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Mouth Management Plan

Verlorenvlei Estuary

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ABBREVIATIONS

CapeNature	Western Cape Nature Conservation Board
CWAC	Co-ordinated Waterbird Counts
DAFF	Department of Agriculture, Forestry and Fisheries
DEA&DP	Western Cape Government's Department of Environmental Affairs & Development Planning
DWS	Department of Water and Sanitation
EIA	Environmental Impact Assessment
EMP	Estuary Management Plan
ha	Hectare
IBA	Important Bird and Biodiversity Area
MaintMP	Maintenance Management Plan
MAR	mean annual runoff
MMP	Mouth Management Plan
MSL	mean sea level
NEMA	National Environmental Management Act (Act No. 107 of 1998)
RDM	Resource Directed Measures

1 OBJECTIVE OF THE VERLORENVLEI MOUTH MANAGEMENT PLAN (MMP)

STATEMENT OF THE PROBLEM

The Verlorenvlei Estuary is nearly permanently closed. It only breaches to the sea during periods of high inflow. During the closed phase, under high inflow conditions, water backfloods into the wetlands downstream of Redelinghuys, inundating grazing land and prompting requests for premature breaching of Verlorenvlei.

Resultant lower water levels, together with nutrient enrichment causes eutrophication in the form of phytoplankton algal blooms (green or brown water column), excessive reed growth around the edges and/or submerged macrophyte growth. Phytoplankton algal blooms depletes oxygen and stress fish, while reed growth at the low water bridge increase risk of flooding.

OBJECTIVE OF THE VERLORENVLEI MOUTH MANAGEMENT PLAN

1) **Management of the estuary mouth as an integral part of the Verlorenvlei Estuary Management Plan (EMP).**
2) **Managing the Verlorenvlei Estuary mouth to optimally support estuary functioning.**

IS ARTIFICIAL BREACHING TO BE CONSIDERED AT THE VERLORENVLEI ESTUARY? (Motivation provided in section 3)	**No**	**Yes**
High water levels	✘	
Emergency: Floods	✘	
Emergency: Water quality	✘	
Emergency: Fish Kills		✘
IS A MAINTENANCE MANAGEMENT PLAN (MaintMP) REQUIRED? **(I.e. a formal approval for on-going active management of the mouth from the relevant authority)**	**No**	

KEY DATA /INFORMATION SOURCES

There is little reliable and consistent information available on the physical processes of the Verlorenvlei, i.e. Historical mouth conditions, flow data, accurate bathymetry / volume data. This lack of data could lead to an over, or under estimation, of the historical mouth conditions and a clear understanding of the present state. Fortunately, water level recordings were obtained from the DWS for the period 1993 till 2019 and these provide important information.

Information in this MMP was sourced from local residents, the 2018 Verlorenvlei Ramsar list data sheet, BirdLife South Africa and scientific literature addressing various aspects of the biophysical functioning of the estuary.

This study assumes that at present there is no, to very little, flow in summer. However, more detailed work needs to be done on the hydrology to confirm the current status quo. If verified, ways should be explored to re-establish open mouth conditions during this period.

KEY RECOMMENDATIONS IN SUPPORT OF THE VERLORENVLEI ESTUARY MOUTH MANAGEMENT PLAN

In 2003 a preliminary reserve determination study was conducted on Verlorenvlei as part of the larger Sandveld Reserve Project (DWAF 2003). This study provided a very cursory estimate of the present health of the vlei. The study found Verlorenvlei to be moderately modified (Category C). A number of the assumptions made in the assessment did not appear to reflect the true state of affairs, e.g. the reduction in seasonal inflows was estimated to be 60% and the total recharge abstracted was about 90%, but the frequency of natural opening only changed by 20%. This seems to be far too conservative an assumption based on a volumetric analysis of a Natural Mean Annual Runoff (MAR) of 100 X 10^6 m^3. Based on the natural MAR open mouth conditions should have been much more frequent and for longer periods under the reference conditions. Changes in water levels and mouth conditions drive most of the other physical and ecological features of the system such as nutrient cycling, salinity, micro-algal blooms, growth of emergent and submerged vegetation, invertebrate and fish recruitment from sea, nursery function, and bird abundance. Therefore, most of the components evaluated as part of the Sandveld study would show a further reduction in health if the scores for the mouth state were adjusted.

The Verlorenvlei MMP may require revision if the impact of flow reduction is more severe than currently estimated assumed. The following information needs to be collected to refine the Verlorenvlei MMP:

- **A low flow gauge needs to be installed near the head of the estuary to verify the current inflow to the system.**
- **A detailed hydrological study is required to estimate the current inflow and ground water contribution versus the natural condition.**
- **An Estuarine Ecological Water Allocation based on the Official Department of Water and Sanitation (DWS) Estuary Ecological Water Requirement methods (DWAF 2008) needs to be provided to this system to ensure an open mouth state.**

KEY LEGISLATION RELEVANT TO THIS MOUTH MANAGEMENT PLAN

According to the National Environmental Management Act (No. 107 of 1998) ("NEMA"), viz, the Environmental Impact Assessment (EIA) Regulations 2014 (Government Notice

No. R. 326, R 327, R. 325 and R. 324 in Government Gazette No. 40772 of 7 April 2017), the following activities may not commence without an environmental authorisation from the competent authority:

The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock from:

- **I. the seashore;**
- **II. the littoral active zone, an estuary or a distance of 100 metres inland of the high-water mark of the sea or an estuary, whichever distance is the greater; or**
- **III. the sea.**

but excluding where such infilling, depositing, dredging, excavation, removal or moving

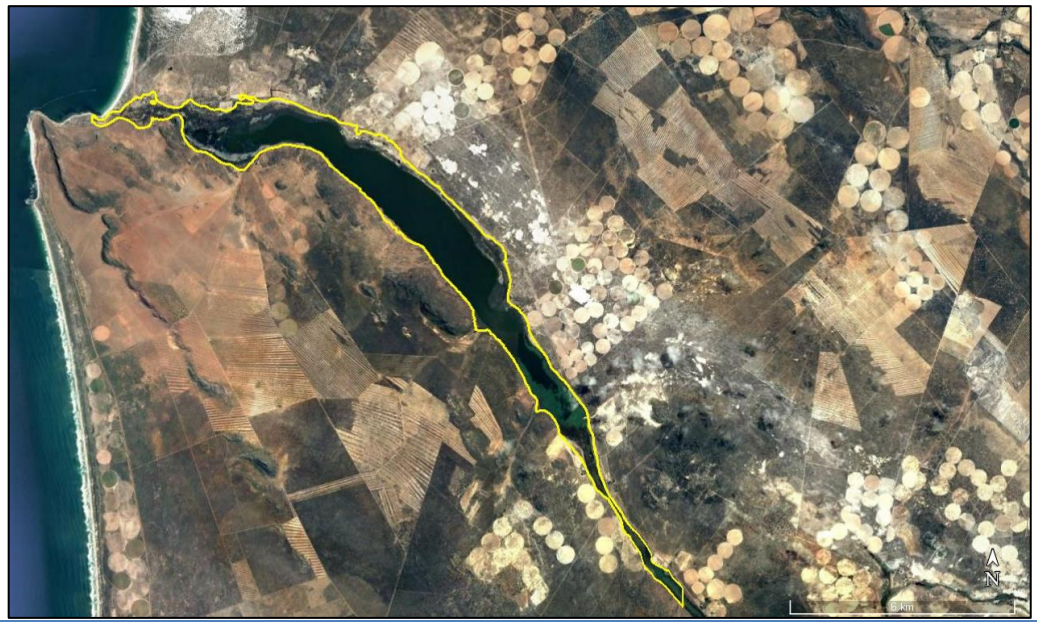
- **IV. occurs behind the development setback line.**
- **V. is for maintenance purposes undertaken in accordance with a management plan agreed to by the relevant environmental authority; or**
- **VI. falls within the ambit of activity 21 in this Notice, in which case that activity applies; occurs within existing ports or harbours that will not increase the development footprint of the port or harbour; or where such development is related to the development of a port or harbour, in which case Activity 26 in Listing Notice 2 of 2014 applies**

[Listing Notice 1, Activity Number 18]

This *Mouth Management Plan* (MMP) would serve to support a formal application for authorisation to implement the interventions recommended in terms of the need for ecosystem maintenance in the form of a *Maintenance Management Plan (MaintMP)*. It is recommended that such authorisation be limited to a five-year period, at the end of which the MMP should be subject to specialist review before being re-submitted for approval by the competent authority prior to the MaintMP lapsing.

2 DESCRIPTION OF THE VERLORENVLEI ESTUARY

Table 1: Description of the estuary and its importance

Aspect	Discussion
Location	Verlorenvlei extends between the West Coast villages of Elands Bay and Redelinghuys and when the mouth is open outflow occurs into Elands Bay in the Atlantic Ocean approximately 25 km south of Lambert's Bay, the nearest sizeable town. Verlorenvlei is one of the largest estuarine lakes in South Africa and is one of the country's few coastal freshwater lakes. **Downstream boundary:** Estuary mouth (32°18'58.34"S, 18°20'5.96"E) **Upstream boundary:** Head of the estuary (32°25'55.82"S, 18°29'57.78"E) **Lateral boundaries:** Estuary Functional Zone (~5m above mean sea level (MSL)) 
Estuary Importance	The Estuary is a large estuarine lake system. The estuary is an "Important estuary from a biodiversity perspective" (Importance rating score = 72) (Turpie and Clark 2007, Van Niekerk et al. 2012).
Conservation status	Verlorenvlei is a proclaimed a Ramsar site (No. 525) and the vlei itself is owned by the state. The Verlorenvlei estuary, however, does not have any statutory protection; it is, however. included in the subset of estuaries identified as requiring protection in order to conserve South Africa's estuarine biodiversity estate in the National Estuary Biodiversity Plan (Van Niekerk et al. 2012).
Important vegetation	Verlorenvlei exhibits a transition from salt tolerant species near the mouth to freshwater species further inland. More salt tolerant species include: *Sarcocornia natalensis, Scirpus maritimus* and *Juncus kraussi.* Extensive beds of emergent aquatic macrophytes occur along the margins of the vlei with *Phragmites australis*, *Typha latifolia* and sedges as dominants. Downstream of Redelinghuys there are fairly wide and open wetlands with patches of mixed sedges and reed communities along the course of the Verlorenvlei River over a distance of 11km. Dense reedbeds are present in the upper part of the lake. There has been a substantial increase in *Typha* and *Phragmites* growth especially in the lower and upper reaches of Verlorenvlei since the 1930s. During the late 1980s *Myriophyllum spicatum*, a submerged macrophyte, dominated large areas of the lake where the water is less than 2m deep. This submerged macrophyte was not present during the 2003 Sandveld study (DWAF 2003) nor during a 2008 field visit (personal observation), but has since been observed in 2012, and possibly again in 2016. The reason for the switch between macrophytes and microalgal blooms was not clear and is something that needs further investigation.

Aspect	Discussion
	The water lily, (*Nymphaea capensis*), a species which is becoming rare in South Africa as a result of wetland destruction, occurs in small numbers in the system.
Important fish nursery	The Ramsar Information Sheet, updated in 2018, indicates the following: A total of 14 fish species from 9 families has been recorded from Verlorenvlei and a further two are expected to occur (Harrison et al. 2000, Sinclair et al. 1986, Robertson 1980, Poggenpoel 1996, DWAF 2003). Four (25%) of these are entirely dependent on estuaries to complete their lifecycles. One, the estuarine round-herring *Gilchristella aestuaria*, breeds and spends its entire lifecycle in the estuarine environment whereas three, the white steenbras *Lithognathus lithognathus*, flathead mullet *Mugil cephalus* and freshwater mullet *Myxus capensis* are dependent on estuaries as nursery areas for at least their first year of life. In addition, *Myxus capensis* and to a lesser extent, *Mugil cephalus* are facultative catadromous species that require estuaries as transit routes between the marine and freshwater environment. A further three (19%) species namely the harder *Liza richardsonii*, white stumpnose *Rhabdosargus globiceps* and Knysna sand-goby *Psammogobius knysnaensis* are at least partially dependent on estuaries. In all, 44% of the fish species recorded, or expected to occur, in Verlorenvlei can be regarded as either partially or completely dependent on estuaries for their survival. All 9 (66%) of the remaining species are euryhaline freshwater species whose penetration into estuaries is determined by salinity tolerance. Three of these, the Cape galaxias *Galaxias Zebratus*, Cape kurper *Sandelia capensis* and the recently described Verlorenvlei redfin *Pseudobarbus verloreni* are endemic to the south-western Cape (CSIR 2009, Chakona, Swartz & Skelton, 2014). Six, the Mozambique Tilapia *Oreochromis mossambicus*, carp *Cyprinus carpio*, banded tilapia *Tilapia sparrmanii*, smallmouth bass *Micropterus dolomieu*, largemouth bass *Micropterus salmoides* and tench *Tinca tinca,* are introduced species. (CSIR 2009). Six (38%) of the estuarine fish and three (1 %), of the freshwater fish recorded in Verlorenvlei, are South African or south-western Cape endemics. Verlorenvlei represents about 30% of the available habitat to estuarine fish on the west coast (Lamberth and Turpie 2003).
Important Bird site	Verlorenvlei is regarded as one of the ten most important wetlands for wading birds in the south-western Cape, being a particularly important feeding area for the Great White Pelican and supporting a number of threatened bird species. Information collated by Birdlife South Africa (2019) indicates: Verlorenvlei supports more than 189 bird species, of which 75 are waterbirds. The wetland occasionally hosts more than 4 000 birds; the highest number recorded in a single count was 11 891, according to the data from counts undertaken by CapeNature since 1990. At least 26% of the Western Cape's Great White Pelican *Pelecanus onocrotalus* population congregates at this site at times. Greater Flamingo *Phoenicopterus roseus* and Lesser Flamingo *Phoeniconaias minor* (Near Threatened) also occur here occasionally, when conditions at Rocher Pan (35 km south) or Wadrifsoutpan (13 km north) are unsuitable or water levels in the lake are very low, as occurred in the 2004–2005 season. Relatively large numbers of Little Bittern *Ixobrychus minutus* and Caspian Tern *Sterna caspia* occur regularly in the wetland. Historically an important moulting ground and summer refuge for Anatidae (swimming ducks), the area supported large numbers of Yellow-billed Duck *Anas undulata*, Cape Shoveler *A. smithii* and South African Shelduck *Tadorna cana*. However, many of these species have declined over the past decades, as data from CapeNature illustrate. Large numbers of Great Crested Grebe *Podiceps cristatus*, Red-knobbed Coot *Fulica cristata* and White-breasted Cormorant *Phalacrocorax lucidus* can also be found at this wetland. There is a high density of African Marsh Harrier *Circus ranivorus*, which forages over the

Aspect	Discussion
	marsh and reedbed areas. Black Stork *Ciconia nigra* breeding in the Olifantsrivierberge and Swartberge to the east and Piketberge to the south very occasionally forages in the vlei. The site also holds 4–5 pairs of African Fish Eagle *Haliaeetus vocifer*, and Verreauxs' Eagle *Aquila verreauxii* occurs on the cliffs around the vlei. African Black Oystercatcher *Haematopus moquini* and Chestnut-banded Plover *Charadrius pallidus* (Near Threatened) are recorded at the estuary mouth from time to time. The palustrine habitats are diverse and rich and hold populations of secretive Rallidae such as African Rail *Rallus caerulescens* and Baillon's Crake *Porzana pusilla*. Red-chested Flufftail *Sarothrura rufa* may occur, but has not been confirmed. Rallid species are particularly abundant between Matjiesgoeddrif and Redelinghuys, where the composition and structure of the palustrine vegetation are diverse and the area has extensive and excellent habitat for them and for waders. The diverse ecotonal terrestrial vegetation around Verlorenvlei's fringes supports several biome-restricted assemblage species. In recent years, a pair of Goliath Herons seems to have been resident in the area and may be breeding. The Important Bird and Biodiversity Area (IBA) centred on Verlorenvlei hosts more than 1% of the biogeographic population of Great Crested Grebe (maximum 140 individuals), South African Shelduck (maximum 489 individuals), Pied Avocet *Recurvirostra avosetta* (maximum 1 256 individuals), Hartlaub's Gull *Chroicocephalus hartlaubii* (maximum 377 individuals), Caspian Tern (maximum 34 individuals), Great White Pelican (maximum 478 individuals), White-breasted Cormorant (population regularly exceeds 130 individuals), Kelp Gull *Larus dominicanus* (population exceeded 700 individuals on two counts), Greater Flamingo (population exceeded 750 individuals on one count) and Whiskered Tern *Chlidonias hybrida* (population exceeded 85 individuals on one count). The site also supports more than 0.5% of the population of Lesser Flamingo (maximum 320 individuals), Egyptian Goose *Alopochen aegyptiaca* (maximum 2 041 individuals) and Red-knobbed Coot (maximum 3 104 individuals).
Estuary Condition w.r.t breaching	To assist in the development of an Estuary Management Plan for Verlorenvlei a provisional health rapid level assessment was done following the Estuarine Resource Directed Measures (RDM) methodology developed for determining the Ecological Water Requirements of an estuary (DWAF 2008). Verlorenvlei is currently in a "Moderately to largely modified state", i.e. Category C/D. The degradation of the system's health is largely attributed to: • Significant reduction in the freshwater inflow (ground- and surface water) to the system; • A decrease in open mouth conditions (i.e. frequency and duration); • Increase in the nutrient and sediment load to the system; • Increased coverage by reeds and sedges; and • Changes in the species composition and abundance of fish in the system.
Recommended Ecological Condition	As the Verlorenvlei is a Ramsar site it should be in a much better condition, but it is highly unlikely that the flow reduction to the system can be alleviated easily and as this is the major driver for change in the system it was felt that the Best Attainable State is a moderately modified system (i.e. Category C). The provisional recommended ecological category for the Verlorenvlei, based on the present health state, estuarine importance and conservation importance is a C Category. It is very important that this provisional health rating of Verlorenvlei be confirmed by an Intermediate or Comprehensive level Estuarine Reserve (Ecological water requirement) study to determine its Estuarine Recommended Ecological Category with a confidence

Aspect	Discussion
	that would allow for decisive management actions. A high confidence reserve determination would also allow for stricter licensing and more decisive action form the relevant authorities regarding the necessary intervention required to increase the health of the system. An updated hydrological assessment of the combined impact of abstraction on surface and ground water resources is urgently needed to halt further decline in condition. **In the meantime, decisions and actions should follow a precautionary approach based on the existing evidence; evidence that confirms the estuary's ecological and social value, and the severity of the threats faced.**

3 MOTIVATION FOR ARTIFICIAL BREACHING

3.1 Surface Runoff and Groundwater

Noble and Hemens (1978) estimates the mean annual runoff at 102 x10^6 m^3. The Sandveld Reserve Study revised this estimate down to 89 x10^6 m^3 based on the WR90 model defaults (DWAF 2003). This does not take into account any direct contributions of groundwater into the system. No more detailed quantitative data are available (in spite of the Sandveld Reserve study). It is very important that the both the natural and present-day inflow to the system be quantified.

Groundwater provides an important source of freshwater to Verlorenvlei. Fresh groundwater (EC 30-70 mS/m) contributes to the river/wetland from the north. Two specific areas have very fresh groundwater and the exact source of this water is unknown, but is suspected to be deep groundwater flow from recharged groundwater up in the higher lying areas. The groundwater towards the south of the Verlorenvlei has an EC of between 100 and 200 mS/m. It is unknown if this water contributes to the water balance of the Verlorenvlei river. An estimated 12000 m^3d^{-1} groundwater is contributed to the Verlorenvlei G30E catchment (DWAF 2003).

The volume of groundwater abstracted for irrigation purposes was calculated for 1998, based on summer and winter Landsat5 images (DWAF 2003). The RDM study assumed that 95% of all irrigation water was abstracted from groundwater, with the remainder being abstracted from surface water. In summer an average irrigation rate is 1000mm/ha/season. In winter this rate reduces to 600 mm/ha/season. There are typically two potato-growing seasons per year. The satellite image classification involved the identification of centre pivot circles and then classifying them as: unvegetated (dry), cover crop or intensively irrigated.

The Resource Quality Objectives stipulated for the Sandveld Reserve study recommended that no additional users of the ground or surface water be permitted. It was further recommended that the lawfulness of the users in these areas be evaluated and illegal use of water should be stopped. A monitoring network to evaluate the seasonal impact of abstraction is in place and will assist in future to better quantify the impacts of the users of the resources (DWAF 2003).

Shifts in the nature and volumes of agricultural products in the catchment of the Verlorenvlei, such as a perceived move to irrigated citrus and grapes, should be investigated and quantified as part of the RDM.

3.2 Verlorenvlei Estuary Physical processes

The wetlands of the Verlorenvlei system are between 1 and 5 m above mean sea level. Its catchment is 1 900 km^2 and the surface area of the main water body is estimated to be 1 630 ha. The average depth of open water area of the lake is between 2 and 3 metres with maximum depth of 5 metres (Robertson 1980).

A small estuarine channel about 2.6 km long connects the lake to the sea. The entire channel is very shallow (about 0,5m deep), tending to inhibit free water exchange. During the dry summer months the mouth is usually closed by a sandbar overlying a rocky sill and the estuarine channel may be reduced to a few series of stagnant saline pools. The bar is formed by wave action and a south-going longshore current in combination with frequent onshore winds. When good rains provide sufficient water the lake and estuary fills and the bar is overtopped. The outflowing water scours the sandbar away thus permitting some tidal interaction.

Tidal exchange continues until the velocity of the outflowing water decrease sufficiently so as to allow the accretion of sand to form a new bar at the mouth. During storms and high spring tides the sea washes over the sandbar (Figure 1). Sea water is reported to penetrate as far as Verloren Farm (Robertson 1980).

Figure 1: Dried kelp wrack on inside of Verlorenvlei sand spit

There are four major obstructions to tidal exchange in the lower vlei: the sandbar at the mouth; a natural rocky sill; a partial causeway below the railway bridge and the road crossing to Elands Bay. In addition to the constrictions in the estuary there are also two causeways in the upper vlei at Grootddrift and Redelinghuys that also pose a constraint to flow.

Sandbar at the Mouth: The rocky barrier at the mouth (~1 m MSL) is covered by a 1 to 2 m thick sand layer (Figure 2). Since mean high tide is about 0.8 m MSL, overwash from the sea can only occur during high spring tides and storm surges. Evidence of overwash is clearly to be seen as dried kelp wracks on the sand spit near the mouth or decaying pieces of kelp in the lower mouth area (Figure 1). During a November 2008 field visit the mouth of the Verlorenvlei was open, but perched, with fresh water running strongly out to sea on the ebb tide and entering the estuary in a very limited manner on the flood tide, i.e. the mouth acted as a natural constriction to tidal flows.

Sandbar at the mouth of Verlorenvlei, November 2008

The rocky sill causing a natural obstruction to tidal exchange about 500m from the mouth

Railway bridge crossing

2015 Refurbishment of the road bridge culverts

Figure 2: The major obstructions to tidal exchange in Verlorenvlei

Rocky sill 500m from the mouth (Figure 2)***:*** This rock feature allows for free outflow of water from the vlei, but still acts as a natural obstruction to normal tidal flows. Seawater is only expected to penetrate beyond this point during high spring tides and storm surges. Although this rocky sill represents a hydraulic constriction to tidal flows it is deep enough to allow for the recruitment of invertebrates and fish into the system. This was demonstrated during a November 2008 field visit by the presence of the first recorded juvenile steenbras in Verlorenvlei since the 1970s.

***Railway bridge crossing*:** The railway bridge crossing is situated about 1 km from the current mouth position, and used to form part of the maintenance road that runs along the Sishen/Saldanha railway line (Figure 2). The road was raised 1 m above the river bed on a crude rubble and clay causeway until removal in 2012. It prevented a free connection to the vlei and reduced the nursery function of the system. The causeway was temporarily reinstated during 2015 as part of upgrade works on the main road crossing further upstream, but has since been removed.

Road crossing: The main road to Elands Bay from Dwarskersbos crosses the uppermost narrow section of the estuary channel (2.6 km upstream of the mouth) via a recently upgraded 275 m – long embankment about 2 m above the lake bed level. The 2014/15 road upgrades installed new box culverts which allow flow to pass through against the southern bank of the channel (Figure 2). Although this constriction does not pose a major constraint to flow under normal conditions, it does prevent normal circulation and, in the past, has contributed to the substantial vegetation growth in the lower vlei. The culverts also are a constriction under flood conditions and contribute to backflooding of adjacent land.

Grootdrift causeway: The causeway at Grootdrift hinders the natural meandering of the channel and flow in the upper vlei. The causeway only allows limited flow through 4 sets of culvert structures, retarding flow both up and downsteam (Figure 3). The main culvert in the main channel consists of 15 pipes (Figure 4). The result is more stagnant conditions and a related increase in sedimentation and vegetation growth. It is very important that an effort be made to increase the flow through the causeway.

Figure 3: Grootdrift causeway obstructing flow going upstream (photo is looking South) (21 August 2013) (Nick Taylor)

Figure 4: Main Grootdrift culvert structure (12 May 2016) (Photo: Charles Malherbe)

Redelinghuys causeway: Similar to the Grootdrift causeway, the Redelinghuys causeway also restricts flow and reduce free movement of water in the upper channels, resulting in sedimentation and increased vegetation growth in the upper Verlorenvlei. An effort should be made to increase the flow through the causeway.

3.3 Water levels

The relative water levels recorded at DWS gauging station DWS Gauge G3T001 from 1993 to 2019 are shown in Figure 5. Low water levels are shaded in red on the graphs. Note however that the recorder "bottoms out" and cannot record values below 0.

The highest water level on record was during the July 2008 flood, when Verlorenvlei was able to breach on its own. Measurements at the DWS gauge plate indicated that it was 3.284 m. A screenshot of the road bridge from 2008 Flood Video (N Taylor & F Strange) is shown in Figure 6.

Relative high water levels also occurred in 1996, 2006, 2013, and 2014. After the mouth was illegally artificially breached in 2014 the water level (as recorded at the DWS gauge) continued to rise for several days due to the construction works on Elands bay road bridge and the associated coffer dam. Water level continued to rise until 7th/8th September and only dropped below the 29th July level on 18th October 2014.

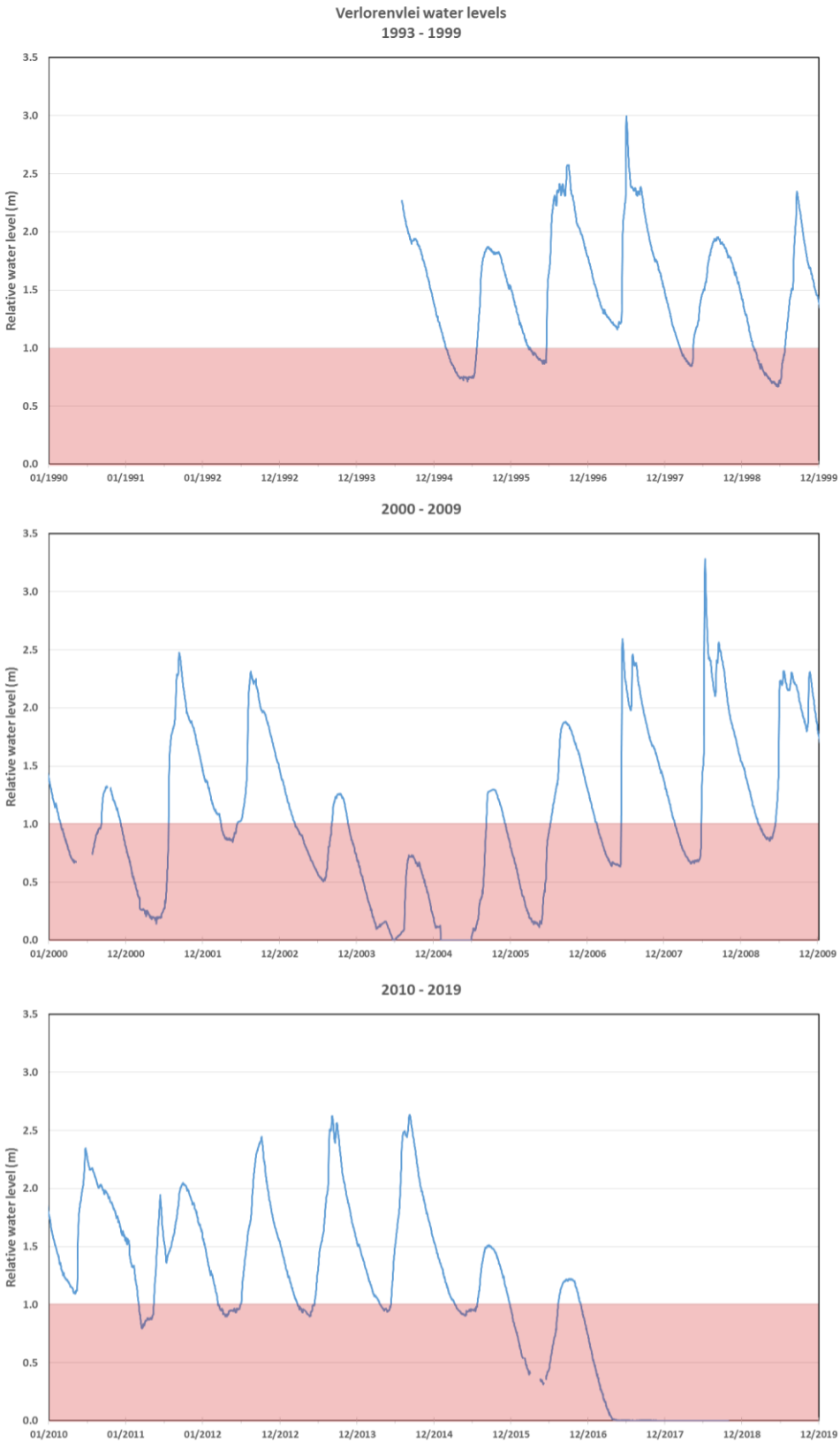


Figure 5: Relative water levels at DWS Gauge G3T001 for 1993 to 2019, with extremely low levels indicated by red shading. Note water level recorder does not record values less than 0 m.

Figure 6: High water levels observed near causeway on 11 July 2008 (Source: N Taylor).

More concerning is the increasing incidences of very low water levels in the vlei, with 2000, 2003, 2004, 2015, 2016 to 2019 being the lowest on record. Under these extremely low water Levels large parts of Verlorenvlei are dry at times (Figure 5 and 7).

Figure 7: Water levels observed near causeway on 11 July 2008 (Source: F Strange)

Lower water levels in turn are associated with fish kills and a loss of bird life (Figure 8). In February 2019 there was a fish kill of large fish in the system, comprising about 90 % springers *Mugil cephalus*, 5 % Mozambique tilapia *Oreochromis mossambicus*, 3 % carp *Cyprinus carpio* and 2 % other. Small dead fish comprised 99% estuarine round-herring *Gilchristella aestuaria*. Surprisingly, no harder *Chelon richardsonii* were recorded which is usually the dominant fish in Verlorenvlei. Mullet are very resilient to poor water quality, often feeding on Microcystis and other blue-green algae, so they may have been hiding out in the deeper areas of the vlei.

Figure 8: Fish kill at Verlorenvlei, February 2019 (Source: F Strange)

Salinity was very much up from the usual 1to 2 in the vlei to 16 to19. There was uncertainty whether the elevated salt content was due to marine salt (NaCl) or partly more corrosive salts from the catchment. Oxygen levels were at 6 to 8 mg/l, saturation levels at 76 to120%, but this was probably due to daytime Microcystis photosynthesis and wind mixing. Night oxygen levels were likely to be much lower due to algal respiration and fish would have had to surface breathe. pH was high at 7.9 to 8.4 which may indicate some ammonia toxicity in the system. Temperatures were 18 to 24 °C, which was fairly normal for the time of year. Overall, the fish kill was likely a combination of exhaustion from repeatedly having to surface breathe at night and high pH / ammonia toxicity.

Overall, artificial breaching lowers the water level, and reduces the reservoir of water that buffers the system against droughts and water quality issues thus putting the ecology of the Ramsar site under pressure.

It is strongly advised that abstraction from the river and surrounding groundwater be capped during drier periods to prevent the development of such low water levels in the system. This should be determined through a high confidence ecological water requirement study.

3.4 Salinity

Salinity data on Verlorenvlei is summarised in Figure 9 (Robertson, 1980; Grindley *et al,* 1980; DWAF 2003; Verlorenvlei SAR study). Verlorenvlei normally functions as a freshwater system: the mouth is perched and only allows occasional seawater inflow during high spring tides and stormy conditions at sea. When water levels in the vlei are high, there is a continuous discharge to the sea maintaining freshwater dominated conditions as was observed in September 1985, September 2002 and November 2008 (Figure 9). When the water level in

the vlei drops, the outflow to the sea no longer occurs, creating a stagnant water body in the lower reaches. During these low water levels the shallower areas - downstream of the road crossing – can become more saline, even hypersaline when interchanges of fresh water between the larger vlei and this shallow regions are no longer sufficient to counterbalance salt build-up associated with occasional overwash and evaporation. Such conditions were evident in 1978/79 when a drought resulted in a marked drop in water levels and when the old causeway and railway service road were still present, preventing proper exchange between the shallower area and the larger estuary.

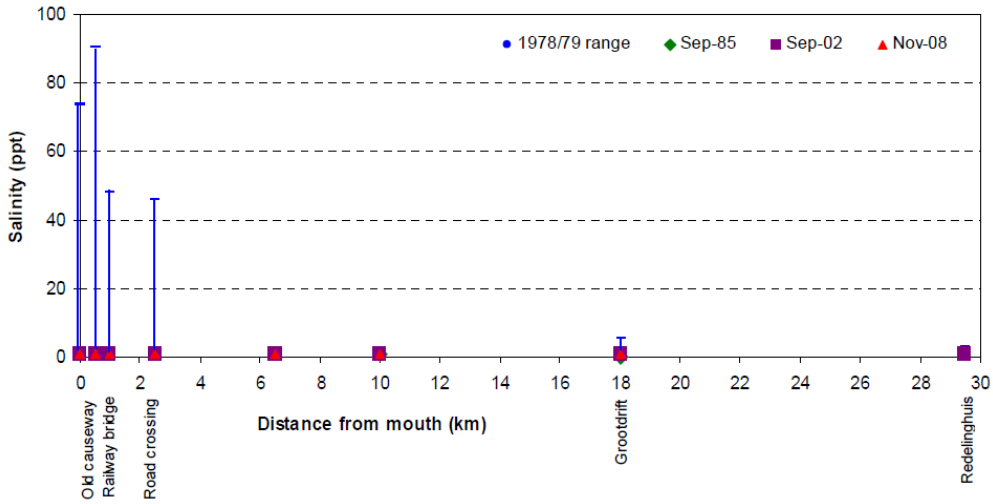


Figure 9: Summary of salinity data collected in Verlorenvlei between 1978 to 2008

3.5 Summary of breaching motivations

Artificial breaching reduces water levels, increases the risk of the vlei drying out during drought conditions, increases reed growth and reduces estuarine connectivity with the marine environment and with the catchment thus decreasing the nursery function of Verlorenvlei. Not enough information is presently available to justify the artificial mouth breaching of the Verlorenvlei to address problems relating to local hotspots around the estuary. Little information is available regarding flow and catchment dynamics, however the existing body of knowledge shows that freshwater reduction and the road and rail bridge obstructions have already markedly impacted on the connectivity in the system, with the occurrence of both lower and higher water levels being significantly reduced from natural Imposing further artificial manipulations on the mouth of the vlei will result in further decline in condition and ecosystem services.

A summary of the motivations for potential artificial breaching of the Verlorenvlei is provided below in Table 2.

Table 2: Summary of artificial breaching motivation

	Potential Threat	Relevance	
Human wellbeing and safety	Threat to human life (as a result of high water levels)	No threats to human life	
	Threat to immoveable property and infrastructure (as a result of high water levels)	No threats to immoveable property, but some movable intake points and abstraction pumps can become inundated under high water levels.	
	Human health impact (e.g. flooding of sewage pump station, septic tanks, chemical storage yards, etc.)	Under severe flood conditions, domestic septic tanks and soakaways will get inundated.	
	Potential loss of agricultural resources (as a result of high water levels)	Some backflooding under closed mouth conditions occur in the upper reaches near Redelinghuys. This is the main pressure for artificial breaching.	
	Potential impact on nearshore environment if breached (e.g. aquaculture facilities)	Not applicable.	
	Loss/impaired access (e.g. roads, footpaths, cattle crossings)	Some footpaths are inundated under high water levels in the upper reaches of the system. Road bridges can be overtopped under flood conditions.	
	Harmful / Noxious algal blooms	No information. Assume not relevant.	
	Impact(s) on recreational use (e.g. increase depth / surface area when mouth is closed, reduce fishing).	This is not a high use recreational system. Motor boats with engines in excess of five horsepower are not permitted on the lake. The deeper areas are suitable for sailing. However, the varying depth of the vlei throughout the year and the fringing and submerged vegetation can place considerable limitations on sailing in terms of access to open water. Swimming, although not prohibited, due to the thick layer of silt and its unhygienic water conditions, is discouraged. Recreational line fishing is allowed under normal permit conditions, but under most conditions this will only land alien freshwater fish. The vlei and its environs lend themselves to ideal bird-watching conditions.	
		Impact of artificial breaching	Varying conditions render this irrelevant
		Impact of NOT breaching	Varying conditions render this irrelevant
Ecosystem requirements	Impact on avifuana abundance, species richness/ community composition	Important bird habitat	Yes, large concentrations of waterbirds. Ramsar site.
		Impact of artificial breaching	Premature breaching can disturb feeding and breading cycles.
		Impact of NOT breaching	Birds adapted to varying water levels in the system. Higher water levels associated with more productive system, i.e. more food availability and better water quality.
		Occurrence of avian botulism	Unconfirmed records of bird deaths believed to be linked to avian botulism.
	Impact on estuarine fish abundance, species richness/ community composition	Important fish nursery	An important nursery system. Verlorenvlei represents about 30 % of the available habitat to estuarine fish on the west coast (Lamberth & Turpie 2003). In terms of fishery yield (including nursery function), Verlorenvlei contributes approximately R3 030 / ha or R 3,03 million to the value of the inshore fisheries annually. This represents 15 % of the total value of the seine and gillnet fishery or 30 % of the estuarine contribution to the value of the inshore marine fisheries on the west coast (Lamberth & Turpie 2003).

	Potential Threat		Relevance
		Impact of artificial breaching	Timing of breaching is important: to permit fish recruitment an estuary has to be open during the appropriate period. Mullet is a partially estuarine dependent species which spawns throughout the year with peaks in the summer months. Juveniles are equally at home in estuaries and the marine environment and can remain in the surf-zone until such time as an estuary opens with a chance of recruitment Steenbras on the other hand is entirely dependent on estuaries for its first year of life and has a relative short spawning season. Its recruitment window is thus very short and if an open estuary is not found within that period the larvae or juveniles will die. The recruitment window is probably 2 of 3 months, August-October of each year depending on when spawning took place and the proximity of the estuary encountered to the spawning ground. In Verlorenvlei, water abstraction has resulted in the mouth staying open for shorter periods and closing earlier than it did historically. The recruitment opportunities for *L. lithognathus* therefore has been greatly reduced.
		Impact of NOT breaching	The ability of fish to recruit into an estuary varies between species and can only really be gauged by their relative abundance or presence / absence within a particular system. Mullet species and white Steenbras are known to recruit through wave overwash into temporarily open / closed systems. In addition, they also recruit by swimming from standing wave to standing wave in systems where there is a strong outflow. In all, the high abundance and presence of mullet as opposed to the absence of Steenbras in Verlorenvlei may be at least partially explained by their being much more adept at recruiting into the system.
		Occurrence of fish kills	Some fish kills in lower estuary due the system drying out and/or hyper saline conditions developing. In addition, lesions have been observed on most adult Mozambique Tilapia.
	Impact on estuarine invertebrate abundance, species richness/ community composition	Impact of artificial breaching	Open mouth linked to increased opportunity for invertebrate species to increase in biomass and abundance.
		Impact of NOT breaching	Closed mouth leads to decrease in species richness (absence of marine associated species).
		Occurrence of invertebrate kills	No information available
	Estuarine Macrophytes (plants)	Impact of artificial breaching	Lowers the water level and dries out the wetland in the upper reaches of the system.
		Impact of NOT breaching (i.e. die back of saltmarsh)	Die-back of salt marsh and reeds and sedges due to inundation and high water level (>1.6 m MSL). Submerged

	Potential Threat		Relevance
			macrophytes may expand further if maximum levels are not maintained for long periods. Anthropogenic nutrient inputs presently encourage macroalgal growth. In summary, as a result of reduce freshwater input, estuary mouth management can only in a limited manner contribute to the management of reeds: 1) slowing down growth through inundation at higher water levels for longer periods (similar to reference) and 2) through the limited scouring that now occurs at the bridges during an breaching outflow event. The higher the water level before a breaching, the more the scouring potential and outflow period, the more reeds will be removed. These interventions should be supported by a "Reeds maintenance management plan (maintMP)" at local hot spots, however a large-scale reed eradication programme WILL lead to further algal and macropphyte blooms causing oxygen problem in the systems. A better long term strategy is to look a nutrient reduction from agricultural activities in the vicinity of the vlei.
	Water quality (Thresholds of concern that would compromise estuarine ecosystem or ecosystem services	Salinity (high or low) that would compromise ecosystem or ecosystem services	Currently there are no limits set related to policy
		Dissolve Oxygen levels	< 4 mg/l
		Ammonia levels	Currently there are no limits set related to the breaching policy
		Toxic substances	Currently there are no limits set related to the breaching policy
		Pollution source are mostly agricultural runoff.	
	Eutrophication	Excessive reed growth	Yes. Extensive beds of emergent aquatic macrophytes occur along the margins of the vlei with *Phragmites australis*, *Typha latifolia* and sedges as dominants. Reeds are regularly removed from the lower bridge in winter to prevent the obstruction of outflowing water.
		Macrophyte blooms	Yes. During the late 1980s *Myriophyllum spicatum*, a submerged macrophyte, dominated large areas of the lake where the water is less than 2m deep (Sinclair *et al* 1986). *Myriophyllum spicatum* was observed in 2012, and again in 2016-17.
		Harmful algal blooms	Yes, alga blooms, including cyanobacterial such as *Microcystis aeruginosa* occur in spring. Phytoplankton assemblage is representative of an eutrophic system. The microalgal assemblage mainly comprised cyanobacterial of the genera *Anabaena, Lyngbya, Anabaenopsis, Merismopedia,*

	Potential Threat		Relevance
			Microcystis with minor contributions from chloro- (*Scenedesmus*) and *bacillariophytes* (*Cyclotella*, *Nitschia*). The algal assemblage was indicative of an elevation in trophic status that has been in place for some time and probably reflects eutrophication-associated damage to the lower levels of the foodweb (e.g. depauperate zooplankton and coarse fish dominance) (DWAF 2003). Large masses of filamentous green algae, including *Chaetmorpha* and *Cladophora*, are common in the channel, particularly between the railway bridge and the mouth, where the water is often stagnant and hypersaline (Sinclair *et al* 1986).
	Sedimentation	On-going sedimentation	No information available

Event Type	Breach Yes/No	Motivation
Major flood events associated with severe flood damage	No	Artificial breaching will not be considered to prevent water inundation of low-lying private or public properties as much higher levels were experienced during the time period the berm were in place.
Poor and/or unfavourable water quality	No	Low oxygen levels are not considered an outright emergency in this estuary. Salinity levels are not a consideration because the system is characteristically saline. Artificial breaching will not be considered to flush polluted water out of the estuary (which will pollute the nearshore).
Fish kills	Yes	A medium important nursery system. Department of Agriculture, Forestry and Fisheries (DAFF) to determine if major fish kill can be remedied by breaching, but in general breaching under low oxygen conditions will only reduce the oxygen for the fish that remain in the system.
Hazardous spill	Yes	Breaching will only be considered if hazardous substance holds no risk to nearshore environment and registered as a disaster In the event of an oil spill at sea, the mouth of the Verlorenvlei Estuary can temporarily be closed to prevent oil from entering the system.

4 RELEVANT AUTHORITIES

Table 3 lists the key lead authorities involved in artificial breaching at the Verlorenvlei Estuary.

Table 3: Key lead authority involved in artificial breaching

Management authority	Cederberg Municipality
Advisory Committee	Verlorenvlei Estuary Forum
Authorisation (breaching / emergency)	Western Cape Government's Department of Environmental Affairs & Development Planning (DEA&DP)
Lead authority	**Minimum consultation In case of Emergency**
Cederberg Municipality (Environmental Management and Disaster Management sections)	✓
West Coast District Municipality (Environmental Management and Disaster Management sections)	✓
DEA&DP	✓
Department of Environment Affairs	✗
DAFF	✓
DWS	✗
CapeNature	✓
Non-Governmental Organisations	✗
The decision to artificially breach under emergency conditions will be made by Cederberg Municipality's Environmental Manager in consultation with DAFF, Cape Nature and DEA&DP. These lead authorities are important role players with respect to emergency situations and administer their relevant empowering provisions (Disaster Management Act 2002, NEMA 1998, and the Integrated Coastal Management Act 2008). Data on Oxygen levels, water level and berm height, as well as rainfall where feasible, will be collated by the Municipality. Once the Cederberg Municipality has decided that an artificial breach must occur and authorisation (can be verbal) obtained from DEA&DP, the Disaster Risk Department of the Cederberg Municipality, shall be responsible for overseeing the breaching activities.	

Disaster Management	Authority/Organisation	Status
Early warning system	South African Weather Services (weather)	No
	DWS warning system (flow/water levels/dam safety)	No
Disaster Management Plan	Municipality	Yes
Approved MaintMP	Municipality	No

5 BREACHING SPECIFICATIONS

The following criteria apply to the Verlorenvlei should emergency procedures be invoked (Table 4):

Table 4: Verlorenvlei Estuary Breaching Specifications

Breaching considerations	Details	
Minimum breaching level (water level should be as high as possible before breaching)	>2 m MSL	Level to MSL
	Ideally breaching should occur naturally. If artificial breaching needs to be undertaken then the water level should be as high as possible	
Optimum breaching period (if applicable)	The Verlorenvlei Estuary only occasionally breaches dependent on the occurrence of rainfall and high river flow. Ideally, a breaching should occur in late winter or spring (August to October). The later in the season the better as the incidence of high sea storms reduce from winter to summer, assisting in maintaining open inlet conditions.	
Neap-spring breaching considerations	Preferably 3-4 days before spring tide, but priority should be given to water levels and wave conditions.	
Timing of breaching	Breach 2 hours before high tide, or just after high tide (to prevent high waves from reclosing the opening), to maximize the outflow.	
Consider safety of public during breaching	Breaching holds a small risk to public safety. Care should be taken with the general public to ensure their safety. Cordon the area off with the aid of red and white emergency tape to keep the public out of the area were breaching will take place. Ideally an official or security person must man the area in question. Temporarily close the designated area in circumstances that could pose a danger to the human life or property. This must be accompanied by appropriate signage.	
Breaching trench to maximize outflow	Excavate a deep and wide trench with a backactor before breaching to maximize outflow.	
Location of the breaching position.	At the lowest position of the berm. Care should be taken with the breaching location to ensure that the outflow channel does not become unnecessarily long resulting in increased bottom friction, reduction in tidal flushing and premature closure.	
Estimate amount of sediment to be moved during breaching	Not applicable, as amounts vary significantly between breachings, and cannot be determined in advance.	
Disposal of sediment removed during excavation	The sand excavated from the trench should be pushed out into the sea where wave action will take it away, and not be stored on the banks next to the trench. Otherwise the sand stored on these banks will drop back into the excavated channel reducing the effectiveness of the outflow and the wider and deeper scouring of this trench. In the unlikely event of marine sediment remaining on the beach after a breaching, no additional action is required as it will generally wash away after a few high tides.	
Mobilizing machinery and equipment on site during breaching	Equipment and machinery to be utilised in a breaching must be in be in a good state. Oil leaks are not to cause additional pollution. Care should be taken to ensure that earth moving equipment do not disturb indigenous vegetation of conservation worthiness on route to the excavation site. Bird nesting areas are to be avoided. Where possible existing access roads / tracks should be used.	

Breaching considerations	Details
	Once it has been established that a clear outflow channel has formed and breaching is progressing on its own momentum the earth moving equipment may be removed from the beach. Implement an appropriate control mechanism, such as erecting comprehensive signage with information of the launching areas and the associated dangers. Allow DEA&DP officials access to the designated area for the purpose of assessing and/or monitoring compliance with the conditions contained in the MMP/MaintMP, at all reasonable times. Be responsible for all costs necessary to comply with these conditions unless otherwise specified The municipality retains the management responsibility of the designated area, even though the applicant may grant permission to manage the designated area, on their behalf, to any competent contractor /service provider. Ensure that all users adhere to the local authority By-Laws relating to the designated areas at all times. The legal requirements associated with the use of the designated area must be brought to the attention of all persons that are granted access to the designated area by the applicant (licensee) in terms of the conditions of this licence and the applicant shall take measures necessary to bind such persons to these requirements.
Noise & light pollution	Noise on during a breaching should be kept to a minimum and within the relevant noise control by-laws/regulations of the municipality.
Water Quality considerations related to breaching	Salinity: Currently not a consideration for breaching in this system
	Oxygen: >4 mg/l
	Ammonia: Currently not a consideration for breaching in this system
	Toxic substances: Currently not a consideration for breaching in this system
Ecological considerations	Birds: Annual breaching per natural conditions. Maintain the highest possible water levels.
	Fish: Annual breaching per natural conditions. Maintain the highest possible water levels.
	Invertebrates: Annual breaching per natural conditions. Maintain the highest possible water levels.
	Plants: Annual breaching per natural conditions. Maintain the highest possible water levels.

6 OPERATIONAL PROCEDURES

In the absence of more detailed information on flow reduction and the mouth behaviour of the Verlorenvlei Estuary only emergency breaching under extremely rare conditions is considered appropriate, i.e. where people's lives are endangered and not agricultural infrastructure or livestock.

Two types of breachings are generally distinguished, namely (a) Planned artificial breachings undertaken according to an approved Maintenance Management Plan and (b) Emergency breaching (e.g. to avoid danger of flooding).

The Cederberg Municipality is responsible for the operational aspects of the Verlorenvlei Estuary MMP/MaintMP. They can delegate this function, but ultimately they have oversight. The Municipality (or its delegated structure) are required to co-ordinate the breaching activities, which include:

- Convening emergency breaching meetings;
- Recording the minutes of the meetings;
- Distributing relevant information to the committee members; and
- Sharing the post-breaching incident report;

The Municipality is also responsible for continuous monitoring of the conditions in the estuary and catchment. Once the emergency breaching criteria (see Section 5) is met, the decision to artificially breach will be made by the Municipality. Note that an estuary mouth is highly dynamic and unforeseen events may require special management actions. In such an event, verbal (followed by written) authorisation may be required from the authorising authority (i.e. DEA&DP).

A flow chart for the undertaking of mouth breachings under emergency conditions is included in Figure 10. Breachings should be undertaken in the swiftest manner possible and in most cases the Disaster Risk Department of the local municipality is responsible. While breaching should be conducted according to an Estuary Mouth Management Plan, some of the general breaching principals may be waivered under emergency conditions to ensure an expedient breaching.

Emergency conditions could develop when an estuary mouth is closed and oxygen levels falls below 4 mg/l. Constant monitoring of the conditions in the system is then required when emergency conditions develop. Communication between the different role players, i.e. the local municipality and key authorities (DEA&DP) involved, should take place, if time is available, to monitor the situation. Included in the monitoring are:

- The actual and expected rainfall in the catchment.
- The water level in the estuary and its rate of increase.
- The height and width of the sand berm at the mouth.
- The actual and predicted wave conditions.
- The availability of equipment to breach the mouth on short notice.

While most emergency breachings relate to floods, Section 3 lists some additional events that can constitute an emergency at the Verlorenvlei Estuary.

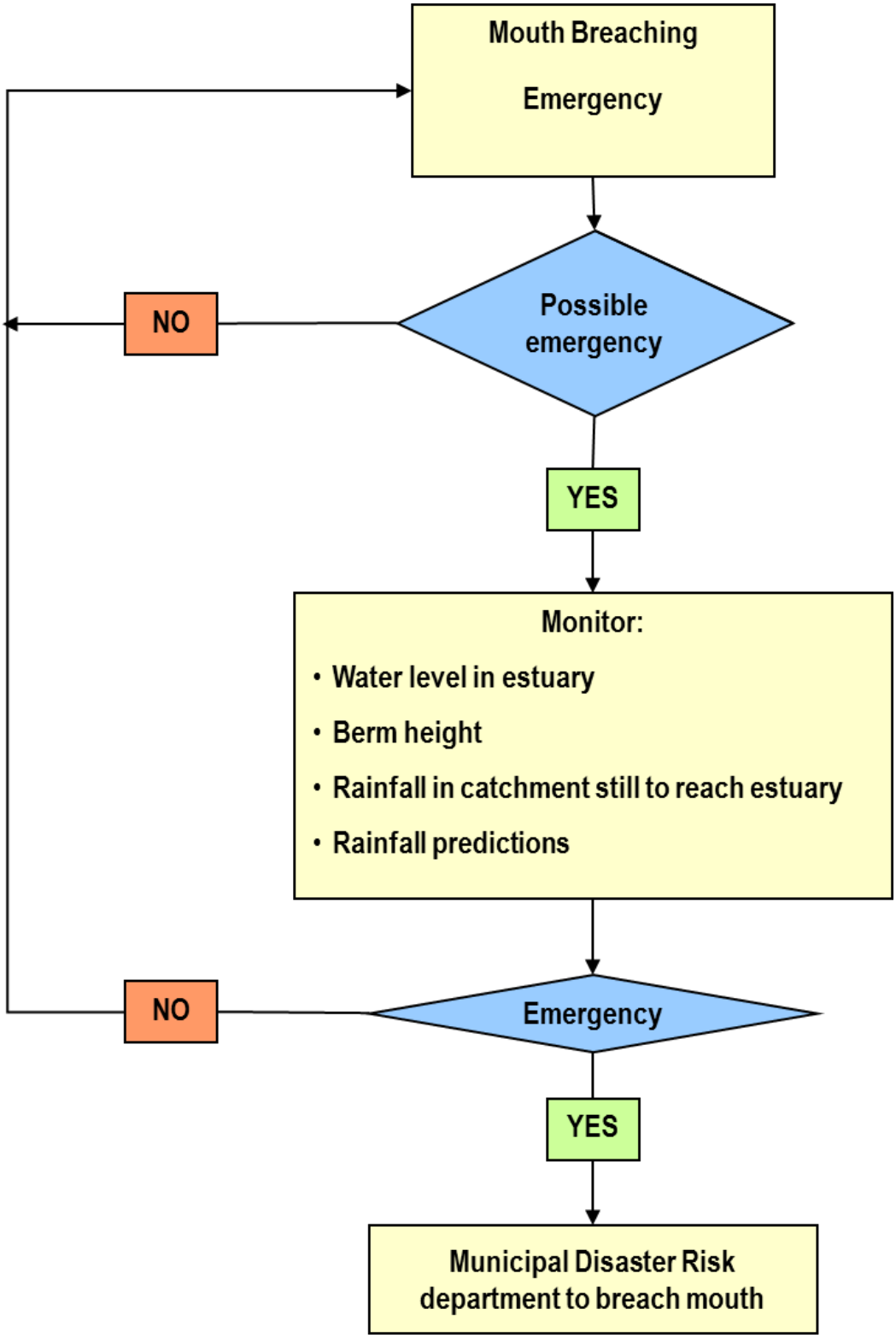


Figure 10: A flow chart illustrating the breaching plan for emergency conditions

Once the Cederberg Municipality has established that the relevant criteria have been met and that artificial breach must occur, the Disaster Risk Department of the Municipality, shall be responsible for overseeing the breaching activities. The Disaster Risk Department of the Cederberg Municipality is responsible for the following:

- Ensuring the availability of Earth moving equipment on day of breaching;
- Establishing the exact location of the breaching channel;
- Verifying that the sandberm at the mouth is high enough above the water line that there is no risk of "fluidization" of berm sediment (i.e. turns to quicksand) and associated risk to operator and equipment;
- Deployment of flags and signage to warm public of risk to safety; and
- Breaching of the estuary mouth.

Finally, the Cederberg Municipality is responsible for the compilation of a Breaching Incident Report to be provided to DEA&DP within 14 days of the actual breaching (see Section 8 for more detail on the report).

7 MONITORING PROGRAMME

The following monitoring programme supports the responsible management of artificial breaching in the event of an emergency breaching (Table 5):

Table 5: Monitoring programme for the Verlorenvlei Estuary

MONITORING ACTIONS	FREQUENCY	CRITICAL REQUIREMENT - YES/NO	AGENCY RESPONSIBLE
Weather forecast	Period leading up to breaching	Yes	SA Weather Services
Water levels	Continuous	Yes	DWS gauge
River inflow data	**Daily**	**Yes**	**DWS gauge (proposed)**
Bathymetric surveys	Every 3 years	No	Municipality
Salinity (quarterly)	Monthly	Yes	Municipality
In situ water quality measurements (e.g. oxygen)	Monthly	Yes	Municipality
Berm levels	Monthly (and just before breaching)	Yes	Municipality
Photographs	To be arranged between authorities before, during and after breaching	Yes	Municipality
Observations on estuarine vegetation (e.g. inundation of salt marsh, reeds & sedges, occurrence of algal blooms)	Quarterly (and just before breaching)	Yes	Municipality
Observations on Invertebrate behavior (e.g. invertebrate kills)	Quarterly (and just before breaching)	Yes	Municipality
Fish surveys Observations on fish behavior (e.g. spawning aggregations, fish kills)	Bi-annually	No	DAFF
Co-ordinated Water bird Counts (CWAC)	Bi-annually	Yes	CapeNature

8 REPORTING

Following an emergency breaching a Breaching Incidence Report needs to be compiled and provided to DEA&DP within 14 days of breaching. This report should contain as much as possible information on the breaching motivation for the breaching and the process followed.

In addition to the Breaching Report, the Managing authority needs to compile an Annual Breaching Report that summarises information on all mouth manipulation activities, ecological responses and consequences to human well-being and safety. The Annual Breaching Report needs to be presented to all Interested and Affected Parties (I&AP) (relevant authorities and civil society) to communicate progress with the implementation of the MMP. Such feedback sessions provide the opportunity for a critical review of breaching practises and discussions on possible improvements to future MMPs.

8.1 Breaching Report

Table 6 below summarises the minimum content of post-breaching report in the event the Verlorenvlei Estuary were breached under emergency conditions. The initial incidence report should be compiled within 14 days of breaching, with data gaps (e.g. duration open) addressed after mouth closure.

Table 6: Content of Verlorenvlei Estuary breaching report

ACTIONS	LOCAL REQUIREMENT - YES/NO	AGENCY RESPONSIBLE
Met-ocean information • State of the tide (spring-neap/ high-low tide) • Sea conditions (calm/stormy)	Yes	Cederberg Municipality
Estuary Information • Water level from DWS (and volume) before breaching • Maximum outflow rate during breaching calculated from water levels and surface area of system • Outflow duration (from water level graph) • Lowest water level achieved after breaching (from water level graph) • Volume of sediment removed during breaching and what was done with the excavated sediment • Did flooding problems arise before or during the breaching? If so, quantify these problems. • Could measures be taken to prevent such problems in the future? For example by protection of low laying properties. Distinguish between short-term and long-term measures. • Could further problems arise by design of new developments at too low levels?	Yes	DWS & Cederberg Municipality

ACTIONS	LOCAL REQUIREMENT - YES/NO	AGENCY RESPONSIBLE
• Were there problems with septic tanks before the breaching? If so quantify data since last breaching		
Location of channel • Align with historical position of channels • Estimated volume of sediment excavated during the breaching	Yes	Cederberg Municipality
Period for which the mouth stayed open	Yes	Cederberg Municipality
Bathymetric surveys before breaching events to establish erosion /deposition rates	Yes	Cederberg Municipality
Salinity measurement before and after breaching	Yes	Cederberg Municipality
Macrophyte conditions	No	
Fish recruitment survey	Yes, in summer after breaching	DAFF
Avifuana counts (CWAC)	Yes	CapeNature
Other		
Assessment record compiled by: Name: Organization: Date: Contact details:		

8.2 Feedback on breaching activities

Table 7 below summarises the minimum information required as evidence of breaching feedback reporting. Ideally the breaching report should be provided to the Estuary Advisory Forum and other interested stakeholders / specialists post breaching. The breaching process should be communicated to the forum on an ongoing basis throughout the process to keep stakeholders abreast of all developments and decisions taken. If this is not possible, such report back sessions should be held at least once a year to ensure that the correct breaching procedures are being followed and that additional interventions are not required.

Table 7: Minimum information required on breaching feedback sessions

MONITORING ACTIONS	LOCAL REQUIREMENT - YES/NO
Responsible agency /authority	Cederberg Municipality
Place & Workshop venue	
Date	
Meeting/committee/workshop participants (attached attendance register)	
Workshop chaired by:	
Key lessons learned that could assist with future breaching	
Material presented at meeting (including copies)	

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