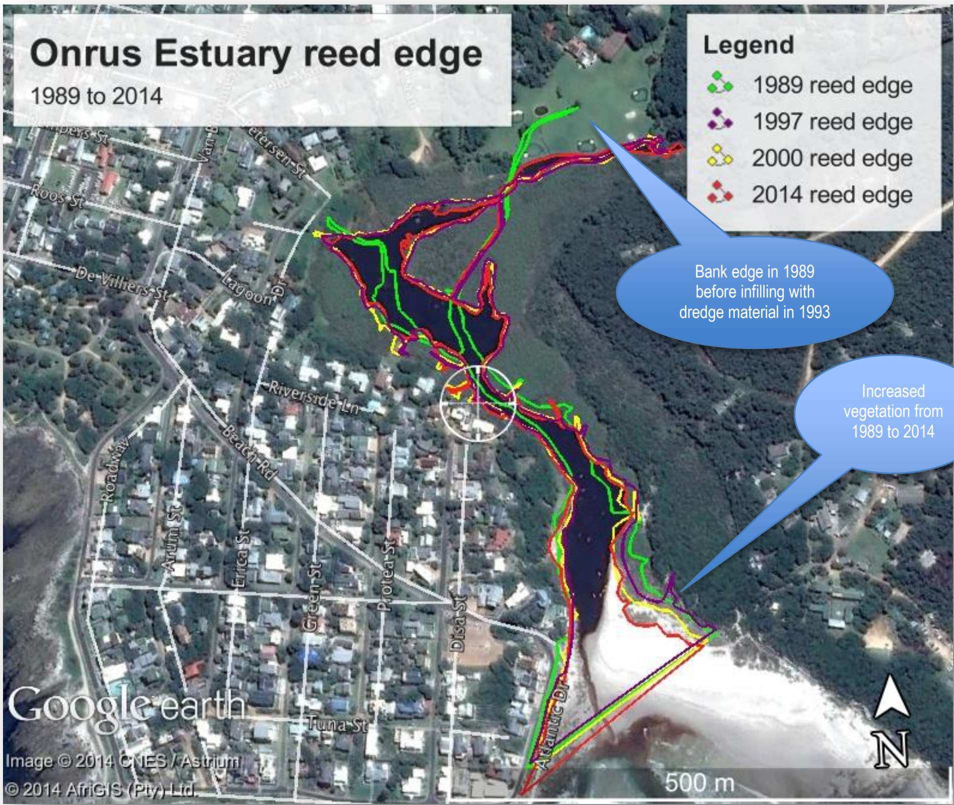


Figure 2.17: Onrus Estuary reed edge 1989 to 2014

Table 4: Comparison of open water surface area and volumes for the 1994 and 2002 surveys.

	1994		2002		2014	
	Surface	Volume	Surface	Volume	Surface	Volume

	area (m²)	(m³)	area (m²)	(m³)	area (m²)	(m³)
B	5027	5673	4 915	6 324		
C	7072	17979	7 020	18 315		
D	10218	7662	9 633	8 375		
E	10399	14873	10 488	13 709		
Total	32716	46187	32056	46723		

Figure 2.17 shows that since dredging in 1993 only very minor changes of the reed edge occurred. This is more visible in Figure 2.18 with comparison of 1997 (shortly after dredging) and 17 years later in 2014. The only area where there is a real visible change is closer to the mouth area on the eastern bank where vegetation increased. The aerial photographs, however, only show the horizontal changes and not any changes in depth. With sedimentation it would be expected that reeds would encroach into the shallower areas thereby decreasing the water surface. The only way to really confirm changes in bottom level is to do a survey. From Table 4 it is already known that very little sedimentation took place between 1994 and 2002. Therefore, a survey similar to that of 2002 was undertaken in May 2014. The survey contours are shown in Figure 2.19 indicating that the deepest areas are still around -1m MSL. The contour comparison between 2002 and 2014 is shown in Figure 2.20. Some sedimentation took place in the more upstream area of the estuary as shown in Figure 2.20 whereas erosion took place in the area closer to the mouth. The volume calculation shows an increase in volume, which means that overall rather than sedimentation, minor erosion took place. Volume to be verified and table 4 completed

Comment [LB1]: Pieter, kon jy al hierdie voltooi sodat dit ingevul kan word asb.

The above finding means that no overall sedimentation has taken place in the estuary since after dredging in 1993/94. The source of sediment must therefore have been stabilised and/or sedimentation is taking place upstream of the estuary. Although the draft AR and visual inspection of late 2013 indicated there are sources of potential sediment in the catchment those sediment is apparently not reaching the estuary. The reason for this is unknown but it could be:

- that the dam reduced the occurrence and/or flows of strong floods
- that sedimentation potential from the catchment has decreased
- that sedimentation is taking place above the estuary

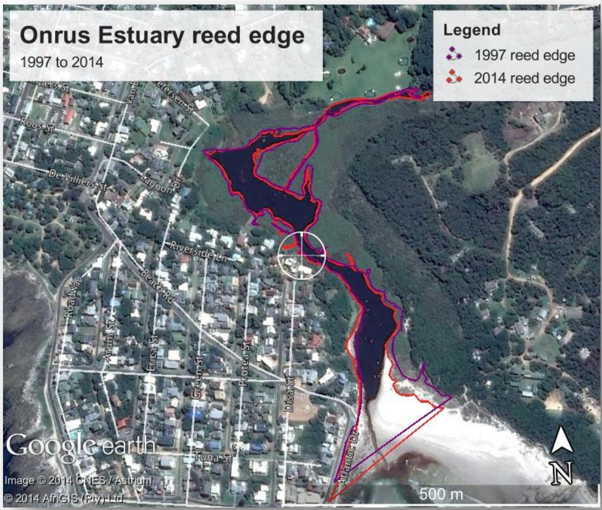


Figure 2.18: Onrus Estuary reed edge 1997 to 2014

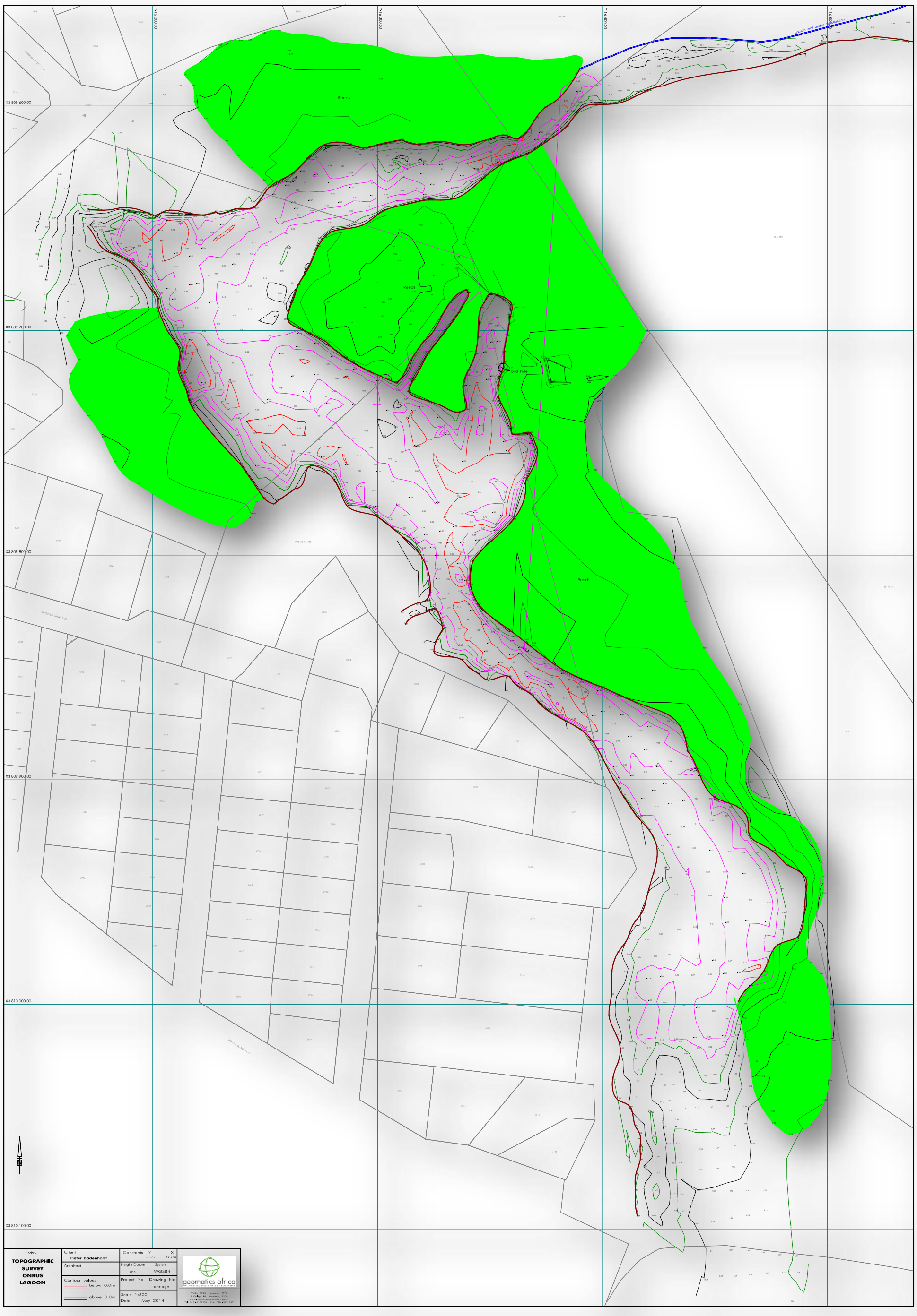


Figure 2.19: 2014 Survey contours

[Note red indicate -1m MSL]

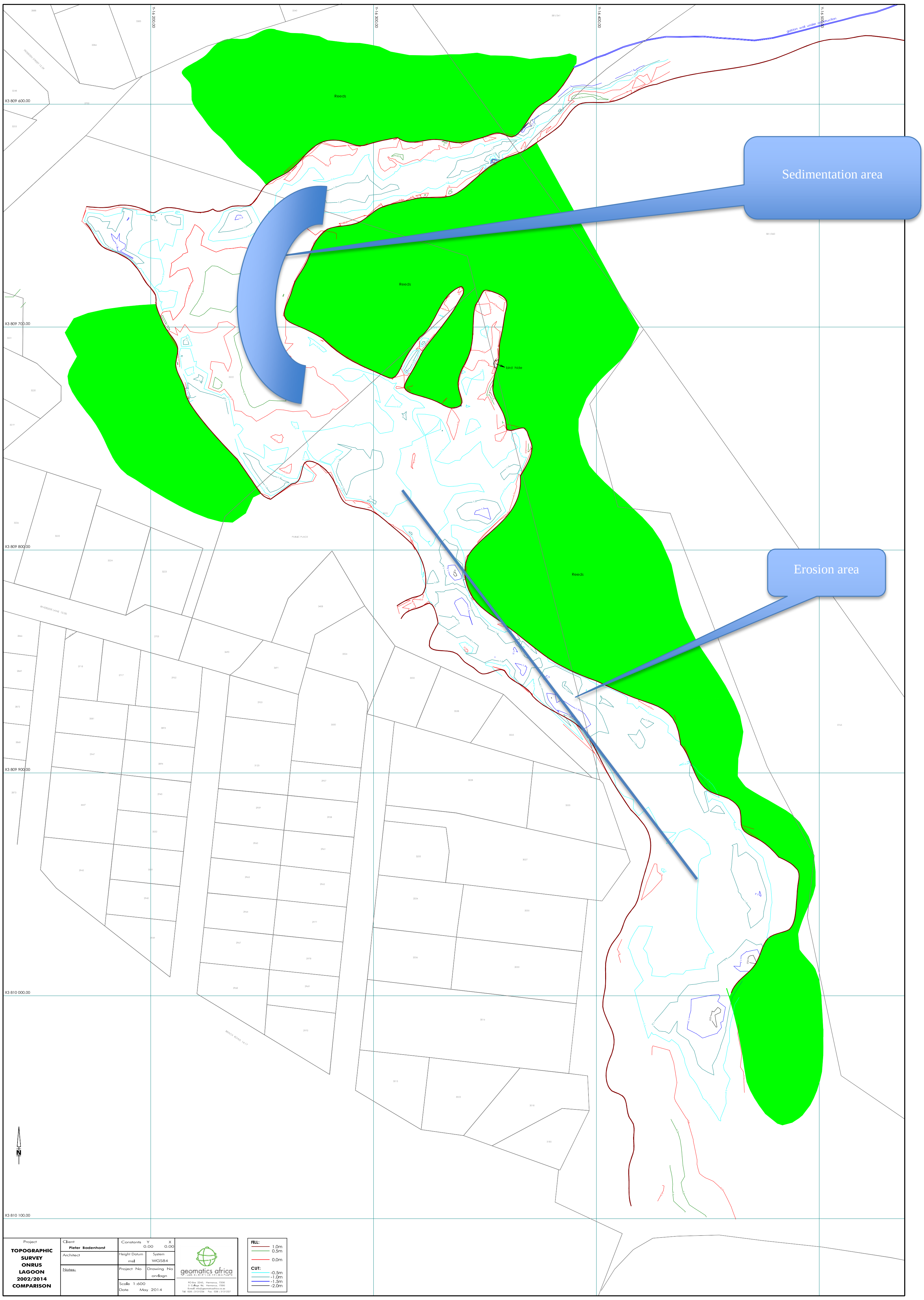


Figure 2.20: 2002 and 2014 Survey comparative contours

2.6 Re-assessment conclusion

From this section on the re-assessment the following can be concluded grouped as per the project deliverables:

3) Check on availability of other available data.
    - New available data has been incorporated with the information of the 2002 Report. This included a further assessment of available aerial photography and a survey undertaken in May 2014 as well as a study by Agrimentor and the draft AR the (for latter see the next section).
4) Undertake an engineering assessment of the lower reaches of the Onrus Lagoon to check on sedimentation sources and possibility of introducing sedimentation traps to prevent sedimentation of the lagoon.
    - This has been undertaken and the finding is that the construction of a sediment trap is not a feasible option.
    - It is possible that a natural trap exists upstream of the estaury and management of this area might be a better solution.
8) Update the aerial photographic assessment as was included in previous reports.
    - The latest available aerial photography is for January 2014 and the reed bed edge was added to those for 1989, 1997 and 2000.
    - The comparision shows that few changes in the reed bed edge took place which seems to indicate that little sedimentation has taken place over the period.
9) Check on requirements of Estuarine Protocol for inclusion.
    - The undertaking of this report and completion of the Estuarine EMP to be implemented by the Management Authority after approval by DEA is a requirement of the protocol.
10) Arrange meeting with DWA to discuss their requirements.
    - This will form part of the next phase under stakeholder consultation.
11) Discuss with locals (Estuary Management Forum) and Municipality their requirements for management of the lagoon.
    - This will form part of the stakeholder consultation, development of Vision and Objectives, identification of Forum members, approval by DEA and implementation by the Management Authority.
    - The details will be included in section 4 as part of the next phase of this project.
12) Compile a technical report that is an updated version of the 2002 report.
    - This section of the EMP adresses the updating of the 2002 Report.
    - The overall findings can be summarised as follows:
        - The findings of the 2002 Report is still valid re possible rehabilitation solutions.
        - The aerial photographs show that few changes in the reed bed edge took place which seems to indicate that little sedimentation has taken place over the period.
        - The survey of May 2014 confirmed the above conclusion from the aerial photographs.
        - The survey quantified the present status compared with 2002 and indicate that overal the volume in the estaury has increased. It seems there was some sedimentation in the upper area of the estaury with erosion in the lower areas. (*Amend when info per section is available)*

- It is therefore clear that the system retained itself for about a 20 year period after dredging in 1993/94. In addition the reeds also played an important role in maintaining water quality. Although the 2002 Report recommended that further dredging should be undertaken the question is now whether this should still be done. This is an aspect that should be addressed by the stakeholder consultation and final Vision and Objectives for management of the estaury.

3 Draft Situation Assessment Report

The draft SAR of June 2013 in Section 6.1 summarises previous available data for the estuary and catchment. The report identified the following main impacts:

- Reduced inflows as a result of De Bos Dam.
- Increased erosion in catchment as a result of farming activities and removal of vegetation causing sedimentation in the estuary. It is, however, also indicated that large scale sedimentation took place during a flood after a fire in the later 1940s or early 1950s. A comparison of the “after dredge” survey in 1994 and a further survey in 2002 indicated that very little sedimentation has taken place.
- Sewage overflows from manholes and pumpstation close to the estuary.
- Reduced water quality as a result of sewage inflows.
- Increased reed growth as a result of sedimentation and poor water quality.

The overall estuarine health score for Onrus Lagoon is a Category E, representing a Highly Degraded condition. The estuary was considered to be under high pressure in terms of change in flow, pollution and habitat loss. Although the estuary is in a degraded state and has a low importance from an estuarine habitat perspective according to DWA’s water resource protection policy, estuaries that are in an Ecological Category of E or F need to be managed towards achieving an Ecological Category of at least D. Management action that will result in some level of rehabilitation of the estuary is therefore warranted.

4 Vision and Objectives

4.1 Vision

To be developed with stakeholders

Stakeholder database in section 6.3.

4.2 Objectives

To be developed with stakeholders

4.3 Approval and Implementation

5 References

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6 Appendices

6.1 First Draft Assessment Report

Onrus Estuary

Situation Assessment Report

Draft
June 2013

Compiled by Sue Matthews
Estuary Management Coordinator
(June 2010-June 2013)

Environmental Management Section
Overstrand Municipality

Executive Summary

The Onrus Estuary – popularly known as Onrus Lagoon – is situated approximately 7 km from the Hermanus CBD, in the Overstrand Municipality of the Western Cape Province. Its catchment covers an area of only 59 km^2, but currently provides the main source of water for the Greater Hermanus Area, which has a population of almost 49 000 people.

Catchment characteristics

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. 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. Due to the combined impacts of agriculture, urban development and invasive alien vegetation on flow, water quality and the river course, about 50% of the Onrus River's total length has been assigned an ecological category of D. This represents a largely modified state associated with a significant loss of natural habitat, biota and basic ecosystem functions.

There are numerous farm dams in the catchment, as well as the municipal De Bos Dam, which was built in 1976 and has a storage capacity of 6 Mm^3. The municipal allocation is 2.8 Mm^3 per year, but this was exceeded from the late 1990s. In recent years the surface water supply has been supplemented with groundwater from the Gateway Wellfield, and for the past two years the Municipality has not exceeded the permitted allocation. A new groundwater development scheme is being implemented in the Hemel en Aarde Valley, but this water abstraction is not expected to affect flows in the Onrus River.

Alternative sources of water were necessary because the 1995 Yield Analysis conducted by the Department of Water Affairs indicated that the De Bos Dam could supply 3.3 Mm^3 per year at a normal risk profile. The municipal allocation of 2.8 Mm^3 and the 'compensation release' of 0.47 Mm^3 then being made to downstream users already amounted to 3.27 Mm^3 per year. At the time it was noted that the compensation release might not be sufficient to meet the ecological needs of the river and estuary, and that the dam could be assumed to have had a drastic impact on the estuary by greatly decreasing the size and frequency of winter floods. Water currently released from the dam has been estimated to amount to 0.25 Mm^3 per year.

A tributary and a number of streams join the Onrus River below the dam, but agricultural development and invasive alien vegetation have reduced their flow volumes compared to the pristine state of the catchment. As a result, the mean annual runoff to the estuary is thought to have been reduced from 14.5 Mm^3 for the natural state to 5 Mm^3 today, representing a 65% decrease.

Estuary characteristics

Onrus Lagoon is a small (15 ha) temporarily open-closed estuary, which historical anecdotes suggest has always been a freshwater-dominated system. After the mouth breaches and the estuary drains, the sandbar is rapidly rebuilt as sand is deposited back on the beach by wave action, preventing seawater intrusion into the estuary. During the winter months, a shallow overflow channel opens in the western corner of the sandbar, but this is beyond the reach of the tides. Some overwash of seawater does, however, occur during storm events coinciding with high tides, when kelp is washed into the lagoon.

Since the duration that the mouth would stay open after breaching is partly determined by the amount of follow-up flow, the reduction in mean annual runoff and attenuation of floods by De Bos Dam may have altered the salinity regime of the estuary. This is supported by the complete disappearance of sandprawns, which were recorded at the seaward end of the estuary in a survey three years after construction of the dam. Although bait collection would probably have contributed to local extinction of the population, sandprawns require salinities above 17 ppt for successful breeding. Salinity in the estuary is typically <5 ppt.

The fish fauna in Onrus Lagoon consists mainly of freshwater and estuarine residents that breed in rivers and estuaries. Some marine migrants with estuary-dependent juveniles do occur, but the estuary is not considered an important fish nursery area due to its small size. The birdlife includes a few species that attract birdwatchers as they are difficult to find in other parts of the Overberg. The waterbody is used by ducks, coots and dabchicks, while the reedbeds provide habitat for weavers, starlings, bishops and waxbills, as well as migratory swallows in summer.

In the estuary component of the National Biodiversity Assessment 2011, Onrus Lagoon was assigned to Category E, representing a Highly Degraded health condition. It was not identified as a priority for conservation via formal protected area status, but rehabilitation efforts are certainly warranted. According to Water Affairs' policy, water resources in an Ecological Category of E or F should be managed towards achieving an Ecological Category of at least D.

Management issues

Onrus Lagoon is not commonly used for fishing or other resource-harvesting but it is popular for recreation, particularly amongst families with young children, as the shallow waters near the beach offer a safe swimming and playing area. Water quality is therefore a major public concern. Recreational use has at times been prohibited during the peak summer season due to high faecal bacteria counts, and sewage spills are known to have occurred from the sewerage line situated in the bed of the Onrus River and the pump station on the northern shore of the estuary. The Overstrand Municipality commissioned an investigative study of the sewerage line, which confirmed that parts of it are in poor condition and made recommendations to address this. Other potential sources of faecal contamination include sewage tanks, stormwater and upstream sources.

Another issue of public concern is encroachment by *Phragmites* reeds. The reedbeds expanded rapidly from the 1950s and had almost completely covered the waterbody by the time the estuary was dredged in 1993. The dredging aimed to restore an area of open water and deepen parts of the estuary, as the distribution of reeds is limited by depth. It was recommended that the reeds be controlled with annual herbicide-spraying following the dredging to limit regrowth. This was not done, although some areas of reedbed were periodically cleared and sprayed by local residents. Aerial and satellite photographs indicate that the reedbeds have not expanded significantly since the dredging, but perceptions remain that they are 'taking over the lagoon'. The Onrus Lagoon Trust has offered to purchase a Truxor reedcutter machine to control the reeds on condition that the Municipality funds its operation and maintenance, but this proposal has not been accepted.

Although the encroachment of reeds at the expense of open water area and exposed shoreline constitutes habitat transformation, the reedbeds support a variety of species and also take up nutrients that might otherwise be used opportunistically by weeds and algae, with potentially more detrimental impacts.

Infilling and landscaping of approximately 1 ha of reedbed on the north-eastern shore in the 1990s has resulted in erosion problems at the site, prompting proposals to stabilise the bank with gabions and indigenous vegetation. Managed retreat should be considered instead, to allow for rehabilitation of the riparian zone.

Natural habitat in the river course and in the vicinity of the estuary has also been transformed by invasive alien vegetation, but plans are in place to clear certain areas. A previously infested property on the eastern shore was cleared in the 1990s after being donated to WWF, and managed as a bird sanctuary. It now provides an area of natural strandveld habitat that should be properly maintained and promoted as an asset for biodiversity conservation, environmental education and recreation.

Clearing of invasive alien vegetation in the catchment will also help to improve flows to the estuary. In addition, reduced reliance on surface water for the municipal water supply, due to groundwater development schemes and the planned recycling of wastewater, offers potential for water releases from De Bos Dam to be increased in future.

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. High flows are attenuated by the De Bos Dam, and the estuary breaches before back-flooding occurs upstream.

Legislation and policy

Legislation relating to environmental and spatial planning matters is reviewed in the report, as well as the municipal Integrated Development Plan and associated sector plans. The Spatial Development Framework and Zoning Scheme are currently being revised, while coastal setback lines are being determined as part of a provincial initiative. The Growth Management Strategy, which forms part of the SDF, uses densification as the main tool to counteract the effects of urban sprawl. Some residential densification and mixed use opportunities are proposed just upstream of Onrus Lagoon, with a high-density development incorporating a retirement village, residential houses and commercial businesses close to Curro school being planned.

No densification is proposed for the estuary's shores, partly because the heritage overlay zone encompassing this area and the 'Point' coastal strip means that heritage development criteria would apply, limiting densification opportunities. The Growth Management Strategy also 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".

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1. Introduction

1.1 Report scope

The National Environmental Management: Integrated Coastal Management Act (Act No. 24 of 2008), promulgated in December 2009, requires estuaries of the Republic to be managed in a coordinated and efficient manner, in accordance with a National Estuarine Management Protocol. The Protocol, which was gazetted on 10 May 2013, provides guidance for the management of estuaries through the development and implementation of estuarine management plans (EMPs) for individual estuaries.

According to the Protocol, where an estuary falls within the boundary of a single local municipality, the municipality must develop the EMP in consultation with the relevant government departments, and through active engagement of non-government organisations and civil society.

The Situation Assessment Report (SAR) is the output of the first stage in the procedure stipulated in the Protocol for developing an EMP, namely the scoping phase. It involves collating and evaluating available information about the estuary that can assist with establishing the status of the estuary and inform management planning. The SAR should also highlight any major information gaps and make recommendations to address these. According to the Protocol, the SAR must:

a) Describe legislative instruments that are currently applicable to the effective management of the estuary, including existing and planned management strategies and plans (catchment management strategies, IDP, SDF, coastal management programmes, etc.) and their relevance to the proposed management of the estuary;

b) Provide a detailed understanding of the structure (abiotic and biotic components), functioning and state of the estuary, including the underlying processes and drivers. This should also include the Reserve for the estuary if it has been determined (or identify the need for determining a Reserve) and estimate the present ecological state of the estuary where possible. This should be done using the Estuarine Health Index as applied in 'Ecological Water Requirement Methods' (Department of Water Affairs and Forestry 2008) or subsequent versions of the Estuarine Health Index that are approved by DWA. This is a standardised approach for estimating the degree of modification of an estuary from its reference state to present;

c) Describe the socio-economic context (demographic, economic profile, etc.) and the level/s of dependence of local communities on the estuary. This will include assessment of the opportunities and constraints within the ecological system (including potential carrying capacity for activities), taking into account its current and recommended ecological state and limits of acceptable change where available; and

d) Identify the goods and services or human use activities and their impacts or potential impacts on the present ecological state of the estuary.

The scoping phase is followed by an objective-setting phase, in which a realistic, achievable vision and a list of objectives are set. The objectives should consider the conservation and utilisation of living resources, social issues, management of water quality and quantity, land-use and infrastructure planning and development, climate change, education and awareness, and compliance and enforcement.

The procedure for developing an EMP culminates in the development of the implementation plan, in which management actions necessary to achieve the vision and objectives are identified. These management actions would then be translated into project plans by the government department responsible for particular aspects of estuary management in terms of their legislative mandate.

1.2 Geographic and demographic context

The Onrus Estuary – popularly known as Onrus Lagoon - is situated on the south-west coast of South Africa, in the Overstrand Municipality of the Western Cape Province. It is approximately 7 km from the Hermanus CBD.

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 the dwelling. 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. However, the Onrus catchment currently provides the main source of water supply to the Greater Hermanus Area, which is home to almost 49 000 people.

Figure 1.1 The Onrus Estuary is located approximately 7 km from the Hermanus CBD.

Estuary or Lagoon?

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. Onrus River Catchment

The Onrus River catchment (G40H) covers an area of only 59 km^2 and lies entirely within the Overstrand municipal boundary. The catchment is bordered by the southern slopes of the Babilonstoringberge and the northern slopes of 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.

Figure 2.1: The Onrus River catchment

2.1 Catchment characteristics

2.1.1 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 2.2). 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.

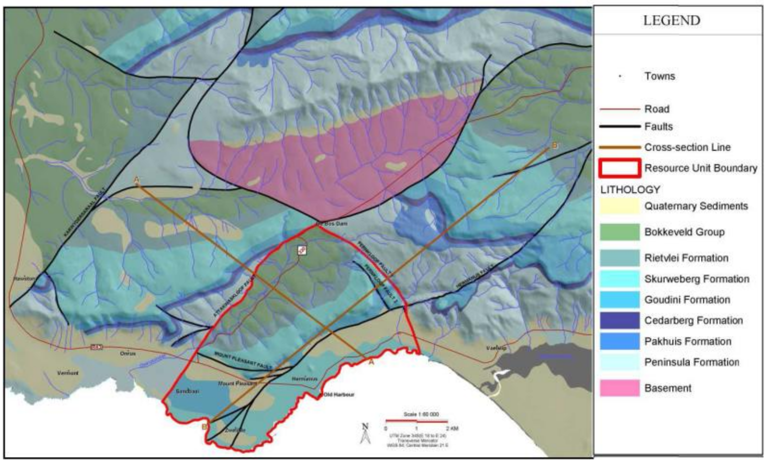


Figure 2.2: Geology of the Hermanus area (Umvoto Africa 2013).

2.1.2 Vegetation

Coinciding with these 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 2.3).

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.

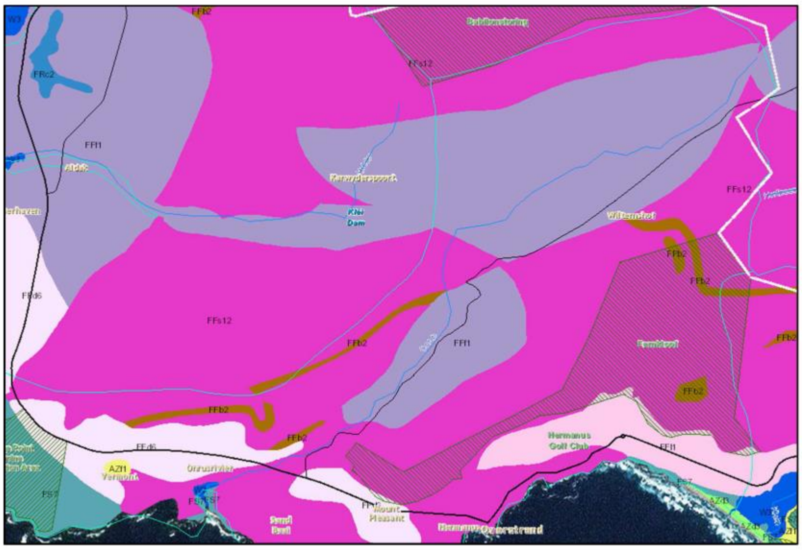


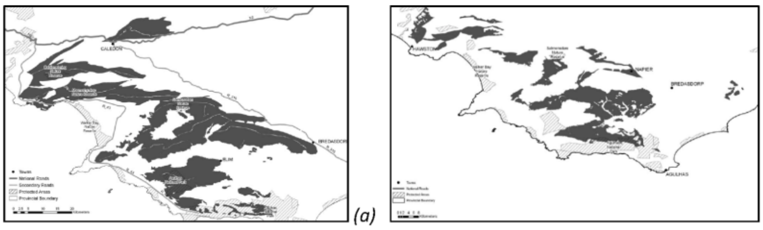
Figure 2.3: Historical distribution of vegetation types in the Onrus River catchment.
FFs12 (pink) = Overberg Sandstone Fynbos; FFf1 (grey) = Elim Ferricrete Fynbos; FFb2 (olive green) = Western Coastal Shale Band Vegetation; FFd6 (white) = Hangklip Sand Fynbos; FS7 (turquoise) = Overberg Dune Strandveld; 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 2.4a) 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 2.4b).

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.



(a) *(b)*

Figure 2.4: The original extent of (a) Overberg Sandstone Fynbos and (b) Elim Ferricrete Fynbos.

2.1.3 Land use and history

Viticulture is the main agricultural activity, 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.

2.2 Onrus River

2.2.1 Biophysical features

The Onrus River rises on the Babilonstoring Mountains and flows some 16.8 km through the Hemel en Aarde Valley and across the narrow coastal plain before discharging into the sea via Onrus Lagoon. 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, while the main tributary, the Antjies River, joins the Onrus River at the top of the lower valley. Further downstream, there are a number of streams draining the steep slopes of the Onrus Mountains.

The river is considered to have a relatively low silt load, as the De Bos Dam and the large vlei areas that occur in both valleys trap sediment. Below the dam, the river course is heavily infested in places by invasive alien wattles, pines and gums.

2.2.2 Ecosystem health

The River Health Programme (DWAF 2006) conducted sampling at three sites (O1=Haygrove Heaven, O2=Volmoed and O3=R43 road bridge) along the river course in October 2004, and found that the instream habitat integrity deteriorates from being moderately modified at the uppermost site (O1) to being extensively modified at the second site (O2) as the effects of agriculture and urban developments become evident. Subsequently the instream habitat recovers slightly to largely modified at the lower site (O3). The riparian habitat integrity rapidly deteriorates from extensively modified at the uppermost site to being critically modified at both the lower two sites. Water quality sampling revealed that the two uppermost sites contained excessively high concentrations of total phosphate, presumably due to runoff from fertilised agricultural land.

Cape galaxias *Galaxias zebratus* were common at the lower two sites, with Cape kurper *Sandelia capensis* also present in good numbers at the lowest site, but no fish were caught at the upper site. It was noted that rainbow trout *Oncorhynchus mykiss* occur in the De Bos Dam and have the potential to move upstream to prey on galaxias. Largemouth bass *Micropterus salmoides* occur in the Volmoed Dam, but the river was thought to be too shallow to support them (DWAF 2006).

These findings were used to determine the Present Ecological State Category for river lengths during the development of the BOCMA Catchment Management Strategy. Some 7.8 km of the Onrus River was considered to be in a moderately modified ecological state (category C), while 8 km was largely modified (category D), associated with a large loss of natural habitat, biota and basic ecosystem functions (BOCMA 2010).

Owing to the presence of galaxias, the Onrus River catchment has been listed as a Fish Support Area in the National Freshwater Ecosystems Priority Areas project. The species *Galaxias zebratus* has been shown to consist of at least 10 different lineages (probably separate species), each with a restricted distribution in the Western Cape, and may be threatened. Fish in the Onrus River have been placed in the "mollus" lineage (Nel et al. 2011).

2.3 Mean Annual Runoff and the De Bos Dam

The Onrus River catchment has a number of small farm dams, as well as the municipal De Bos Dam. This supplies water to the Greater Hermanus Area, which includes Fisherhaven, Hawston, Vermont, Onrus River, Sandbaai, Mount Pleasant, Zwelihle and the suburbs of Hermanus.

The catchment is in a winter rainfall area, although there is often a second rainfall peak in November. Rainfall on the coastal plain is generally lower than in the mountainous areas of the catchment (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

Figure 2.5: The location of the weather stations and De Bos Dam relative to the catchment boundary and Onrus Lagoon.

In August 1973, when Ninham Shand initially determined the yield of the proposed dam, they estimated that the Mean Annual Runoff (MAR) for the catchment above the dam was 6.1 x 10^6 m^3 (6.1 million cubic metres or Mm^3). They noted that in December 1968 DWAF had suggested a MAR at De Bos of 12 Mm^3, but in view of the additional gaugings that had since become available, they had used this more conservative figure in their calculations. These were used to propose a storage capacity for the dam of 6 Mm^3. The dam would have an assured yield of 3.66 Mm^3 if there was no storage of winter flow and 2.87 Mm^3 if only 50% of the winter flow reached the dam in an extreme drought year (Ninham Shand 1973).

In December 1973, the Cape Water Court ruled that the De Bos Dam could be constructed with a storage capacity of 6 Mm^3, and the municipality could extract a maximum of 2.8 Mm^3 per year. Only surplus water could be stored in the dam, and normal flow should be allowed to pass through. However, the normal flow was not defined by the Water Court.

In the De Bos Dam Yield Study of 1987 (Ninham Shand 1987), the Water Court ruling was interpreted to mean that the release required to compensate for normal flow was 0.23 Mm^3 per month during the months of October to April each year, totaling 1.6 Mm^3 per year. The MAR for the portion of the catchment upstream of De Bos Dam was now calculated to be 12.3 Mm^3, accounting for a 5-10% reduction in MAR due to the effect of smaller dams in the catchment. The MAR for the portion below the De Bos Dam was estimated to be about 9.5 Mm^3, resulting in a total MAR for the Onrus catchment of 21.8 Mm^3 (cited in CSIR 1991).

In the revised yield analysis of 1991 (Ninham Shand 1991), the compensation flow of 1.6 Mm^3 per year was applied as before. In addition, properties downstream of De Bos Dam were considered to be entitled to a supply of 92 000 m^3 (0.092 Mm^3) per year, while upstream users were calculated to require a maximum of 3.66 Mm^3 per year, providing all water rights were exercised. If all potentially cultivable land in the catchment above the dam was irrigated at an annual rate of 6 000 m^3 per hectare, the possible future irrigation demand was estimated at 13.3 Mm^3 per year.

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. The report suggested applying for a revision to the Water Court ruling to allow an unlimited amount of water to be abstracted from the dam.

A submission was therefore made to DWAF for a higher allocation, based on a summary of the 1991 report and supporting information (Ninham Shand 1993). In response, DWAF commissioned a number of investigations (Du Plessis 1995), and provided a report-back to the Municipality in January 1996 (Roux 1996). Their investigations had shown that the area under irrigation above the dam had increased from 80 ha in 1969 to 463 ha in 1993, and from 21 ha to 243 ha below the dam over the same period. The capacity of farm dams had increased from 0.47 Mm^3 in 1974 to 0.96 Mm^3 in 1993. Flow records (with numerous data gaps) and rainfall data were used in simulation models to create a modeled flow record for the period 1925-1994.

The natural MAR for the portion of catchment above the dam (32 km^2) was found to be 8.4 Mm^3, and that for the entire catchment 14.5 Mm^3. The present-day (1994) MAR for the same areas was determined as 6.4 Mm^3 and 8.2 Mm^3 respectively. This represented a 56.6% decrease in MAR for the estuary.

The yield analysis indicated that the dam could supply 3.3 Mm^3 per year at a normal risk profile, and the annual municipal allocation (2.8 Mm^3) and compensation release (0.47 Mm^3) already amounted to 3.27 Mm^3. Increasing the municipal allocation did not therefore seem feasible.

While the annual compensation release of 0.47 Mm^3 was being made for downstream users, which was considerably more than the 0.092 Mm^3 estimated in the 1991 yield analysis, the 1.6 Mm^3 annual compensation release for 'normal flow' of the river had not been implemented. The report stated (translated from Afrikaans):

"It is not known whether this volume is enough to meet the ecological needs of the river downstream of the dam and of the estuary. It can be assumed that the building of the De Bos Dam had a drastic impact on the estuary by greatly decreasing the size and frequency of winter floods. While no change is made in the allocation from the dam, it is assumed that the compensation releases will also not be be changed. However, for any increased allocation from the dam, the ecological requirements must be taken into account and the application judged against this.

Before decisions can be made about increasing the acceptable risk and consequently allowing a higher allocation, the effect and acceptability of the increased allocation on the ecology must first be determined. For this purpose, it is suggested that a workshop in collaboration with experts (e.g. CSIR) is held if an increased allocation from the dam must be considered" (Roux 1996).

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.

The 1991 yield analysis had indicated that the De Bos Dam would no longer be able to meet demand by about 2005. It suggested investigating other means of water supply, such as raising the dam wall, exploiting groundwater, damming other rivers in the area, recycling and desalination.

By 2006, the Municipality was drawing 4 Mm^3 of water from the dam (Overstrand WSDP 2010). However, from mid-2007 the surface water supply was supplemented by groundwater from the Gateway Wellfield, and for the past two years the Municipality has not exceeded the permitted allocation of 2.8 Mm^3 (P. Robinson, pers comm).

More recent estimates of present-day MAR reaching the estuary are 3 Mm^3 (Whitfield & Bate 2007) and 5 Mm^3 (Van Niekerk & Turpie 2012). A water use verification and validation study being conducted in the Onrus catchment by Aurecon on behalf of BOCMA will provide useful information for refining the MAR estimate through a hydrological assessment.

3. The Onrus Estuary

According to the National Estuaries Layer, the estuarine functional zone for South Africa's estuaries is defined by the 5 m topographical contour (Appendix 1), 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 3.1. This is a very small system, covering an area of just over 15 ha.

Figure 3.1: The estuarine boundary of Onrus Lagoon. The distance between the estuary mouth and the northern shore is approximately 600 m.

3.1 Historical background

By the early 1800s, people were visiting the area to camp on the commonage around Onrus Lagoon while their stock grazed in the vicinity. In 1886 the Cape Argus described the estuary as "a fine lake, about a mile in length, with an abundance of water tortoise and wild ducks", and in 1903 the Cape Times described it as "a beautiful freshwater lagoon" (Du Toit 2002). In the same year, land on the western bank was acquired by the Onrust River and Sea-Side Township and Estate Company Ltd, who intended to develop the area, but the syndicate disbanded in 1912 when their motivation for a railway from Cape Town failed (Burman 1989).

A new syndicate was formed in the 1920s, and a brochure published to market the planned resort highlighted the recreational potential of the area, noting "The freshwater lagoon, fed by the Onrust River and overflowing into the sea, is a beautiful asset to the town, and the only one of its kind on the whole coast. The water is so fresh and clear that the bed can be continually seen from the surface, and is nowhere more than about 5 feet deep..."

The Onrus River township was ultimately laid out in 1936, and camping was then confined to the more formal campsite demarcated by the developers. A hotel on the western bank had operated since the 1920s or earlier, but this was closed in the 1970s and demolished to make way for residential development. The township became a municipality in 1976, but was later absorbed into the Greater Hermanus Municipality, and subsequently the Overstrand Municipality.

The De Bos Dam was built in 1976, and three years later Onrus Lagoon was the focus of a special meeting between municipal officials, local residents and members of the Prime Minister's Advisory Committee for the Coastal Zone. The meeting was convened in response to concerns about long-standing sedimentation and reed encroachment problems in the estuary, and resulted in the first major ecological study of the estuary being initiated in November 1979 by the Habitat Working Group of the University of Cape Town's Zoology Department.

This study (Damstra 1980) focused largely on biological (biotic) features, and formed the basis of the report on Onrus Lagoon published by the CSIR as part of the Estuaries of the Cape series (Heineken & Damstra 1983). A subsequent report (CSIR 1991) had a greater emphasis on physical (abiotic) features of the estuary and its coastal environment, and management interventions to address the sedimentation and reed encroachment problems. Much of the information summarised here was sourced from these reports, but this has been updated and supplemented with new information where possible.

3.2 Abiotic features

3.2.1 Physico-chemical characteristics

Onrus Lagoon is classified as a temporarily open-closed estuary. Historical information suggests that it has always been a freshwater-dominated system. No data is available for the period prior to the construction of the De Bos Dam, but salinity readings conducted in November 1979 reveal that the entire estuary was fresh (0 ppt) (Heineken & Damstra 1983). During a fish survey in March 2006, salinity was recorded as 4 ppt in the lower reaches adjacent to the beach (S. Lamberth, pers comm). Readings taken throughout the estuary on 7 February and 21 March 2013 ranged between 1.6 and 2.3 ppt. Following a breach in April 2013, the mouth closed within a week and salinity in the mouth area was measured at 3.9 ppt. 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 (Appendix 2) 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 greens and overflow from water features. The river adjacent to the greens 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.

3.2.2 Hydrologic characteristics

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 (see section 2.3). 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 is meant to amount to 0.47 Mm^3, which equates to 15 ℓ/s. However, there is no gauge measuring outflow through the outlet pipe, which can be opened or closed with a valve. The current (April 2013) flow rate has been 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. For the past few years, the Municipality was releasing less than this, but opened the valve slightly when the dam filled to overflowing in October 2012 (M. Bartman, pers comm).


(a)

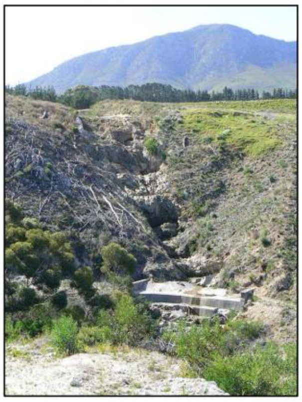

(b)

Figure 3.2: (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.

Data from the Onrus Lagoon water level gauge indicates that the sandbar was breached and the estuary drained at least a dozen times between 1994 and 2011 (Figure 3.3). No breachings 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 3.4). The estuary breached again in April and June 2013.

At such times, the estuary experiences tidal fluctuations in water level for a short period until the sandbar starts rebuilding (Figure 3.5). This does not necessarily imply significant seawater intrusion, however; the 'salt wedge' may extend only a short distance up the breaching channel, but high tides would restrict the outflow and cause the water level to back up.

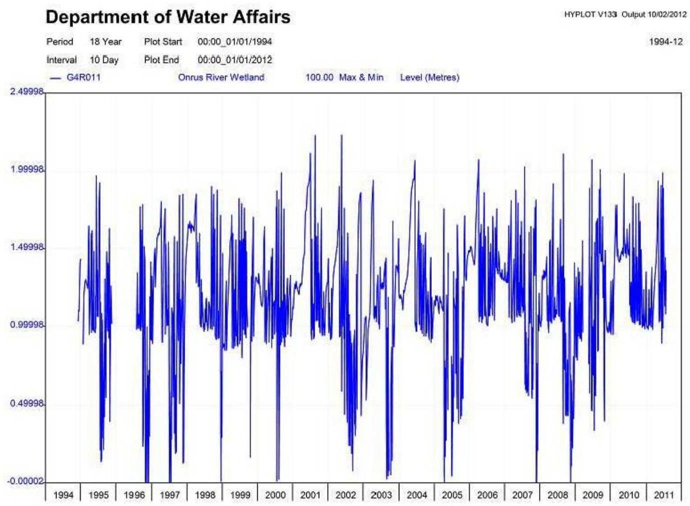


Figure 3.3: A plot of data from the Onrus Lagoon water level gauge for the period 1994-2011, indicating occasions when the estuary drained after breaching of the sandbar.

Figure 3.4: The estuary mouth on 23 October 2012, following the natural breaching on 19 October. Seawater can be seen surging up the breaching channel.

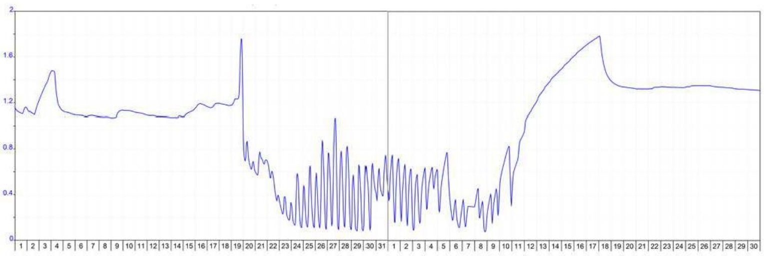


Figure 3.5: Data from the Onrus Lagoon water level gauge plotted for one-hour intervals for the period 1 October to 30 November 2012, showing draining of the estuary following the natural breaching of the sandbar on 19 October after heavy rainfall, tidal fluctuations, and the increase in water level following mouth closure (monthly graphs courtesy of Dept Water Affairs) .

The narrow channel that opens during winter on the western edge of the sandbar serves only as an overflow from the estuary, and no seawater enters the system via this route. During particularly high spring tides and heavy seas, some overtopping of the sandbar occurs, but this seawater would be quickly diluted in the freshwater-dominated estuary. Nevertheless, these overwash events are an important means of recruitment of larval and juvenile marine fish and invertebrates into Onrus Lagoon.

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 (Figure 3.6). 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, and hence higher flows, in June and July re-opened the overflow channel.

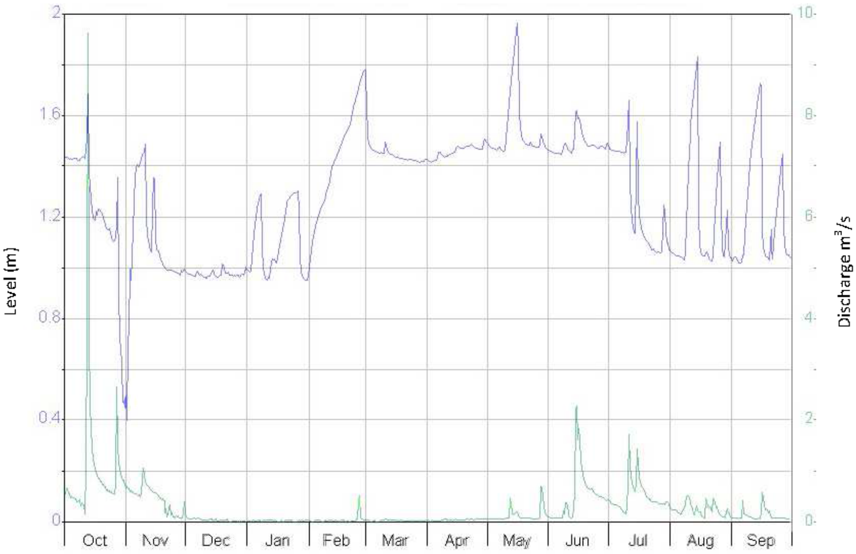


Figure 3.6: River flow (green line) and estuary water level (blue line) for a one-year period starting October 2009, shows how Onrus Lagoon responds to rainfall events. Graphs courtesy of Dept Water Affairs.

3.2.3 Sedimentation and bathymetry

The 1979-1980 survey found that marine sediment (coarse sand) extended about 100 m upstream of the mouth, after which it was replaced by finer, catchment-derived sediment with a higher percentage of organic mud. 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. The shape of the estuary, together with the relatively low inflow and the reduction of winter spates by the De Bos Dam, results in very little scouring or flushing of accumulated sediment (Heineken & Damstra 1983).

The subsequent CSIR study estimated that the average deposition of catchment-derived sediment over the previous five decades was approximately 1 200 m^3 per year (CSIR 1991). Using the Mean Annual Runoff figures from the initial De Bos Dam Yield Study (Ninham Shand 1987), the flood flow rates in the Onrus River were estimated to be of 75, 121 and 157 $m^3 s^{-1}$ for expected recurrence intervals of 5, 20 and 50 years respectively. 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 $m^3 s^{-1}$ for the same recurrence intervals. The authors concluded that, since flood flow rates are reduced by less than 40%, the dam did not have a major effect on either siltation or scouring, even though smaller floods would probably be trapped by the dam (CSIR 1991). These findings would need to be re-evaluated in light of the revised estimates of natural and present-day MAR.

A survey in 1991 revealed that most of Onrus Lagoon was above mean sea level (MSL) and only about 1 m deep, but there was a basin of approximately 1.5 m opposite 'the peninsula'. It was proposed that the estuary be dredged, with the aim of removing 45 000 m^3 of sediment. Channels 40-60 cm wide and 1.5 m deep would be created to increase flow velocities during floods and hence reduce sedimentation rates (CSIR 1991), with some deeper holes excavated to -2 m MSL to trap sediment (CSIR 1993).

The dredging was conducted in 1993, and succeeded in removing about 30 000 m^3 of sediment. A bathymetric survey immediately after the dredging was completed indicated that the -1 m MSL level was reached in only a few areas. In 1994 a more detailed survey was done by the Dept Water Affairs following a major flood, and a visual comparison of the two surveys revealed that very little infilling had taken place. Another survey was conducted in October 2002 (Figure 3.7). A digital comparison with the 1994 survey showed that very little sedimentation had taken place in the open water area, although a visual comparison suggested that the deeper sections had filled in somewhat, especially in the northern channel (Badenhorst 2002).

Onrus Estuary

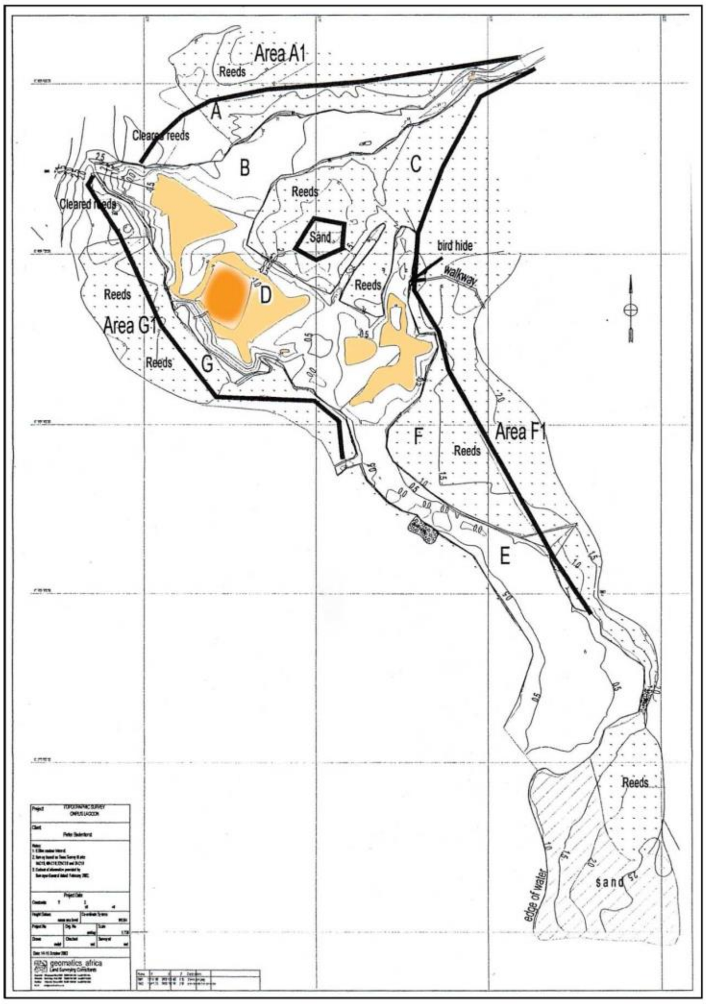


Figure 3.7: Bathymetry of Onrus Lagoon, according to the 2002 survey. The coloured areas are the deepest parts of the estuary, dark orange being -1 m MSL and light orange -0.5 m MSL (adapted from Badenhorst 2002).

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3.2.4 Coastal processes

Onrus Lagoon discharges into a small cove with a steeply sloped pocket beach on an exposed, high-energy coastline. The 1991 CSIR study concluded that although the potential gross longshore sediment transport rate is relatively large, the actual net annual transport is probably minimal due to the rocky coastline on both sides of the short beach. The promontory to the west and a combination of wave diffraction and refraction effects means that the local longshore transport near the mouth will almost always be towards the rocks at the western end of the beach, which will tend to fix the estuary mouth in this position (CSIR 1991).

The shoreline was found to be in a dynamically stable state as a result of there being no net influx of sediment. An analysis of aerial photographs for the years 1938, 1973, 1977, 1979, 1980, 1981, 1987 and 1991 showed no apparent long-term erosion or accretion trend in the shoreline position. 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. Short-term seasonal variation in shoreline position would occur, however, with the beach accreting in summer and eroding during winter storms (CSIR 1991).

A topographical survey of the berm in August 1991 determined that the average crest height of the sandbar (berm) between the estuary and the sea is +2.8 m MSL. Seawater occasionally overtops the berm at high tide during heavy seas, as evident from kelp in the lower reaches of the estuary, but sand intrusion via this route is expected to be small. Likewise, influx of sand through the small overflow channel is unlikely, as it is beyond the reach of the tides. During breaching events a deeper channel is scoured, but within a few days a wide sill builds up on the seaward side of the sandbar as sand is deposited back on the beach by wave action. The breaching channel typically fills in within 10 days, reverting to an overflow channel.

Wind roses and aeolian creep diagrams indicated a constant influx of sand towards the north-west in all seasons, with up to 3000 m^3 of sand estimated to be blown off the beach into the estuary annually. Since much of this sand is trapped in the water, a gradual accumulation of sand can be expected in the long term (CSIR 1991). However, marine sand in the immediate vicinity of the mouth is flushed out during breaching events.

3.3 Biotic features

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3.3.1 Algae and aquatic vegetation

The earlier studies conducted on the estuary did not include phytoplankton or benthic micro-algae, so no information on typical micro-algal assemblages or chlorophyll concentrations is available. 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 form an unsightly sludge when they become stranded on the shoreline, and generate foul odours as they decompose.

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 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.

3.3.2 Riparian vegetation

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, there does not appear to have been significant expansion of the reedbeds since the dredging. Encroachment by *Phragmites* reeds is nevertheless an issue of public concern, and is covered in more detail in section 4.3.1.

The 1980 survey recorded *Scirpus* (now *Schoenoplectus*) *triqueter* growing amongst the *Phragmites* reeds in shallow water, and *Juncus*, *Stenotaphrum secundatim* and *Scirpus nodosus* (now *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).

In recent years, the reedbed in front of the 'common' on the northern shore has occasionally been cleared by local residents. The first aerial photographs of the area in 1938 reveal that the northern perimeter was the only place reeds occurred at that time, and it was recommended that this extent of reed cover be used to identify areas that should be excluded from the dredging operations in the early 1990s (CSIR 1991).

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.

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, and should be maintained. 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. It 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.

FAUNA

3.3.4 Invertebrates

The 1979-1980 survey noted that the seaward end of Onrus Lagoon had an estuarine fauna, as holes of the sandprawn *Callianassa kraussi* were scattered on the sandy bottom in the shallower water, and crown crabs *Hymenosoma orbiculare* were caught in the seine net (Heineken & Damstra 1983). However, crown crabs prefer a muddy bottom, and were presumably netted in slightly deeper water. The species has been recorded at salinities as low as 1 ppt in estuaries, and in fresh water in Lake Sibaya.

C. kraussi can survive in relatively fresh water but salinities below 17 ppt prevent successful breeding. 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).

3.3.5 Amphibians and reptiles

The earlier survey recorded two species of frog caught in a seine net (Heineken & Damstra 1983). One was named as *Rana fascigulata*, which is presumably meant to be *Rana fuscigula*, the Cape river frog, since reclassified as *Amietia fuscigula*. The other species was the western leopard toad *Bufo pardalis*, now named *Amietophrynus pantherinus*.

These were both on the list of 18 amphibian species either recorded from the area covered by the 1:50 000 map sheet 3419AC, or likely to occur (A de Villiers, cited by Heineken & Damstra 1983). However, this area extends from Kleinmond to Hermanus and 6 - 12 km inland, covering a diverse range of habitats, so all these species would not necessarily occur in the vicinity of Onrus Lagoon.

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 also on the Red List, but is considered to be of 'Least Concern' as it is relatively abundant within its range and can tolerate disturbance.

Three tortoises, 21 snakes and 16 lizards were listed as either recorded or likely to occur in the area covered by the 1:50 000 map sheet 3419AC (A de Villiers, cited by Heineken & Damstra 1983), but it is not known which of these occur in the vicinity of Onrus Lagoon.

3.3.6 Fish

The 1980 survey recorded six species of fish caught in a seine net. Knysna sand goby *Psammogobius knysnaensis* were most abundant, followed by southern mullet or harder *Liza richardsonii*. Estuarine round herring *Gilchristella aestuaria* and Cape stumpnose *Rhabdosargus holubi* were also recorded, as well as the freshwater species, Cape galaxias *Galaxias zebratus* and Cape kurper *Sandelia capensis* (Heineken & Damstra 1983).

In March 2006, fish sampling involving four seine hauls (Turpie & Clark 2007) revealed estuarine round herring to be the most abundant species, followed by Knysna sand goby and harder. In terms of biomass, harder was most important, followed by estuarine round herring and Knysna sand goby. Other species recorded were Cape silverside *Atherina breviceps,* white stumpnose *Rhabdosargus globiceps*, flathead mullet *Mugil cephalus*, freshwater mullet *Myxus capensis* and Mozambique tilapia *Oreochromis mossambicus*, which is an alien invasive species. It is possible that the alien invasive species sharptooth catfish (barbel) *Clarias gariepinus*, carp *Cyprinus carpio* and largemouth bass *Micropterus salmoides* are also present in the estuary (S. Lamberth, pers comm).

3.3.7 Birds

In November 1979, 28 bird species were recorded at Onrus Lagoon, with Hartlaub's Gull and Cape Weaver listed as abundant (Heineken & Damstra 1983). Mike Ford and Lee Burman of the Hermanus Bird Club have provided an updated species list of water-associated birds that occur at the estuary (Appendix 3).

Dr Anton Odendaal, former Chairman of Birdlife Overberg, has recorded 152 bird species at the estuary over the past 15 years. These include 17 species that are endemic to southern Africa, seven that are near-endemic, and 27 migratory species. 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, 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 (A. Odendaal, pers comm). Such hybridisation is a threat to biodiversity by compromising 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.

3.3.8 Mammals

Documented information on mammals in the vicinity of the estuary could not be found, but there are likely to be a variety of rodents, including the vlei rat *Otomys irroratus* and the dune mole rat *Bathyergus suillus*. 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.

3.4 Estuarine health and conservation value

For the estuarine component of the National Biodiversity Assessment 2011 (van Niekerk & Turpie 2012), a team of 13 specialists evaluated estuarine health for almost 300 estuaries countrywide according to a number of abiotic and biotic variables. The abiotic variables considered were hydrology (percentage change in Mean Annual Runoff), hydrodynamics and mouth condition, water quality and physical habitat, while the biotic variables were microalgae, macrophytes (aquatic plants), invertebrates, fish and birds. The weighted mean scores for the abiotic (habitat health) and biotic (biological health) components were then averaged to give an overall estuarine health score. A desktop assessment of the pressures faced by estuaries in terms of change in flow, pollution, mining, artificial breaching, fishing effort and bait collection was also conducted.

The overall estuarine health score for Onrus Lagoon was between 21 and 40, which equates to a Category E, representing a Highly Degraded condition. The estuary was considered to be under high pressure in terms of change in flow, pollution and habitat loss. The summary results of the desktop assessment for all the Overstrand estuaries is depicted in Figure 3.8.

Name	**Pressures**						**Health condition**													
	Change in flow	Pollution	Habitat loss	Artificial breaching	Fishing effort	Bait collection	Hydrology	Hydrodynamics	Water quality	Physical habitat	Habitat state	Microalgae	Macrophytes	Invertebrates	Fish	Birds	Biological state	Estuary Health State	Ecological category
Rooi Els	L	L	L		L	Y													B
Buffels	L	L	L		L	Y													B
Palmiet	M	L	M		L	Y													C
Bot/K'mond	M	M	M	Y	VH	Y													C
Onrus	H	H	H		L	Y													E
Klein	M	M	M	Y	H	Y													C
Uilkraals	M	M	M		M	Y													D

Figure 3.8: Summary results of the Desktop National Health Assessment for the Overstrand estuaries (L = low; M= medium; H = high; VH = very high; dark blue = excellent; blue = good; green = fair; brown = poor).

Estuaries were also assessed in terms of the types and diversity of habitat they contain, such as intertidal mudflats, salt marshes, mangroves, macrophytes, and reeds and sedges, and whether these support rare communities. 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 E or F need to be managed towards achieving an Ecological Category of at least D (DWA 2010). Management action that will result in some level of rehabilitation of the estuary is therefore warranted.

3.5 Ecosystem goods and services

3.5.1 Defining goods and services

Ecosystem goods (such as food) and services (such as waste assimilation) represent the benefits human populations derive, directly or indirectly, from ecosystem functions (Costanza et al. 1997). The Millennium Ecosystem Assessment (2005) grouped them as follows:

- Provisioning services supply the goods themselves, such as food, water, timber and fibre
- Regulating services govern climate and rainfall, waste, and the spread of disease
- Cultural services cover the beauty, inspiration and recreation that contribute to our spiritual welfare
- Supporting services include soil formation, photosynthesis and nutrient cycling, which underpin growth and production.

Provisioning	**Regulating**	**Cultural**
Goods obtained from ecosystems, e.g. food fresh water fuel wood fibre biochemicals genetic resources	Benefits obtained from regulation of ecological processes, e.g. climate regulation disease control flood control water purification carbon sequestration erosion control	Non-material benefits obtained from ecosystems, e.g. spiritual recreational aesthetic communal educational sense of place
Supporting Services necessary for the production of all other ecosystem services, e.g. soil formation nutrient cycling water cycling photosynthesis primary production habitat provision		

Figure 3.9: The Millennium Ecosystem Assessment's depiction of ecosystem services.

3.5.2 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. There is also no harvesting of reeds by local communities for building materials (e.g. thatching) or craft production (mats, baskets).

3.5.2 Regulating services

Studies have shown that the high biomass production of *Phragmites* reedbeds 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.

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* reedbeds 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.

3.5.3 Cultural services

Onrus Lagoon is very popular as a 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. A zonation plan proposed by the CSIR in 1993 (Figure 3.11) was adopted for a while but not enforced. It was considered unnecessary given the low level of recreational boating and the lack of user conflict.

Figure 3.10: Onrus Lagoon is a population destination for families with young children.

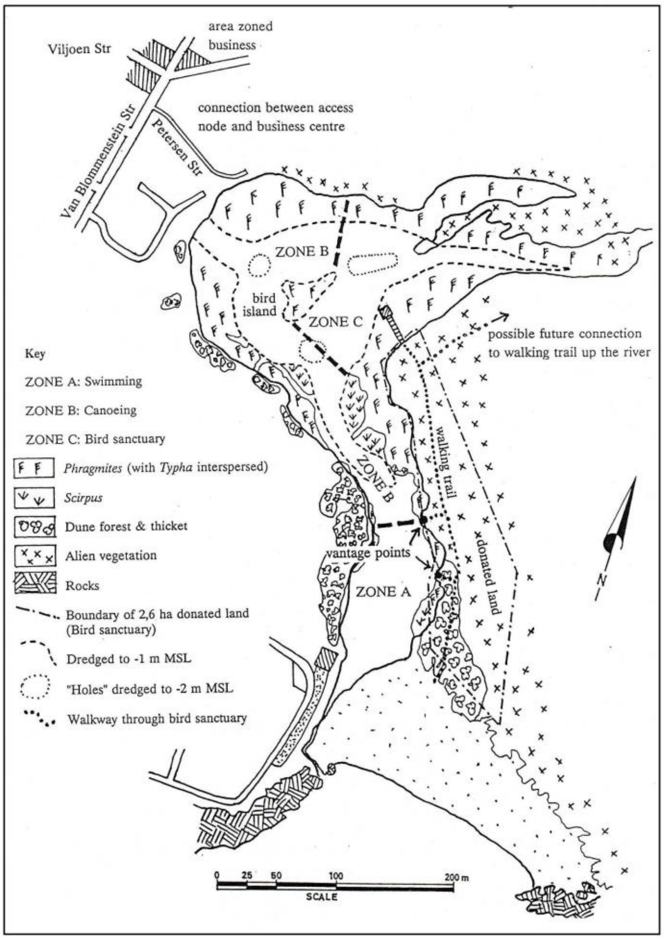


Figure 3.11: The zonation plan proposed by the CSIR for implementation after dredging of Onrus Lagoon in 1993 (CSIR 1993).

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 overlook the water. 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 3.12: 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.

3.5.4 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 reedbeds 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 (Appendix 3).

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.

3.5.5 Value of ec*osystem* 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.

These overall estimates were disaggregated to individual estuaries. Table 2 shows how Onrus Lagoon compares with the rest of the Overstrand estuaries.

Table 2: Preliminary estimates of the recreational, subsistence and nursery value of estuaries, and their relative existence value, largely associated with scenic beauty (Turpie & Clark 2007)

Estuary (west to east)	Recreational value (R millions/yr)	Subsistence value (R millions/yr)	Nursery value (R millions/yr)	Scenic / Existence value
Rooiels	1-5	<0.05	0.1-0.5	Medium
Buffels	1-5	<0.05	0.1-0.5	Medium
Palmiet	0.5-1	<0.05	0.5-1	High
Bot/Kleinmond	10-20	0.1-0.5	20-50	High
Onrus	1-5	<0.05	1-5	Medium
Klein	>100	0.05-0.1	50-100	Medium
Uilkraals	1-5	<0.05	1-5	Medium

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 above study drew upon the findings of an MSc project (Maswime 2006) that collated property value data for selected Cape estuaries, including Onrus Lagoon, to investigate any relationships between total property value and estuary characteristics. Although the project confirmed a high premium associated with proximity to an estuary (Figure 3.13), there was no significant correlation between this premium and the physical characteristics of the estuary, such as size and accessibility.

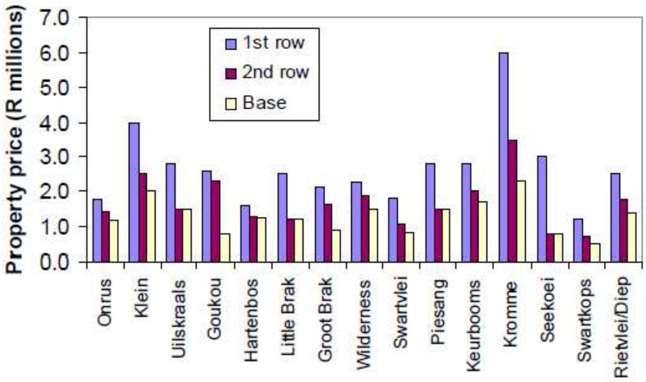


Figure 3.13: Property prices for the front and second rows of houses around 15 estuaries in relation to the base price for a house without close access to or view of the estuaries (Turpie & Clark 2007).

3.6 Land ownership

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 3.14). 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.

According to the Integrated Coastal Management Act (Act No. 24 of 2008), coastal waters (including estuaries), land submerged by coastal waters and any natural resources therein are defined as Coastal Public Property, which is held in trust by the State on behalf of all South Africans. The ICM Act aims to secure equitable access to the opportunities and benefits of Coastal Public Property. People have a right of reasonable access to Coastal Public Property provided this does not adversely affect the rights of members of the public to use and enjoy it, hinder the State in performing its duty to protect the environment, or cause an adverse effect.

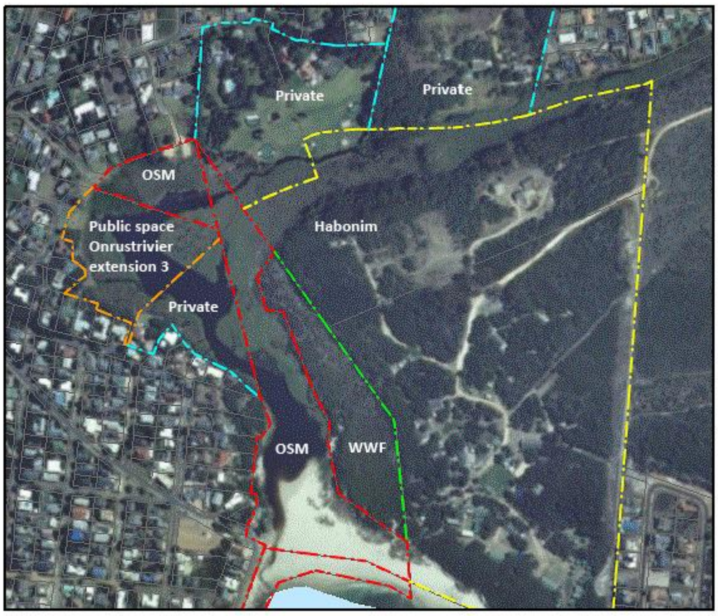


Figure 3.14: Land ownership around Onrus Lagoon.

4. Priority pressures and management response

The main issues affecting the ecological health of the Onrus Estuary, as well as its socio-economic value, relate to water quantity, water quality and habitat transformation. The contributing factors and the past and current management response are highlighted in this section. Future management options will be addressed in the Estuary Management Plan.

4.1 Water quantity

The reduced inflow is recognised as being one of the main pressures on the health of Onrus Lagoon. The role of the De Bos Dam in this regard has been addressed elsewhere in this report.

4.1.1 Groundwater abstraction

Since the De Bos Dam has reached its maximum yield in terms of water supply, a groundwater development scheme has been initiated to meet the future water requirements of the Greater Hermanus Area. The Camphill and Volmoed Wellfields have now been established in the Hemel en Aarde Valley to augment the water supply from the De Bos Dam and the Gateway Wellfield in Hermanus. The wellfields target the Peninsula Aquifer, which has been estimated to have a combined yield of 4 to 5 Mm^3 per annum. The reduced dependency on the dam in future raises the possibility of higher water releases from the dam.

A maximum groundwater abstraction of 1.6 Mm^3 per annum would be made from the two Hemel and Aarde wellfields. An environmental authorisation was issued by the Department of Environmental Affairs and Development Planning in October 2011, following submission of a Basic Assessment in accordance with the NEMA: EIA regulations. This addressed the potential impacts of groundwater abstraction, but a comprehensive hydrological and ecological monitoring programme is also being conducted by Umvoto Africa to ensure that any significant impacts on aquifers, associated surface water systems and groundwater-dependent ecosystems will be detected. The monitoring will inform management of the groundwater abstraction in terms of the Water Use Licence to be issued by the Department of Water Affairs. A Monitoring Committee that includes representatives from Overstrand Municipality, Cape Nature, Water Affairs, BOCMA and other key stakeholders will play an oversight role.

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). Nor will it affect groundwater seepage into Onrus Lagoon, as this is sustained by the sandy (primary) aquifer on the coastal plain.

4.1.2 *Invasive alien 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 in the past few years clearing has taken place in the lower catchment too (Figure 4.1).

Figure 4.1: Alien-clearing by Overstrand Working for Water during the past five years.

More recently, a new project has been initiated to increase these efforts. The project will be 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 to be cleared are the Habonim property on the eastern bank of the river and the riparian zone below the R43 bridge, the river course south of Camphill, and the mountainside above the suburb of Berghof (Figure 4.2).

Figure 4.2: Alien-clearing work to be completed by mid 2015.

In terms of the tender specification, contractors must make provision for the removal of all plant material in the river course that is deemed to be causing a blockage to the normal flow of the river, and must stack the material at least 32 m away from the banks. The project is due to be completed by 30 June 2015.

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.

4.1.3 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.

4.2 Water quality

Sewage contamination of Onrus Lagoon has been a long-standing concern. Sewage spills have occurred on occasion, and counts of the bacterial indicators of faecal contamination are frequently high (Appendix 2). The estuary has had to be closed to swimming at times, often during the peak summer season. The Overstrand Municipality established a task team in 2011 to investigate pollution sources and appropriate remedial action.

4.2.1 Sewerage line

Sewage spills have frequently occurred from the sewerage pipeline laid in the bed of the Onrus River. The pipeline was constructed in 1996 to convey sewage from Kidbrooke Place, as well as any future developments adjacent to the line, to the pump station on the northern shore of Onrus Lagoon.

Originally the pipeline consisted of a combination of 160 mm uPVC structured wall and 200 mm and 250 mm uPVC pressure pipes, with brick and concrete ring manholes. Following numerous incidents of sewage pollution of the river and estuary, V3 Consulting Engineers were contracted in 2000 to investigate the problem. A survey and visual and camera inspections were conducted, and the pipeline was found to be in a poor physical condition, with several dips, bends and holes, as well as root ingress and leaks. The consultants noted that the flow used in the design was too high, and some of the design gradients were flatter than those generally recommended by the 'Red Book' (Guidelines for Human Settlement Planning and Design), i.e. at least 1:300 for a 200 mm pipe and 1:400 for a 250 mm pipe. The low summer flows, in combination with the line's flat gradients and low points, caused fat to accumulate against the pipe wall. They recommended that regular cleaning and dosing be undertaken, but not jet-cleaning as this would damage the pipe walls. The 160 mm uPVC pipe was particularly prone to damage, and was considered unsuitable. The section of pipe from Kidbrooke Place had no more fat accumulation than other areas, but it was recommended that the fat trap at the Kidbrooke restaurant be re-commissioned.

Figure 4.3: Municipal sewerage infrastructure in the vicinity of Onrus Lagoon.

As a result of these findings, a 280 m section of sewerage 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. This entailed placing a new line on top of the old one. Stone mattresses were placed over the new line to protect it from flooding, and two 90° bends were replaced with 45° bends.

Nevertheless, high bacterial counts in Onrus Lagoon, and occasional sewage spills reported by Mr Haumann at the manholes on his property, indicate that the sewerage line is still problematic. In September 2010, a CCTV camera inspection on a remotely operated vehicle (ROV) was conducted by Trenchless Technology Specialists in the 280 m section from below the R43 bridge to the western border of Mr Haumann's property. This is the original 160 mm pipe. Apart from grease deposits and root ingress, a large crack in the pipe was filmed, and the ROV was blocked by stones and debris in places.

(a) (b)

Figure 4.4: CCTV camera footage from 2010 reveals (a) root ingress and (b) fractures in the Kidbrooke sewerage line.

In September 2012, the Overstrand Municipality appointed Lyners Consulting Engineers for a further investigation of the sewerage line. As part of the study, Jetvac was sub-contracted for jet-cleaning and camera inspections.

The report, submitted in April 2013, confirms that the gradients are 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 represents 14% of the pipeline's total length. Poor construction and the pipe's location in the riverbed results in settling of sections and high ingress of water. Large quantities of fatty deposits, grit, sand and roots were removed during the cleaning process. However, 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 be raised to reduce infiltration during high river flows. New, enlarged fat traps should 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 of pipe cracking will be implemented within the next few years. Lining would cost approximately R1 million, and would entail using the CIPP (cured-in-place pipe) process, in which a resin-saturated felt tube made of polyester is inverted or pulled into the damaged pipe. The total cost of implementing all the short-term recommendations was estimated at R1.75 million.

Implementing the recommended long-term option, pipe cracking, would cost approximately R2.56 million. This would entail replacing the existing pipeline with an HDPE continuously butt-welded pipe. Two other options were considered, namely the diversion of the Kidbrooke Place sewage by means of a pump station and re-alignment of the pipeline along an alternative route, but these were rejected, partly because other connections to the existing sewer (e.g. at Bosplasie) must be accommodated.

4.2.2 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 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 the 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.

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 by May 2013.

4.2.3 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. The report states that "it is standard practice to provide emergency storage capacity in the design of a pump station in an environmentally sensitive area", and recommended that underground emergency overflow tanks with a capacity of 1000 m^3 be constructed next to the pump station to accommodate shorter operational interruptions. This 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 is 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 concrete tanks was R1 450 000 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 V3 report 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, known as the 'Red Book', compiled for the Department of Housing by CSIR Building and Construction Technology. In a section entitled 'Sumps for pump stations' it states:
'A minimum emergency storage capacity representing a capacity equivalent to four hours flow at the average flow rate should be provided, 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). This provision applies only to pump stations serving not more than 250 dwelling units. For pump stations serving larger numbers of dwelling units, the sump capacity should be subject to special consideration in consultation with the local authority concerned.'

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.

4.2.4 Stormwater and upstream 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, but this will 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).

The Camphill Farm and School complex approximately 4 km upstream 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. Smaller developments and farm settlements typically rely on septic tanks with soakaways. Runoff from farmlands may also contribute to faecal contamination of the river. However, 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.

4.3 Habitat transformation

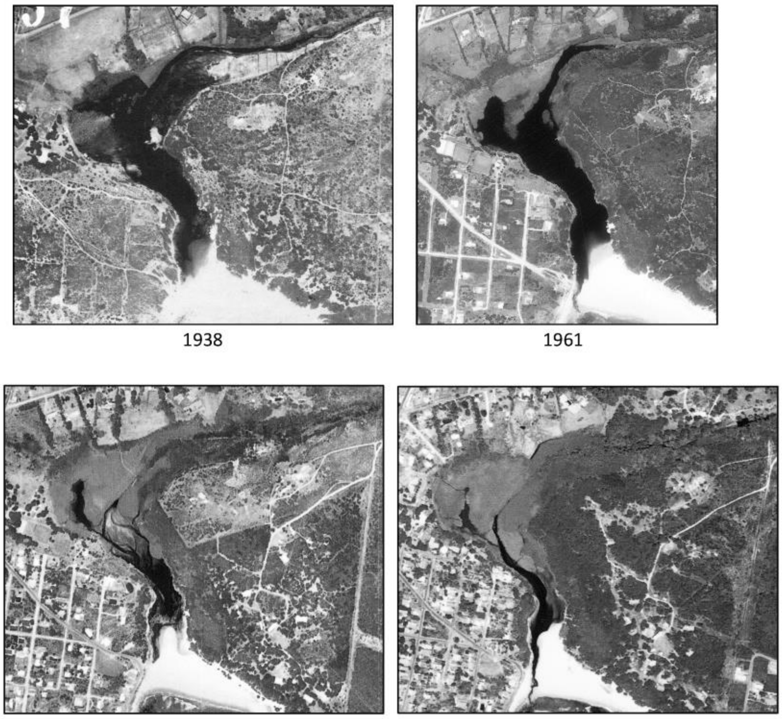
Sedimentation in Onrus Lagoon from about 1950, and subsequent encroachment by the common reed or 'fluitjiesriet' *Phragmites australis*, was mentioned in sections 3.2.3 and 3.3.2 respectively. The following sections provide further detail on this issue.

4.3.1 Reed encroachment

The reported shallowing of the estuary through sedimentation facilitated rapid expansion of the reedbeds via shoot production from the horizontally growing, underground rhizomes. The reeds in turn contributed 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.

Aerial photographs from 1938 (Figure 4.5) reveal that reeds were then 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.

The same year a 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).



1938 1961 1973 1989

Figure 4.5: Onrus Lagoon, 1938 - 1989

In 1991 the CSIR was contracted by the Save Onrus Lagoon Committee to review potential rehabilitation options. It 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 be removed as they filter nutrients and slow down sedimentation (CSIR 1993).

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. In addition, a request 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 4.6).


(a)


(b)

Figure 4.6: Photos from (a) 1989 and (b) 1998 show the extent of infilling in the river course.

In 2002 the Overstrand Municipality commissioned a new report on the rehabilitation of the Onrus Lagoon from Pieter Badenhorst. A survey revealed that there had been no significant sedimentation since the 1993 dredging. 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 CSIR had 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 Onrus Lagoon Trust was established in 1992 to remove reeds and invasive vegetation, but the current Chairman, Ron Gaylard, has indicated that reed-clearing was only undertaken by the Onrus Lagoon Trust on one occasion about four years ago, on the eastern side of the channel area. Cutting the reeds had been 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 has recently 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 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. The CSIR had recommended that these reeds be retained, apart from a small strip to launch canoes.

Figure 4.7: Reed-clearing in front of the 'common' in autumn 2012.

Consideration has also been given to using the Working for the Coast teams for reed-clearing. The teams are funded by the Expanded Public Works Programme through the national Department of Environmental Affairs' Social Responsibility Programme.

However, new EIA Regulations promulgated under the National Environmental Management Act in 2010 require that a Basic Assessment is submitted to the provincial Department of Environmental Affairs & Development Planning, and an authorisation obtained, prior to "The clearance of an area of 300 square metres or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation", where this is within 100 m inland of the high water mark of an estuary.

Perceptions that the reeds are 'taking over' the estuary are in any case not supported by aerial and satellite photographs, which reveal that there has been no significant change in reed cover in the 20 years since the estuary was dredged (Figure 4.8).

By increasing the depth of the estuary, the dredging has evidently been successful in preventing the reeds from spreading across the waterbody. *Phragmites* does not thrive in deep water for long periods, owing to the reduced efficiency of oxygen transport from the stalks protruding above the water surface down to the rhizomes.

Although the encroachment of reeds at the expense of open water area and exposed shoreline constitutes habitat transformation, with negative impacts on species that depend on those habitat types, the reedbeds do support other species, including a number of birds that are difficult to find elsewhere in the Overberg. They also take up nutrients that would otherwise be used opportunistically by weeds and algae, resulting in more extensive mats of filamentous algae such as *Cladophora*, for example, or blooms of toxic blue green algae, which might have a greater detrimental impact.

4.3.2 Sediment sources

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.

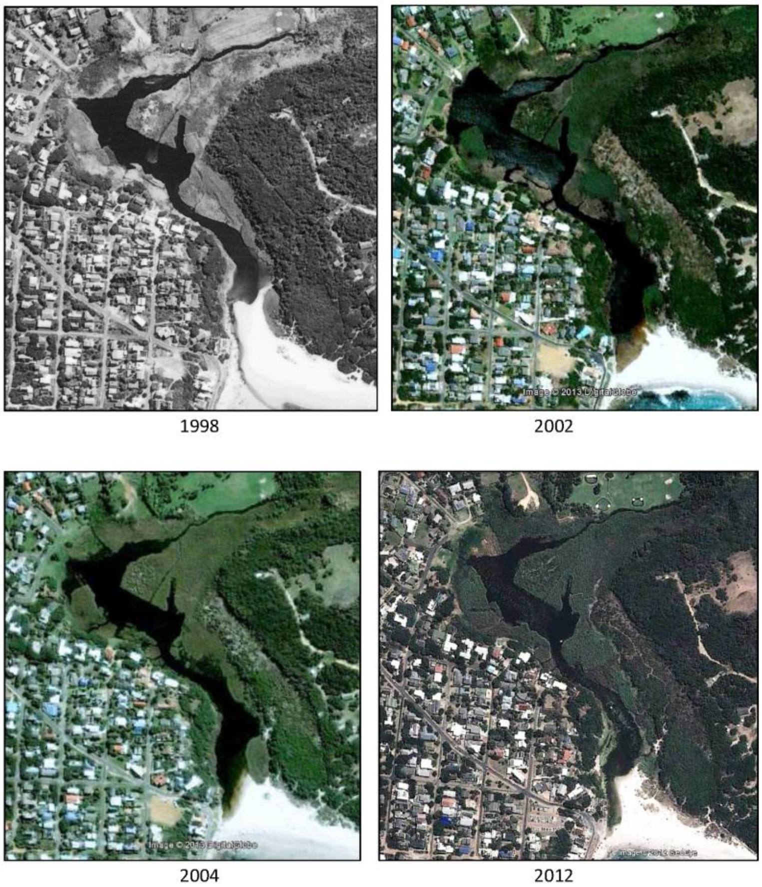


Figure 4.8: Onrus Lagoon, 1998 - 2012

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-repellant 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 a higher priority.

The earlier CSIR reports noted that bridge and road construction in the vicinity of the Onrus River might have contributed to sedimentation of the estuary in the past. During the public participation process for the Hemel en Aarde groundwater development EIA, Cape Nature expressed concern about the risk of erosion during pipeline construction, and suggested that construction take place manually and outside the wet winter season where aquatic features are present. The Comments and Responses Report noted that this would be possible providing environmental authorisation was received in time to do the work during the summer months, so it had been included in the Environmental Management Plan. The site where the pipeline would cross the Onrus River near the Preekstoel water treatment works was identified in the Basic Assessment Report as an area of particular concern, due to the steep slopes here. The photos below, taken after heavy rain in October 2012 resulted in the De Bos Dam overflowing, indicate that the recommendations were not adhered to. The slope has since been stabilised.

Figure 4.9: Construction work for the Hemel en Aarde groundwater development project may have increased the sediment load in the Onrus River.

4.3.3 Urban development and invasive vegetation

The area around Onrus Lagoon has been substantially transformed by urban development, resulting in a loss of terrestrial habitat. The shores of the estuary have been altered through bank hardening, infilling and landscaping, and garden escapees have colonised the riparian zone. Alien tree species have invaded the river course and the surrounding land, but plans are in place to clear certain areas. The WWF property on the eastern shore provides an overlooked area of natural habitat that should be properly maintained, and promoted as an asset for biodiversity conservation, environmental education and recreation.

Given that approximately 1 ha of the river course on the north-eastern shore of the estuary was infilled during the 1990s and building rubble was subsequently used to replace eroded material, it is of great concern that consideration is being given to the stabilisation of the embankment extending along these private erven. It has been proposed that a gabion structure would be built along the edge of the watercourse to provide erosion protection up to the level of the 1:5 year storm event. The embankment would be landscaped with indigenous plant species, “which will contribute to the stabilisation .... [and] to the visual and ecological enhancement of the eroded northern embankment” (Guillaume Nel Environmental Consultants 2013). An alternative solution should be considered, such as removal of infilled material prior to rehabilitation of the river course.

5. Legislation and Policy

As a natural feature in the midst of an urban environment, a wide variety of legislation has potential relevance to Onrus Lagoon. A full review entitled 'Interpretation of legislation pertaining to management of environmental threats within estuaries' (Taljaard 2007) was compiled as part of the C.A.P.E. Estuarine Guideline series. In accordance with the requirements of the National Estuarine Management Protocol, however, this chapter will focus more specifically on the legislative instruments, as well as management strategies, that are currently applicable and directly relevant to Onrus Lagoon.

5.1 International agreements and obligations

The Convention on Biological Diversity was adopted in June 1992 at the United Nations Conference on Environment and Development (the Rio "Earth Summit"). It has three main objectives: the conservation of biological diversity; the sustainable use of the components of biological diversity; and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources. South Africa ratified the Convention in 1995, and subsequently developed a National Biodiversity Strategy and Action Plan.

South Africa is also a contracting party to the Nairobi Convention (Convention of the Protection, Management and Development of the Marine and Coastal Environment of the Eastern Africa Region) and the Abidjan Convention (Convention for Cooperation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region). The Nairobi Convention executed the WIO-LaB project as a demonstration project for the Global Programme of Action (GPA) for the Protection of the Environment for Land-based Activities. The GPA targets major threats to the health, productivity and biodiversity of the marine and coastal environment resulting from human activities on land, and proposes an integrated, multi-sectoral approach based on commitment to action at local, national, regional and global levels. As part of the WIO-LaB project, the Western Cape Department of Environmental Affairs and Development Planning (DEA&DP) developed a provincial Programme of Action to address pollution impacts on estuaries, but Onrus Lagoon was not among the 10 focus estuaries.

The estuary would not qualify for Ramsar status (Convention on Wetlands of International Importance), and supports no migratory species requiring special protection under the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals). It is neither a UNESCO World Heritage Site or UNESCO Biosphere Reserve.

5.2 National and provincial environmental legislation

5.2.1 The Constitution of the Republic of South Africa (1996)

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.'

The Constitution also has implications for estuary management in terms of government mandates at the national, provincial and municipal level. Provincial government is given exclusive powers over matters listed in Schedule 5, and powers concurrent with the national government over matters listed in Schedule 4. The latter includes environment, pollution control, and nature conservation (excluding national parks, national botanical gardens and marine resources).

Municipalities are granted the power to administer matters listed in Part B of Schedules 4 and 5. These include municipal planning, jetties, sewage disposal, beaches, local amenities, municipal parks and recreation, and public places, among others.

5.2.2 National Environmental Management Act (Act 107 of 1998) (NEMA)

NEMA provides for cooperative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance, and procedures for coordinating environmental functions exercised by organs of state.

Chapter 7 of the Act, dealing with Compliance and Enforcement, has particular relevance to Onrus Lagoon. Section 28: 'Duty of care and remediation of environmental damage' stipulates that 'every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment'. Should a person fail to comply adequately with a directive to address such damage, the DEA Director-General or provincial head of department may take measures to remedy the situation, and recover all costs incurred.

Section 30: 'Control of emergency incidents' stipulates the steps that must be taken in the event of incidents leading to serious danger to the public or potentially serious pollution or environmental degradation.

Furthermore, new Environmental Impact Assessment (EIA) Regulations were promulgated under NEMA in 2010. Listings 1 and 3 stipulate those activities that would require a Basic Assessment, such as:

- Construction of structures of 50 m^2 or more in the coastal public property, any watercourse or within 32 m of a watercourse, or within 100 m of the high water mark of the sea or an estuary
- Construction or expansion of channels, bridges, weirs and stormwater outlets in a watercourse or within 32 m of a watercourse
- Construction or expansion of jetties, slipways, buildings and infrastructure exceeding 10 m^2 in estuaries or within 32 m of watercourses
- Construction, expansion or earth-moving activities in an estuary, or within a distance of 100 m inland of the high-water mark of an estuary, for fixed or floating jetties and slipways, embankments, rock revetments or stabilising structures
- Infilling or depositing of any material of more than 5 m^3, or dredging, excavating, removing or moving soil, sand, shells, shell grit, pebbles or rock of more than 5 m^3 from a watercourse, the littoral active zone, an estuary or a distance of 100 m inland of the high-water mark, unless this is for maintenance purposes according to a management plan agreed to by the provincial authority.
- Clearing an area of 300 m^2 or more of vegetation where 75% or more of the vegetative cover is indigenous vegetation (including *Phragmites* reeds) within the littoral active zone or 100 m inland from the high water mark of an estuary.
- Construction of tourism accommodation facilities within 1 km of the high-water mark of the sea if no development setback line has been determined.

Listing 2 indicates those activities that would require a Full Assessment, including:

- The construction of facilities or infrastructure for any process or activity which requires a permit or license in terms of national or provincial legislation governing the generation or release of emissions, pollution or effluent.
- The construction of facilities or infrastructure for the transfer of 50 000 m^3 or more of water per day to water treatment works.

Further information on the EIA Regulations can be downloaded here:
http://www.westerncape.gov.za/eng/directories/services/11537/10199

The NEMA Regulations for the Control of Vehicles in the Coastal Zone have little relevance to Onrus Lagoon, as there is no public vehicular access point to Onrus Beach, while boating is limited to canoes and small dinghies that are carried from the beachfront carpark or the grassed 'common' at the northern end of the estuary.

5.2.3 National Environmental Management: Integrated Coastal Management Act (Act 24 of 2008)

The ICM Act was promulgated 'to establish a system of integrated coastal and estuarine management in the Republic, including norms, standards and policies, in order to promote the conservation of the coastal environment and maintain the natural attributes of coastal landscapes and seascapes, and to ensure that development and the use of natural resources within the coastal zone is socially and economically justifiable and ecologically sustainable; to define rights and duties in relation to coastal areas; to determine the responsibilities of organs of state in relation to coastal areas; to prohibit incineration at sea; to control dumping at sea, pollution in the coastal zone, inappropriate development of the coastal environment and other adverse effects on the coastal environment; to give effect to South Africa's international obligations in relation to coastal matters.'

The Act came into effect on 1 December 2009, with the exclusion of those parts that would repeal the *Sea Shore Act* (Act 21 of 1935) and the *Dumping at Sea Control Act* (Act 73 of 1980). Administration of the former was delegated to the provinces, with the result that Cape Nature is currently the authority that issues leases for the seashore relating to jetties and other structures below the high-water mark. However, it is anticipated that the Sea Shore Act will be repealed under the ICM Act soon (the ICM Amendment Bill was published in January 2013).

The ICM Act defines and establishes coastal public property, which includes estuaries, and a coastal protection zone. It stipulates that coastal setback lines must be established, and that construction seaward of these lines should be prohibited or restricted. It provides for coastal committees and coastal management programmes at national, provincial and municipal level. In the case of municipalities, by-laws may be introduced for the implementation, administration and enforcement of the coastal management programme. Coastal planning schemes may also be established, but municipalities may not do so without consultation with the MEC and other relevant authorities, and may not adopt a land-use scheme that is inconsistent with any coastal planning scheme.

The Act stipulates that owners or occupiers of land adjacent to coastal public property may not require any organ of state or any other person to take measures to prevent erosion or accretion of the shore, coastal public property or land adjacent to it, nor may they take such measures themselves, except as provided for by the Act, NEMA and other Acts defined in NEMA. It gives delegated law enforcement officials the power to issue coastal protection, removal and repair notices for any activity that is deemed to have an adverse effect on the coastal environment.

Chapter 4 of the Act deals specifically with estuaries, noting that estuaries should be managed in accordance with a national estuarine management protocol and an estuary management plan that is consistent with the protocol and the respective coastal management programmes.

5.2.4 National Environmental Management: Biodiversity Act (Act 10 of 2004)

The Act provides for the management and conservation of South Africa's biodiversity, the protection of species and ecosystems that warrant national protection, the sustainable use of indigenous biological resources, the fair and equitable sharing of benefits arising from bioprospecting involving indigenous biological resources, the establishment and functions of a South African National Biodiversity Institute, and related matters. Its promulgation gives effect to South Africa's ratification of the Convention on Biological Diversity and other relevant international agreements.

The National Biodiversity Assessment 2011 was conducted as part of SANBI's mandate in terms of the Act to monitor and report regularly on the state of biodiversity. Ecosystem threat status and ecosystem protection level were assessed for terrestrial, freshwater, estuarine and marine environments. It also dealt with species of special concern and invasive alien species, presented new work on geographic areas that contribute to climate change resilience, and provided a summary of spatial biodiversity priority areas that have been identified through systematic biodiversity plans at national, provincial and local scales. The NBA 2011 will inform the revision and updating of key national biodiversity policies and strategies, including the National Biodiversity Strategy and Action Plan, the National Biodiversity Framework and the National Protected Area Expansion Strategy. The estuary component of the NBA 2011 was the basis of Section 3.4 of this report.

Draft Alien and Invasive Species Regulations were published under the Biodiversity Act in 2007, and a second draft in 2009, together with draft lists of alien plant and animal species declared exempted, prohibited and invasive. Invasive species are listed according to category, with Category 1a requiring compulsory control, Category 1b controlled as part of an invasive species control programme, Category 2 regulated by area and Category 3 regulated by activity. Listed animal species potentially occurring in Onrus Lagoon include carp and tilapia (Category 2), and Mallard x indigenous duck hybrids (Category 1b). Plant species in the vicinity include rooikrans and black wattle (Category 2), Port Jackson and various eucalypts (Category 1b). Alien and invasive plant species are also listed and categorised in the *Conservation of Agricultural Resources Act*, Act 43 of 1983 (CARA).

Threatened or Protected Species Regulations were also published in 2007, and have been amended a number of times, most recently on 16 April 2013. The new regulations deal mostly with permit and registration systems for boat-based whale-watching, shark cage-diving, hunting or keeping of wildlife, and possession of rhino horn and elephant tusk, as well as registration for wildlife facilities. At the same time a list of threatened (critically endangered, endangered or vulnerable) and protected species, and activities that are prohibited or exempt from restriction, was gazetted. The only threatened animal species that occurs at Onrus Lagoon is the Cape Cormorant (listed as vulnerable), while the protected animals include otters, seals and seabirds that occur in the estuary or the vicinity.

A 'National list of threatened ecosystems' was published in December 2011. It identifies ecosystems that are threatened (critically endangered, endangered or vulnerable) and in need of protection, but consists of terrestrial ecosystems only. The purpose of listing threatened ecosystems is primarily to reduce the rate of ecosystem and species extinction, which includes preventing further degradation and loss of structure, function and composition of threatened ecosystems. Overberg Sandstone Fynbos that historically occurred in the vicinity of Onrus Lagoon is listed as critically endangered, but much of this has already been transformed or disturbed by urban development and invasion by alien vegetation.

5.2.5 Environment Conservation Act (Act 73 of 1989)

The Act provides for the conservation or protection and sustainable use of the environment. Most of its provisions have been repealed and replaced by NEMA and other legislation, but Section 31A has been retained. This gives the Minister, the competent authority, local authority or government institution concerned the power to issue a directive against any person performing an activity, or failing to perform an activity, which results in the environment being seriously damaged, endangered or detrimentally affected. The directive can be an instruction to cease the activity and/or rehabilitate any damage, and if this is ignored the issuer of the directive can take the necessary steps and recover costs from the perpetrator.

5.2.6 Marine Living Resources Act (Act 18 of 1998)

The Act aims to provide for the conservation of the marine ecosystem, the long-term sustainable utilisation of marine living resources, and the orderly access to exploitation, utilisation and protection of certain marine living resources. The Act is applicable to South African waters, defined as the seashore, internal waters, territorial waters, tidal lagoons and tidal rivers. As such, it includes estuaries.

In terms of the Act, commercial or subsistence fishing requires the allocation of a fishing right, while recreational fishing may not take place without an annual permit. Regulations issued under the Act include those relating to prohibited and bait species, bag and size limits, closed seasons and areas, and fishing gear and methods. No fishing rights have been issued for trek-netting or gill-netting in any estuaries in the Overstrand area, but holders of a recreational fishing permit endorsed for cast-netting may catch certain fish by this method according to listed bag and size limits, and only between sunrise and sunset.

Chapter 4 of the Act deals with marine protected areas, which would include estuarine protected areas. However, Onrus Lagoon does not meet criteria for protected status, according to the National Biodiversity Assessment 2011. (The *National Environment Management: Protected Areas Act*, 57 of 2003, caters for nature reserves or protected environments, amongst others, but there are none with formal status in the immediate vicinity of the estuary.)

Since the Chief Directorate: Marine & Coastal Management was split between two departments, the Department of Agriculture, Forestry and Fisheries (DAFF) administers those parts of the Act dealing with consumptive exploitation (fisheries), while the Department of Environmental Affairs: Oceans and Coast Branch covers ecosystem management (including estuaries) and non-harvested marine living resources (seabirds, seals, sharks, dolphins and whales). Seabirds and seals were not included in the MLRA due to the existing Seabirds and Seals Protection Act (No 46 of 1973), but an updated Seals, Seabirds and Shorebirds Management Policy was published in 2007. An MLRA Amendment Bill was published in April 2013.

5.2.7 National Water Act (Act 36 of 1998)

The Act provides for fundamental reform of the law relating to water resources. Sustainability and equity are identified as central guiding principles in the protection, use, development, conservation, management and control of water resources. These guiding principles recognise the basic human needs of present and future generations, the need to protect water resources, the need to share some water resources with other countries, the need to promote social and economic development through the use of water, and the need to establish suitable institutions in order to achieve the purpose of the Act.

Chapter 3 deals with protection of water resources, which includes watercourses, surface water, estuaries and aquifers. It addresses the classification of water resources and resource quality objectives, the Reserve, pollution prevention and emergency incidents. The Reserve consists of two parts — the basic human needs reserve, which ensures that individuals dependent on the water resource have enough for drinking, food preparation and personal hygiene, and the ecological reserve, which relates to the water required to protect the aquatic ecosystems of the water resource. The Reserve refers to both the quantity and quality of the water in the resource, and will vary depending on the class of the resource.

Recognising that it would take some time to develop a Classification System, the Act made provision for the determination of a Preliminary Reserve until such time as the resource could be properly classified. The Preliminary Reserve Methods involve setting a Recommended Ecological Category and Resource Quality Objectives for a resource on the basis of its present condition/health/integrity and its conservation importance or status. A suite of Preliminary Reserve Methods was developed for rivers, estuaries, wetlands and groundwater. The updated *Methods for the Determination of the Ecological Reserve for Estuaries* (DWA 2010) are used as the basis of Ecological Water Requirement studies and the estuary component of the National Biodiversity Assessment (NBA). An EWR study has not yet been conducted for Onrus Lagoon, but NBA 2011 used a rapid, desktop approach to assess the health of the estuary.

In terms of pollution prevention, the Act stipulates that the person who owns, controls, occupies or uses land on which potentially polluting activities occur is responsible for taking measures to prevent pollution of water resources. If these measures are not taken, the Catchment Management Agency may do whatever is necessary to prevent the pollution or to remedy its effects, and to recover all reasonable costs from the persons responsible for the pollution. The same applies to emergency incidents, which includes any incident or accident in which a substance pollutes or has the potential to pollute a water resource, or is likely to have a detrimental effect on the resource. Such incidents must be reported to the Catchment Management Agency.

Chapter 4 of the Act deals with water use, which includes taking and storing water, activities which reduce stream flow or impact detrimentally on a water resource, waste discharges and disposals, altering a watercourse, removing water found underground for certain purposes, and recreation. In general a water use must be licensed unless it is listed in Schedule I, is an existing lawful use, or is permissible under a general authorisation. Schedule 1 activities of relevance to Onrus Lagoon and its immediate vicinity include taking water for reasonable domestic (household) use, small gardening not for commercial purposes, and recreation.

General authorisations are periodically revised and are activity specific. A new 'Draft general authorisation for the taking and storing of water' was published for comment on 4 April 2012. For the Onrus catchment, this stipulates that the maximum volume of surface water that may be extracted on each property or piece of land is 2 000 m^3 per year at a maximum rate of 1 ℓ/s, while 2 000 m^3 is also the maximum that may be stored. However, no water or groundwater may be taken from within a 750 m radius from the boundary of a wetland or estuary, nor may groundwater be taken within a 100 m radius from the delineated riparian edge of a watercourse.

Chapters 7 and 8 allow for the establishment of Catchment Management Agencies and Water User Associations. The Breede-Overberg Catchment Management Agency (BOCMA) was the first CMA to be established in South Africa. The Onrus River catchment falls within BOCMA's area of jurisdiction, and many of the Department of Water Affairs' responsibilities in terms of the National Water Act have been delegated to BOCMA, which has developed a Catchment Management Strategy (see section 5.4). An Onrus Water Users Association was established in 2008, but it not fully functional.

5.2.8 National Forests Act (Act 84 of 1998)

The Act aims to promote the sustainable management and development of forests; create the conditions necessary to restructure forestry in State forests; provide special measures for the protection of certain forests and trees; promote the sustainable use of forests for environmental, economic, educational, recreational, cultural, health and spiritual purposes; promote community forestry; and promote greater participation in all aspects of forestry and the forest products industry by persons disadvantaged by unfair discrimination.

Its relevance to Onrus Lagoon is that the white milkwood *Sideroxylon inerme* is protected in terms of Section 15(1) of the Act. It is one of 47 tree species most recently listed in the Government Gazette of 7 September 2012, which states that 'no person may cut, disturb, damage or destroy any protected tree or possess, collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree or any forest product derived from a protected tree, except under a licence or exemption granted by the Minister to an applicant and subject to such period and conditions as may be stipulated'.

5.2.9 National Health Act (Act 61 of 2003)

The Act requires that metropolitan and district municipalities ensure the provision of appropriate municipal health services, which include water quality monitoring and environmental pollution control, amongst other things. Municipal health services are identified as a municipal function in the Constitution, and the *Municipal Structures Act* of 1998 provided clarity by identifying the responsible tier of local government as the District Municipalities. In 2006, Treasury made an allocation of funding for this service.

5.2.10 Nature and Environmental Conservation Ordinance (No. 19 of 1974)

This provincial ordinance allows for the establishment of provincial, local and private nature reserves, and regulates the hunting and keeping of wild animals, the laying of poison, fishing in inland waters and flower-picking, amongst other things. National legislation that takes precedence has rendered parts of the Ordinance and the accompanying regulations invalid. The lead agent, Cape Nature, began developing new legislation that would repeal the Ordinance but a draft Bill has not yet been released for public comment.

5.3 National and provincial planning legislation

5.3.1 Spatial Planning and Land Use Management Bill, and legislation to be repealed

In February 2013 the National Assembly approved the Spatial Planning and Land Use Management Bill (SPLUMB). If endorsed by the National Council of Provinces and signed into law, the new statute will repeal the Physical Planning Act and the Development Facilitation Act.

The objective of the *Physical Planning Act* (Act 125 of 1991) was 'to promote the orderly physical development of the Republic, and for that purpose to provide for the division of the Republic into regions, for the preparation of national development plans, regional development plans, regional structure plans and urban structure plans by the various authorities responsible for physical planning'.

The *Development Facilitation Act* (Act 67 of 1995) aimed 'to introduce extraordinary measures to facilitate and speed up the implementation of reconstruction and development programmes and projects in relation to land; and in so doing to lay down general principles governing land development throughout the Republic'. Its promulgation was intended to be an interim measure to facilitate accelerated housing delivery by waving other legislation and giving decision-making powers to provincial Development Tribunals. Sections of this legislation were declared unconstitutional by the Constitutional Court in June 2010 as it usurped the decision-making powers of municipalities. Its repeal or replacement was required by June 2012, hence the gazetting of the SPLUMB in May 2011.

5.3.2 Draft Western Cape Land Use Planning Bill, and legislation to be repealed

Provinces are required by SPLUMB to create their own tier of compatible legislation. The Draft Western Cape Land Use Planning Bill, 2013, was published for comment in January 2013. When enacted, this legislation would repeal the Land Use Planning Ordinance, 1985, and the Western Cape Planning and Development Act, 1999. The Bill has five main objectives. (1) It establishes a firm link between forward planning and development management by requiring development management decisions to be aligned with spatial development frameworks. (2) It seeks to clarify municipal and provincial roles in land-use planning. (3) It puts in place an 'asymmetric' planning system which caters for various levels of planning capability. (4) It seeks to find a way to deal with the impact of land-use decisions and land-use planning instruments on the provincial interest by providing for compulsory provincial comments. (5) The Bill seeks to rationalise the current fragmented legislative framework and facilitate mechanisms for integrated applications. It consolidates the various land-use control instruments (such as rezoning, subdivision, removal of restrictions, etc.) into one provincial menu of instruments that can be addressed in one application to the municipality.

The Bill positions local municipalities as the sphere of government that is responsible for adopting a municipal spatial development framework (SDF), approving zoning schemes and by-laws to regulate planning in the municipal areas, and deciding on all land-use applications in the municipal area. The provincial government is made responsible for adopting a provincial SDF and, where applicable, regional spatial development frameworks. Furthermore, the provincial government must regulate, support and monitor municipal land-use planning activity.

Under the current *Land Use Planning Ordinance* (Act 15 of 1985), local authorities had to submit Structure Plans to provincial government for approval. Structure Plans lay down guidelines for the future spatial development of the area, while zoning schemes provide control over use rights and over the utilisation of land, although landowners may apply for rezoning, subdivision or land-use departure. The latter are for alteration of land-use restrictions or to use land on a temporary basis for a purpose that is inconsistent with the zoning scheme.

The *Western Cape Planning and Development Act* (Act 7 of 1999) aimed to establish a post-apartheid development planning system for the Western Cape, dealing with the restitution of land rights and tenure. It included frameworks and standards for development planning at municipal and provincial level, including environmental protection and land development management. However, the Act was never implemented.

5.3.3 Local Government: Municipal Systems Act (Act 32 of 2000)

The Municipal Systems Act instructs municipalities to adopt a municipal SDF as part of an Integrated Development Plan (IDP) that must be reviewed annually. IDPs aim to coordinate the work of local and other spheres of government in a coherent plan to improve the quality of life for all the people living in an area. They should take into account the existing conditions, problems and available resources, and should look at economic and social development for the area as a whole. They should specify what infrastructure and services are needed and how the environment should be protected.

The Act also states that municipal councils have a duty to 'strive to ensure that municipal services are provided to the local community in a financially and environmentally sustainable manner'. The latter is defined as ensuring that:

(a) The risk of harm to the environment and to human health and safety is minimised to the extent reasonably possible under the circumstances;

(b) The potential benefits to the environment and to human health and safety are maximised to the extent reasonably possible under the circumstances; and

(c) Legislation intended to protect the environment and human health and safety is complied with.

The Act has implications in terms of the Overstrand Municipality's mandate for estuary management, as it confirms that municipalities have the powers and functions conferred by or assigned to it in terms of the Constitution, and must exercise them subject to Chapter 5 of the *Municipal Structures Act*. Section 9 stipulates that if other functions or powers are designated to municipalities through national or provincial legislation, the relevant Cabinet member, Deputy Minister or MEC must first request the Financial and Fiscal Commission to make an assessment of the financial implications of the legislation. They must also take appropriate steps to ensure sufficient funding, and capacity-building initiatives if necessary, for the municipalities' performance of the assigned function of power if the assignment imposes a duty on the municipalities concerned; that duty falls outside the functional areas listed in Part B of Schedules 4 and 5 of the Constitution or is not incidental to any of those functional areas; and the performance of that duty has financial implications for the municipalities concerned.

In giving effect to the provisions of the Constitution, municipalities must give priority to the basic needs of the local community; promote the development of the local community; and ensure that all members of the local community have access to at least the minimum level of basic municipal services. Any municipal expenditure incurred that is not required or condoned by the Municipal Systems Act is a contravention of the *Municipal Finance Management Act* (Act 53 of 2003).

5.4 Breede-Overberg Catchment Management Strategy

The Breede-Overberg Catchment Management Agency (BOCMA) was established by the Minister of Water Affairs in July 2005, in terms of the National Water Act (36 of 1998). The Governing Board was appointed in October 2007 and the CMA became operational with the appointment of the CEO and staff from 2008.

A Catchment Management Strategy was developed through a broad stakeholder consultation and capacity-building process. Through a series of work sessions with a diverse range of stakeholders, the vision for the Breede-Overberg Catchment was identified: "Quality water for all, forever". Stakeholders expanded this into the following three vision statements, reflecting the balance between protection and development achieved through joint action:

- Protecting our rivers, groundwater, wetlands and estuaries in a healthy and functioning state for nature, people and the economy.
- Sharing our available water equitably and efficiently to maintain existing activities, support new development and ensure redress, while adapting to a changing climate and world.
- Cooperating to jointly nurture, take responsibility and comply, so that our water resources are well managed, under the leadership of a strong Breede-Overberg CMA.

These vision statements form the basis of the Catchment Management Strategy's three Strategic Areas, which are given effect through supporting measures, objectives and actions.

Strategic Area 1: Protecting for People and Nature is the strategic area that is most relevant to the management of Onrus Lagoon, as its measures include preliminary classification of water resources; determination of environmental flow requirements; water quality management; groundwater protection; natural asset conservation, and catchment and land-use management. The following are among the actions identified under these measures:

- Conduct comprehensive water resources classification for the Overberg rivers
- Establish environmental flow Reserves for the Overberg rivers and estuaries

- Enforce compliance in municipal waste water treatment works and systems
- Develop conjunctive ground water management plans for priority Breede catchments
- Develop and implement estuary management plans
- Prioritise and maintain endemic fish sanctuaries and alien fish plan.

Strategic Area 2: Sharing Water for Equity and Development deals with water resources assessment; water conservation and demand management; water supply availability and water allocation, plus climate change resilience. The water use verification and validation exercise that Aurecon is conducting in the Onrus catchment on behalf of BOCMA is one of the actions associated with these measures.

Strategic Area 3: Cooperating for Compliance and Resilience addresses institutional arrangements and strategic partnerships; stakeholder engagement and communication; water use compliance (control and enforcement); financial and economic instruments; monitoring and information, and climate adaptation and disaster risk management. One of the actions identified is to expand the water resources monitoring and gauging network in the Overberg. The water quality (faecal bacteria) monitoring conducted in Onrus Lagoon since December 2010 was supported by BOCMA, through the funding of all laboratory analyses.

The Catchment Management Strategy was published in the Government Gazette of 20 July 2012 for public comment. At the same time, the Minister of Water Affairs' approval of the consolidation of 19 Water Management Areas into nine, each to be managed by a Catchment Management Agency, was gazetted. The Breede-Overberg and Gouritz Water Management Areas have been merged into the Breede-Gouritz WMA.

5.5 Municipal legislation and strategic planning instruments

5.5.1 By-law relating to Stormwater Management, 2009

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.

5.5.2 Water Supply and Sanitation Services By-law, 2009

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. This legislation is relevant to the inspection of sewage tanks, as detailed in section 4.2.2 of this report.

5.5.3 By-law relating to the Keeping of Cats and Dogs, 2008

The By-law aims to regulate and control the ownership and general behaviour of cats and dogs. It restricts the numbers of cats and dogs that may be kept without special permission, and deals with aspects such as sterilisation, registration and impoundment, as well as 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.

5.5.4 Integrated Development Plan and associated Sector Plans

The *Municipal Systems Act* defines the IDP as 'the principal strategic planning instrument which guides and informs all planning and development, and all decisions with regard to planning, management and development, in the municipality'.

The Overstrand Municipality's IDP for the five-year period 2012-2017 was adopted by Council on 30 May 2012, and the first annual review was published in May 2013. 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 Town and Regional Planning Consultants, Urban Dynamics, are in the process of compiling a new Spatial Development Framework (SDF), which will be in accordance with the strategies and objectives reflected in the SDFs and IDPs of national, provincial, district and local municipalities. It will also be consistent with applicable legislation on environmental management, agriculture and water, and give effect to national and provincial plans and planning legislation. The draft SDF will be released for public comment in mid-2013. The spatial planning categories will therefore differ from those in the existing SDF of 2006.

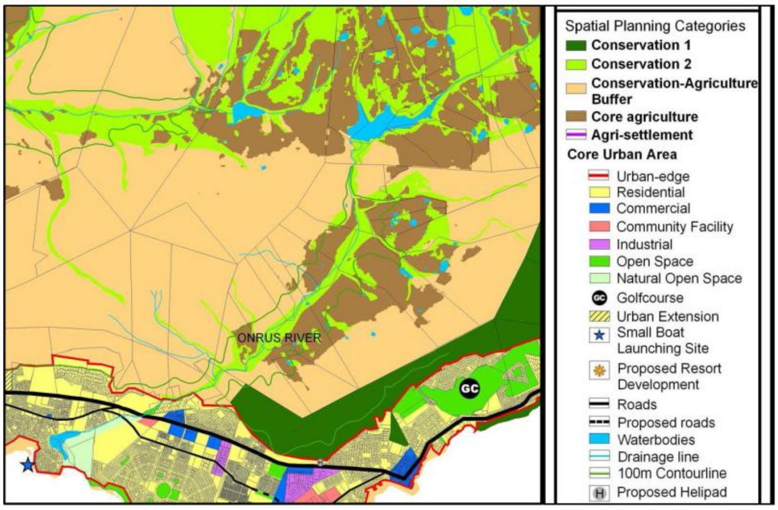
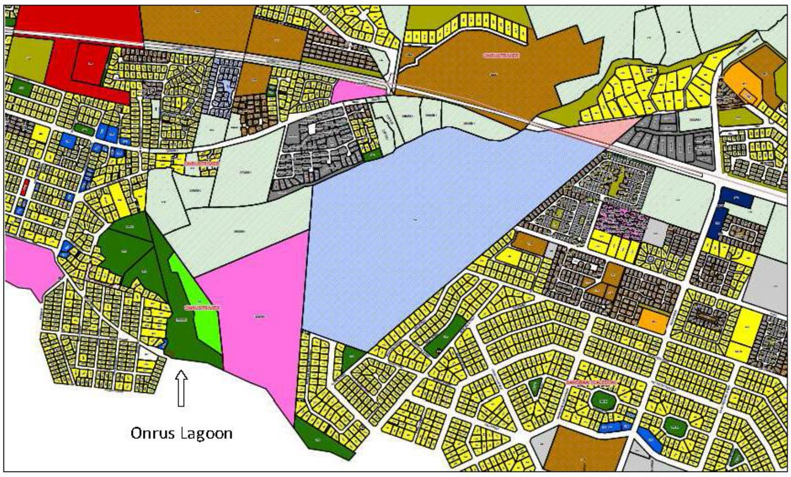


Figure 5.1: The 2006 Spatial Development Framework for the Onrus area. A new SDF using different spatial planning categories will be released for public comment in mid-2013 .

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.

During 2011, a Draft Zoning Scheme was also released for public comment. The proposed zones in the vicinity of Onrus Lagoon are shown in Figure 5.2. The scheme is expected to be finalised during 2013.



	Open Space 1: Nature Reserve		Residential Zone 1: Single Residential
	Open Space 2: Public Open Space		Residential Zone 2: Town housing
	Open Space 3: Private Open Space		Holiday Resort
	Agriculture Zone 1: Agriculture		Subdivisional area
	Special Zones		Business Zone 2: Local Business

Figure 5.2: New zoning in the Onrus area proposed in 2011 for the Overstrand Municipality's Integrated Zoning Scheme.

The IDP Review for 2013/14 notes that the Overstrand Municipality launched 'Overstrand Towards 2050 – an Integrated Development Framework' in October 2012. A Human Settlement Plan and an Environmental Management Framework will be compiled as part of this initiative.

The Environmental Sector Plan in the IDP Draft Review shows that the function of the Environmental Management Services (EMS) Section is to promote a sustainable balance between environmental, social and economic development in accordance with Schedule 4 and 5 (Parts B) of the Constitution. This function can be divided into four main tasks:

i. Effective management of Municipal Nature Reserves and Municipal Open Spaces
ii. Progressive development and implementation of a corporate Environmental Management System to reduce the environmental footprint of the Municipality
iii. Evaluation of all developments (development proposals, town planning applications, building plans and infrastructure projects) for environmental sustainability
iv. Liaison and engagement with stakeholders concerning the state of the environment and advising the Municipal Council and Municipal officials on environmental matters.

The EMS section is also involved in the following initiatives that have relevance to the management of Onrus Lagoon :

- The development of a coastal management programme by the Overberg District Municipality in accordance with the ICM Act
- The formulation of coastal setback lines by the provincial Department of Environmental Affairs and Development Planning
- The clearing of invasive alien vegetation by the Working for Water Programme, for which the Overstrand Municipality acts as Implementing Agent for the Department of Environmental Affairs' Natural Resource Management Programme
- The creation of work opportunities through the EPWP Working for the Coast Programme, which forms part of the Department of Environmental Affairs' Social responsibility Programme
- The administration of the Estuary Management Coordinator post funded by the WWF-Table Mountain Fund for the three-year period June 2010 – 2013.

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APPENDIX 1: Estuarine functional zone

The estuarine functional zone for South Africa's estuaries is defined by the 5 m topographical contour (i.e. 5 m above mean sea level). The estuarine functional zone includes the open water area; estuarine habitat (sand and mudflats, rock and plant communities); and floodplain area.

The 5 m contour has the following biodiversity and planning advantages:

- The 5 m contour encapsulates most dynamic areas influenced by long-term estuarine sediment processes, i.e. sediment stored or eroded during floods, changes in channel configuration, aeolian transport processes and changes due to coastal storms. Allowing for natural variability is important as these are some of the key physical processes that drives biodiversity along the SA coastline;
- The 5 m contour encompasses the floodplain and estuarine vegetation that contribute detritus (food) and provides refuge to the systems. Note, salt-marsh vegetation can occur further than 500 m away at a number of the larger estuaries, such as the Olifants, Berg, Goukou and Klein Brak. Most estuarine-associated biota occur under the 5 m contour, as this is as far as the influence of the ocean can be detected on land.
- Temporarily open/closed estuaries (75% of South African estuaries) can close at levels of between 2.5 and 4.5 m. The 5 m contour allows for water-level increases due to back-flooding under closed mouth conditions or wave action from wind;
- In most cases, the 5 m contour allows for the inclusion of a buffer zone of terrestrial vegetation that represents the transition between terrestrial and coastal ecosystems.
- The 5 m contour should provide a buffer zone that can allow an estuary to retreat in the future in the event of sea-level rise due to climate change. It also allows for the inclusion of some terrestrial fringe vegetation that contribute detritus to the system and refuge areas during floods;
- An accurate delineation of the high-water mark is not available for the entire South African coastline;
- Flood lines (1:50/1:100) for estuaries are often inaccurately determined under open mouth conditions, which leads to underestimation of flood heights. In the absence of long-term berm height data (which can vary substantially under different climatic conditions) the 5 m contour provides the best protection against natural hazards such as floods and storms.

- The 5 m contour minimises the risk of pollution to estuaries. Septic tanks are sunk about 2 m into the ground. During closed mouth conditions (and very high tides) density differences between fresh and salt water causes drainage problems or infrastructure damages if tanks are not situated not above the 5 m contour.
- As water resources development and land-use change in the catchment can lead to the changes in mouth behaviour, i.e. change estuary type from permanently open to temporarily open, e.g. Uilkraals, this level is taken as the default for all systems in South Africa;
- The 5 m contour data is available from Chief Directorate: Surveys & Mapping, Mowbray, as a GIS layer or on black-and-white 1:10 000 orthographic maps. More detailed data are not available on a national scale.

For all the above mentioned reasons it should be clear that in some cases, the estuarine functional zone goes beyond the 5 m contour, for one or more of the following reasons:

- In deeply incised floodplains, where the river/estuary bed may be metres below the mapped floodplain area, tidal action and/or back-flooding may be detected further upstream than indicated by the 5 m contour as indicated on the topographical map. This is an artefact of the mapping process and may need site-specific data to correct.
- For some narrow, deeply incised estuaries with very large catchments the 1: 10 year flood line maybe above the 5 m contour (little floodplain area versus significant flood volume), e.g. Mzimkulu. In such cases it is recommended that a detail topographical survey be conducted and a flood line estimate be done following engineering principals to demarcate more dynamic areas and indicate flood risk on a more local scale.
- The littoral active zones adjacent to an estuary can stretch beyond the 5 m contour, e.g. dune field next to Duiwenhoks and Sundays, and should be incorporate in the estuarine functional zone in site-specific cases.

(Van Niekerk & Turpie 2012)
http://bgis.sanbi.org/estuaries/project.asp

APPENDIX 2: Water quality monitoring

Laboratory analyses funded by BOCMA.
Results expressed as counts per 100 ml water sample.

Site	River opp restaurant		Lagoon from beach	
Date	Enterococci	E. coli	Enterococci	E.coli
14-03-13	0	178	0	91
21-02-13	480	26	6	26
31-01-13	720	240	290	16
10-01-13	370	1414	1540	152
12-12-12	0	365	34	291
22-11-12	45	62	0	63
01-11-12	510	172	140	46
11-10-12	109	99	127	147
13-09-12	76	104	0	276
23-08-12	52	>1000	78	>1000
02-08-12	220	353	530	164
12-07-12	50	116	90	248
21-06-12	950	1734	770	1203
31-05-12	540	88	280	90
03-05-12	6300	83	4900	80
10-04-12	1300	1000	1900	650
15-03-12	0	61	110	130
16-02-12	0	43	0	67
26-01-12	0	49	0	29
04-01-12	100	0	0	18
15-12-11	500	60	600	15
23-11-11	20 000	128	25 000	25
03-11-11	0	2700	0	6000
13-10-11	0	63	0	62
22-09-11	0	108	0	45
31-08-11	0	1130	0	2100
11-08-11	0	700	0	200
20-07-11	0	0	0	0
30-06-11	0	1100	0	800
02-06-11	500	>3000	910	>3000
05-05-11	670	500	930	700

	New lab contract			
17-03-11	126	230	330	370
24-02-11	530	550	500	720
03-02-11	380	760	44	53
13-01-11	90	10	30	66
23-12-10	300	600	8	4500
02-12-10	630	260	350	49

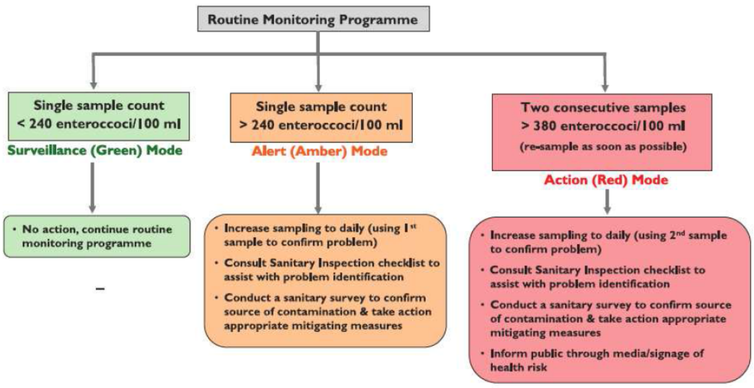
SOUTH AFRICAN WATER QUALITY GUIDELINES FOR COASTAL MARINE WATERS
VOLUME 2: GUIDELINES FOR RECREATIONAL USE

Risk -based ranges for intestinal enterococci and E. coli (microbiological indicator organisms) :

CATEGORY	*ESTIMATED RISK PER EXPOSURE*	*ENTEROCOCCI (Count per 100 ml)*	*E. coli (Count per 100 ml)*
Excellent	*2.9% gastrointestinal (GI) illness risk*	*≤ 100 (95 percentile)*	*≤ 250 (95 percentile)*
Good	*5% GI illness risk*	*≤ 200 (95percentile)*	*≤ 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)*

Proposed Operational Management System:

A proposed operational management process for South Africa is illustrated below:



(Department of Environment Affairs 2012)

APPENDIX 3: Birds of Onrus Lagoon

Species list for water-associated birds. CR = common resident; UCR = uncommon resident; CV = common vagrant; CSV = common summer visitor (courtesy of Mike Ford & Lee Burman)

New Roberts	Common Name	Species Name	Status	Comments
8	Little Grebe (Dabchick)	*Tachybaptus ruficolis*	CR	
55	White-breasted Cormorant	*Phalacrocorax carbo*	CR	
56	Cape Cormorant	*Phalacrocorax capensis*	CR	Day roosts on rocks at the mouth
58	Reed Cormorant	*Phalacrocorax africana*	CR	
60	African Darter	*Anhinga melanogaster*	UCR	Occasional visits to fish
62	Grey Heron	*Ardea cinerea*	CR	
65	Purple Heron	*Ardea purpurea*	UCR	Occasional visits to fish
67	Little Egret	*Egretta garzetta*	CR	Regular visits to fish
76	Black-crowned Night Heron	*Nycticorax nycticorax*	UCR	Roosts in the reeds
78	Little Bittern	*Ixobrychus minutus*	UCR	Roosts in the reeds
91	African Sacred Ibis	*Threskiornis aethiopicus*	CR	Forages at inner end of lagoon edges
94	Hadeda Ibis	*Bostrygia hagedash*	CR	Forages on grasslands at inner end
102	Egyptian Goose	*Alopochen aegyptiacus*	CR	Roosts in trees along edges
104	Yellow-billed Duck	*Anas undulata*	CR	
105	African Black Duck	*Anas sparsa*	UCR	Occasional visitor to the inner end
106	Cape Teal	*Anas capensis*	CR	Occasional visitor to the inner end
112	Cape Shoveller	*Anas smithii*	CR	Regular visitor to the inner end
	Mallard (and Hybrids)	*Anas platyrhynchos*	CV	Mixes and hybridises with Yellow-billed Ducks
210	African Rail	*Rallus caerulescens*	UCR	More often heard than seen in the reeds
213	Black Crake	*Amaurornis flavirostris*	UCR	More often heard than seen in the reeds
223	Purple Swamphen (Gallinule)	*Porphyrio porphyrio*	UCR	Skulks along the edges of the reeds
226	Common Moorhen	*Gallinula chloropus*	CR	Skulks along the edges of the reeds

228	Red-knobbed Coot	*Fulica cristata*	CR	Breeds at the inner end
246	White-fronted Plover	*Charadrius marginatus*	CR	Found on the rocks at the mouth
249	Three-banded Plover	*Charadrius tricollaris*	CR	Forages along water edges
258	Blacksmith Lapwing (Plover)	*Vanelius armatus*	CR	
298	Water Thick-knee (Water Dikkop)	*Burhinus vermiculatus*	UCR	Day roosts among reed edges
312	Kelp Gull Southern Black-backed)	*Larus Dominicanus*	CR	Looking for scraps on the beach area
316	Hartlaub's Gull	*Larus hartlaubii*	CR	Looking for scraps on the beach area
428	Pied Kingfisher	*Ceryle rudis*	CR	Hover-hunts along the lagoon
431	Malachite Kingfisher	*Alcedo cristata*	UCR	Perch-hunts from a bent reed
518	Barn Swallow (European Swallow)	*Hirundo rustica*	CSV	Night-roosts in the reeds
520	White-throated Swallow	*Hirundo albigularis*	CSV	Hawks insects over the water
533	Brown-throated Martin (African Sand-martin)	*Riparia paludicola*	CR	Hawks insects over the water
631	African Reed-warbler (African Marsh-warbler)	*Acrocephalus baeticatus*	CSV	More often heard than seen in the reeds
635	Lesser Swamp-warbler (Cape Reed Warbler)	*Acrocephalus gracilirostris*	CR	More often heard than seen in the reeds
638	Little Rush-warbler (African Sedge-warbler)	*Bradypterus babeocala*	UCR	More often heard than seen in the reeds
677	Le Vaillant's Cisticola	*Cisticola tinniens*	CR	Noisy and restless in the reeds
713	Cape Wagtail	*Motacilla capensis*	CR	Forages along water edges
757	Common Starling	*Sturnus vulgaris*	CR	Night-roosts in the reeds
813	Cape Weaver	*Ploceus capensis*	CR	Breeds and night-roosts in the reeds
824	Southern Red Bishop	*Euplectes orix*	CR	Breeds and night-roosts in the reeds
827	Yellow Bishop (Yellow-rumped Widow)	*Euplectes capensis*	CR	Forages amongst the reeds
846	Common Waxbill	*Estrilda astrild*	CR	Small flocks forage in the reeds

6.2 Costing for rehabilitation methods

ESTIMATED CONSTRUCTION COST						**STEELE CONSULTING**
ONRUS LAGOON REHABILITATION						**18 NOVEMBER 2002**
	COSTING					
	Costs have been estimated and computed for four					
	different rehabilitation methods viz.					
	Rehabilitation Method 1	- Dredger to on-land dumpsite				
	Rehabilitation Method 2	- Dredger to sea				
	Rehabilitation Method 3	- Excavation and trucks to on-land dumpsite				
	Rehabilitation Method 4	- Combination of dredger and trucks to on-land dumpsite				
	Each method has two scopes of work options costed - option (i) the removal of					
	reeds and 35 000m3 of sedimentation and option (ii) the removal of reeds and					
	75 000m3 of sedimentation					
	The programme of the commencement and completion of construction has been					
	assumed as follows:-					
	Commence construction	- Winter 2004 (probably April)				
	Construction period	- Option (i) - 3,5 months				
		- Option (ii) - 5 months				

	REHABILITATION METHOD 1				OPTION 1	OPTION 2
	Dredger to on-land dumpsite				**35 000M3**	**75 000M3**
	ELEMENT					
1.1	Fixed P&G					
	- site establishment				120 000	120 000
	- dredger establishment				180 000	180 000
	- de-establish dredger				180 000	180 000
1.2	Time related P&G					
	- 3,5 months @ R120 000 per month				420 000	-
	- 5 months @ R120 000 per month				-	600 000
2.	Burn reeds				25 000	50 000
3.	Dredge sedimentation material					
	- 35 000m3 @ R26,00				910 000	-
	75 000m3 @ R26,00				-	1 950 000
4.	Booster pump station to pump line					
	- 35 000m3 @ R14,00				490 000	-
	- 75 000m3 @ R14,00				-	1 050 000
5.	Construct No. 3 earth dams from in-situ material					
	- construct dams 50 000m3 @ R8,00				400 000	-

	- connecting pipes between dams				40 000	-
	- waterproof liner to dams				200 000	-
	- maintenance of dams				25 000	-
	- spread and level dams at completion					
	35 000m3 @ R5,00				175 000	-
	- construct dams 110 000m3 @ R8,00				-	880 000
	- connecting pipes between dams				-	50 000
	- waterproof liner to dams				-	400 000
	- maintenance of dams				-	50 000
	- spread and level dams at completion					
	75 000m3 @ R5,00				-	375 000
6.	Maintain spit				30 000	30 000
7.	Professional services - fees					
	- Environmentalist					
	environmental management plan (EMP)				30 000	30 000
	environmental control officer (ECO)					
	- 3,5 months @ R10 000 per month				35 000	-
	- 5 months @ R10 000 per month				-	50 000
	- Project Manager					
	- 3,5 months @ R10 000 per month				35 000	-
	- 5 months @ R10 000 per month				-	50 000

	- Quantity Surveyor					
	- tender documents				65 000	120 000
	- contract administration					
	- 3,5 months @ R10 000 per month				35 000	-
	- 5 months @ R10 000 per month				-	50 000
	- Consulting Engineer (for ad hoc design methods and					
	specifications)				20 000	20 000
	Sub-total				3 415 000	6 235 000
	Escalation (based on BER Building Cost Index)					
	November 2002 - June 2004 - 8%				273 000	499 000
	Sub-total				3 688 000	6 734 000
	Add: VAT				516 320	942 760
	TOTAL EXPENDITURE				**4 204 320**	**7 676 760**

	REHABILITATION METHOD 2				**OPTION 1**	**OPTION 2**
	Dredger to sea				**35 000M3**	**75 000M3**
	ELEMENT					
1.1	Fixed P&G					
	- site establishment				120 000	120 000
	- dredger establishment				180 000	180 000
	- de-establish dredger				180 000	180 000
1.2	Time related P&G					
	- 3 months @ R120 000 per month				360 000	-
	- 4,5 months @ R120 000 per month				-	540 000
2.	Burn reeds				25 000	50 000
3.	Dredge sedimentation material					
	- 35 000m3 @ R26,00				910 000	-
	75 000m3 @ R26,00				-	1 950 000
4.	Collect and cart away reeds deposited on beach					
	to dumpsite					
	- 9 000m3 @ R17,00				153 000	-
	- 19 000m3 @ R17,00				-	323 000
5.	Minor works to haul road for reeds disposal				50 000	50 000
6.	Maintain spit				30 000	30 000

7.	Professional services - fees					
	- Environmentalist					
	environmental management plan (EMP)				30 000	30 000
	environmental control officer (ECO)					
	- 3 months @ R10 000 per month				30 000	-
	- 4,5 months @ R10 000 per month				-	45 000
	- Project Manager					
	- 3 months @ R10 000 per month				30 000	-
	- 4,5 months @ R10 000 per month				-	45 000
	- Quantity Surveyor					
	- tender documents				40 000	69 000
	- contract administration					
	- 3 months @ R10 000 per month				30 000	-
	- 4,5 months @ R10 000 per month				-	45 000
	- Consulting Engineer (for ad hoc design methods and					
	specifications)				20 000	20 000
	Sub-total				2 188 000	3 677 000
	Escalation (based on BER Building Cost Index information)					
	November 2002 - June 2004 - 8%				175 000	294 000
	Sub-total				2 363 000	3 971 000
	Add: VAT				330 820	555 940
	TOTAL EXPENDITURE				**2 693 820**	**4 526 940**

	REHABILITATION METHOD 3				**OPTION 1**	**OPTION 2**
	Excavator and trucks to on-land dumpsite				**35 000M3**	**75 000M3**
	ELEMENT					
1.1	Fixed P&G					
	- site establishment				120 000	120 000
1.2	Time related P&G					
	- 3,5 months @ R80 000 per month				280 000	-
	- 5 months @ R80 000 per month				-	400 000
2.	Burn reeds				25 000	50 000
3.	Excavate sedimentation material					
	- 35 000m3 @ R18,00				630 000	-
	75 000m3 @ R18,00				-	1 350 000
4.	Construct and maintain working platform				400 000	800 000
5.	Pumping and de-watering (to sea)				200 000	400 000
6.	Construct haul road				480 000	480 000
7.	Maintain spit				30 000	30 000
8.	Professional services - fees					
	- Environmentalist					
	environmental management plan (EMP)				30 000	30 000

	environmental control officer (ECO)					
	- 3,5 months @ R10 000 per month				35 000	-
	- 5 months @ R10 000 per month				-	50 000
	- Project Manager					
	- 3,5 months @ R10 000 per month				35 000	-
	- 5 months @ R10 000 per month				-	50 000
	- Quantity Surveyor					
	- tender documents				44 000	73 000
	- contract administration					
	- 3,5 months @ R10 000 per month				35 000	-
	- 5 months @ R10 000 per month				-	50 000
	- Consulting Engineer (for ad hoc design methods and					
	specifications)				40 000	40 000
	Sub-total				2 384 000	3 923 000
	Escalation (based on BER Building Cost Index information)					
	November 2002 - June 2004 - 8%				191 000	314 000
	Sub-total				2 575 000	4 237 000
	Add: VAT				360 500	593 180
	TOTAL EXPENDITURE				**2 935 500**	**4 830 180**

	REHABILITATION METHOD 4				**OPTION 1**	**OPTION 2**
	Combination of dredger and trucks to on-land dumpsite				**35 000M3**	**75 000M3**
	ELEMENT					
1.1	Fixed P&G					
	- site establishment				120 000	120 000
	- dredger establishment				180 000	180 000
	- de-establish dredger				180 000	180 000
1.2	Time related P&G					
	- 3,5 months @ R120 000 per month				420 000	-
	- 5 months @ R120 000 per month				-	600 000
2.	Burn reeds				25 000	50 000
3.	Dredge sedimentation material					
	- 35 000m3 @ R26,00				910 000	-
	75 000m3 @ R26,00				-	1 950 000
4.	Construct small holding dam adjacent dredger				300 000	500 000
5.	Construct haul road				480 000	480 000
6.	Truck dredged material to dumpsite and spread and level					
	- 35 000m3 @ R12,00				420 000	-

	75 000m3 @ R12,00				-	900 000
7.	Maintain spit				30 000	30 000
8.	Professional services - fees					
	- Environmentalist					
	environmental management plan (EMP)				30 000	30 000
	environmental control officer (ECO)					
	- 3,5 months @ R10 000 per month				35 000	-
	- 5 months @ R10 000 per month				-	50 000
	- Project Manager					
	- 3,5 months @ R10 000 per month				35 000	-
	- 5 months @ R10 000 per month				-	50 000
	- Quantity Surveyor					
	- tender documents				62 000	100 000
	- contract administration					
	- 3,5 months @ R10 000 per month				35 000	-
	- 5 months @ R10 000 per month				-	50 000
	- Consulting Engineer (for ad hoc design methods and					
	specifications)				40 000	40 000
	Sub-total				3 302 000	5 310 000
	Escalation (based on BER Building Cost Index information)					
	November 2002 - June 2004 - 8%				264 000	425 000
	Sub-total				3 566 000	5 735 000
	Add: VAT				499 240	802 900

	TOTAL EXPENDITURE				**4 065 240**	**6 537 900**

6.3 Stakeholder database

Civil society (to be updated – list to include all I&AP)		
Government representatives		
Nicolette Botha-Guthrie	Overstrand Mayor	nbotha-guthrie@overstrand.gov.za
Elzette Nell	Ward Councillor	lz@hermanus.co.za
Xola Mkefe	Dept Environmental Affairs - Estuaries	xmkefe@environment.gov.za
Nompumelelo Thwala	Dept Environmental Affairs - Estuaries	nthwala@environment.gov.za
Vuyo Madlokazi	Dept Environmental Affairs - Estuaries	nmadlokazi@environment.gov.za
Steven Lamberth	Dept Fisheries (DAFF)	stephenL@daff.gov.za
Gerhard Cilliers	Dept Water Affairs	cilliersG@dwa.gov.za
Makwarela Matshili	DEADP: Coastal Management	makwarela.matshili@pgwc.gov.za
Gunther Frantz	DEADP: Pollution Management	gunther.frantz@pgwc.gov.za
Patrick van Coller	BOCMA	pcoller@bocma.co.za
Fabion Smith	BOCMA	fsmith@bocma.co.za
Pierre de Villiers	Cape Nature	estuaries@capenature.co.za
Alexis Old	Cape Nature	aolds@capenature.co.za
Tierck Hoekstra	Cape Nature	tierck@capenature.co.za
Andrae Marais	Cape Nature	andrae@capenature.co.za
Rulien Volschenk	Overberg District Municipality	rvolschenk@odm.org.za
Melt Carstens	Overberg District Municipality	mcarstens@odm.org.za