CITY OF CAPE TOWN SURFACE STORMWATER SYSTEMS

LOURENS ESTUARY IMPACT ASSESSMENT

Anchor Environmental Consultants Report No.

IMPACT ASSESSMENT REPORT

LOURENS ESTUARY

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Prepared for
Stormwater and Sustainability Branch
(Planning Department – Transport for Cape Town)
City of Cape Town

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CONTENTS

1 INTRODUCTION

Anchor Environmental Consultants (Pty) Ltd. (AEC) were appointed by GIBB (Pty) Ltd. as marine and estuarine specialists to compile impact assessment reports for seven estuaries / river outlets within the City of Cape Town (CCT) boundaries, namely, the Diep, Disa, Silvermine, Zandvlei, Eerste, Lourens and Sir Lowry's Pass rivers. The purpose of compiling these impact assessment reports is to guide the CCT's maintenance activities, which mainly cover typical stormwater management activities, within sensitive estuarine environments and to identify suitable mitigation measures that will minimize negative environmental impacts of these activities. These maintenance activities require authorization in terms of the National Environmental Management Act (Act No. 107 of 1998). The desired approval from the competent authority (Provincial Department of Environmental Affairs and Development Planning DEA&DP) will be an amendment to the existing environmental authorisation obtained by the CCT in 2015 for its routine stormwater maintenance programme (EIA Ref No. 16/3/1/3/1/A7/4/2031/12). The impact assessment reports include a delineation of the estuary extent; a summary of available information on conservation importance, health status and sensitivity of each estuary; a description of the required maintenance activities; and an environmental impact assessment of the proposed activities. Site visits to each of the seven estuaries were undertaken over the period 2-4 December 2015 during which a variety of maintenance activities were discussed with CCT officials. These impact assessment reports are compiled based on information supplied by CCT officials, observations made during the site visits, available information in the scientific literature and other reports (e.g. estuary management plans), and the consultant's previous experience and specialist knowledge. Finally, the impact assessment reports should be read together with the Environmental Management Programme and Technical Assessment Report (GIBB, 2014) which were compiled as part of the original Basic Assessment Report and EIA application for the authorisation for maintenance and management interventions in the City's surface stormwater systems. Chapter 13 of that EMPr deals specifically with estuaries and river mouths.

This impact assessment report is for the Lourens estuary that enters the sea on the north eastern False Bay coast between the suburb of Strand and the old AECI chemical factory. The estuary forms the eastern border of the Helderberg Marine Protected Area.

2 LOURENS ESTUARY

2.1 Spatial delineation of estuary extent

An estuary is defined in terms of the National Environmental Management: Integrated Coastal Management Act (ICMA) and the NEMA 2014 EIA Regulations as "a body of surface water—

a) that is permanently or periodically open to the sea;
b) in which a rise and fall of the water level as a result of the tides is measurable at spring tides when the body of surface water is open to the sea; or

c) in respect of which the salinity is higher than fresh water as a result of the influence of the sea, and where there is a salinity gradient between the tidal reach and the mouth of the body of surface water.''

While this definition is in line with those used internationally in respect of estuary water bodies it is considered somewhat limited inasmuch as it encapsulates only the estuary water body and not the adjacent physical and biological processes and habitats required to support estuarine function and health. Thus, as part of the Estuary Component of the National Biodiversity Assessment (van Niekerk & Turpie 2012) a definition for the estuarine functional zone (EFZ) was formulated which extended the lateral boundaries of an estuary up to the 5 m contour, with the downstream boundary taken as the estuary mouth and the upstream boundary taken as the limits of tidal variation or salinity penetration, whichever penetrates furthest. Protection/rehabilitation of the estuarine functional zone is considered essential for protection of estuarine biodiversity and associated ecological processes (van Niekerk & Turpie 2012). This definition was adopted for the purpose of the Lourens impact assessment report, with the major difference being that housing or industrial developments were excluded; and the extensive Paardevlei wetlands to the west of the estuary were not included (these are fresh water wetlands and do not connect to the Lourens estuary). The upstream extent of the estuary was defined by a low weir below the bulk water mains bridge approximately 1.1 km from the estuary mouth. For practical purposes the borders were aligned with clear features (such as roads or footpaths) where possible. The spatial extent of the Lourens estuary as defined for the purposes of this impact assessment is shown in (Figure 1).

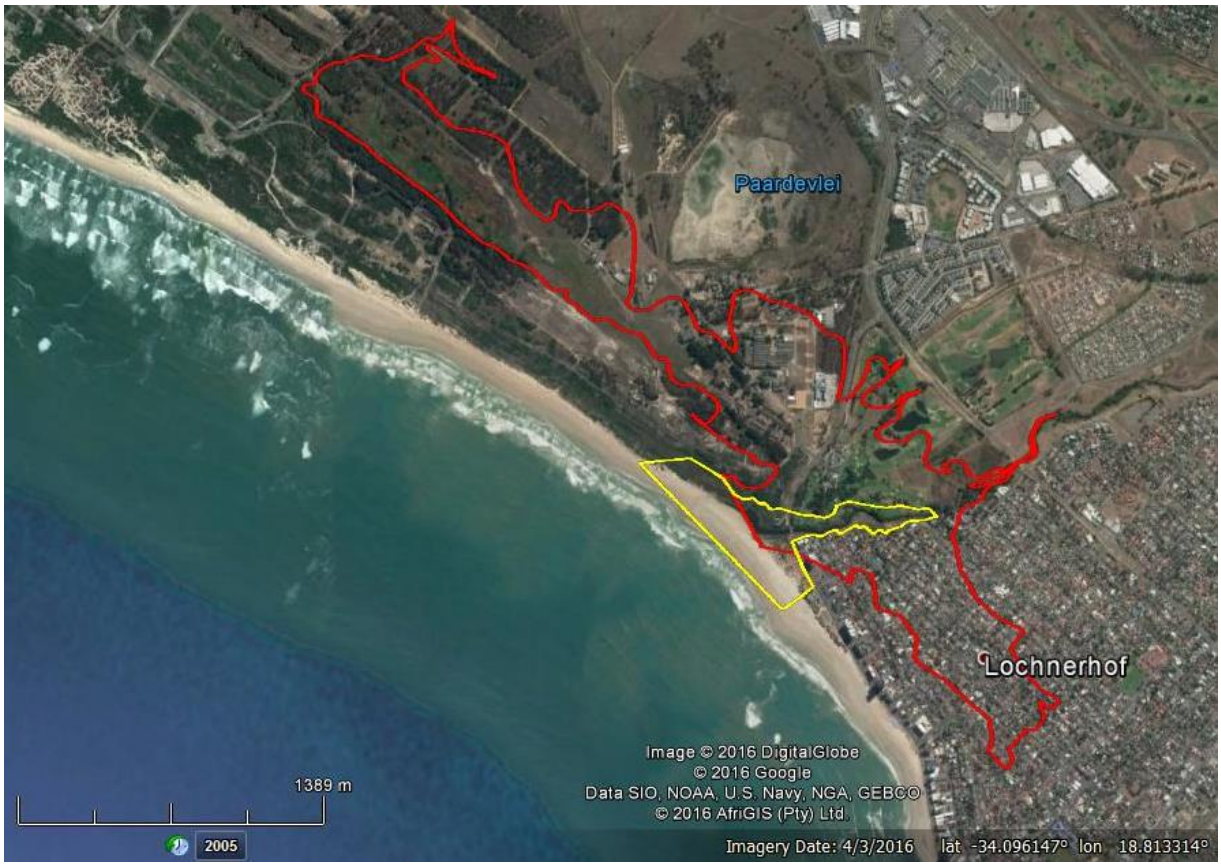

Figure 1. Spatial extent of the Lourens estuary defined for the purposes of this impact assessment (yellow polygon) and the 5m contour (red polygon).

2.2 Catchment and hydrology

The catchment for the Lourens Estuary is approximately 140 km^2. The Lourens River is the main river draining this catchment with other smaller tributaries and mountain streams joining the main channel along its 20 km length.

The upper reaches of the Lourens River begins in mountains where the natural vegetation is mainly intact and under conservation in the Hottentots Holland Nature Reserve. The river then flows through a valley of undulating hills which is privately-owned agricultural land including vineyards, apple, plum and pear orchards. The River then cuts across the flat coastal plain through the towns of Somerset West and then Strand before emptying into False Bay.

The underlying geology of the mountains in the upper catchment form part of the Table Mountain sandstone group. The river valley is comprised of shallow fertile alluvial soils overlaying cape granite or Malmesbury shale groups. The flat coastal plain consists mainly of sand of Tertiary and Quaternary origin.

The flow through the Lourens River is highly seasonal. The highest flows in the Lourens River occur in August (approx. 3-4 $m^3.s^{-1}$) and lowest flows occur in February/March (less and 0.1 3-4 $m^3.s^{-1}$) (Cliff & Grindley 1982).

At the mouth of the Lourens River, a small estuary of approximately 0.7 km^2 forms in the slack of the beach bar. The lagoon that forms is usually along the east/west orientation and is approximately 300 m long and 30-40 m wide. The beach sand bar is built up by the strong wave action and often the channel must extend some several hundred metres to find a low-lying course to the sea. The estuary mouth is open most of the year, however is known to close periodically during dry summer months (Cliff & Grindley 1982).

2.3 Physical and chemical components

Data collected by Cliff and Grindley (1982) suggests that there is tidal influence into the estuary up to 300 m from the mouth. In summer months, when freshwater flow is lowest, it is likely the estuary becomes slightly hypersaline.

Dissolved oxygen levels within the estuary were largely within the expected natural between 2000 and 2005. Between 2005 and 2013 there has been a slight decrease in dissolved oxygen levels to approximately 7$mg.l^{-1}$, which is still considered only a small change from natural conditions (Haskins 2013).

Inorganic nitrogen levels were considered to be only slightly elevated from natural conditions and have shown a slight decrease in concentration between 2000 and 2013. While the inorganic nitrogen levels fluctuate seasonally, being higher in winter than summer. On average the inorganic nitrogen concentration was approximately 0.25 $mg.l^{-1}$ in 2013 (Haskins 2013).

Orthophosphate levels were considered to have had a small/moderate change from natural conditions, and while the average has remained relatively similar (approximately 0.015 $mg.l^{-1}$) between 2000 and 2013, there is less variation in readings in later years (Haskins 2013).

Various pesticides are used to protect food in the crops agricultural land in the catchment. Pesticides including Cypermethrin, fenvalerate, endosulfan total, p,p-DDE, chlorpyrifos and prothiofos were found within the estuary throughout the year with peak concentrations occurring in spring (Sep-Nov) and autumn (Mar-May). (Bollmohr *et al*. 2011)

Monitoring of *E.coli* concentration by the CCT at the Beach Road bridge between 2000 and 2013 indicated that there has been a general increase over this period. Between 2011 and 2013, approximately 80% of the measurements met the Department of Water and Sanitation's intermediate contact water quality guideline of less than 1000 CFU/100 ml, and this figure increased to 90% in 2015 (Haskins 2013 and 2016).

2.4 Biodiversity

Available descriptions of the vegetation of the Lourens Estuary were conducted in the 1980s and are likely no longer very accurate. Cliff and Grindley (1982) describe the estuary as having a dense algal mat covering the surface and bottom of the Estuary. They did not record any salt marsh and only a few species of marginal plants including the reed *Phramities australis* and bulrush *Typha capensis*. It appears that in 1982, there was very little natural vegetation occurring around the lower Lourens River. There are however, a number of invasive species that are prevalent in the catchment including Port Jackon *Acacia saligna*, and giant reed *Arundo donax*.

Sampling of meiofauna within the Lourens Estuary found a total mean abundance of 6 600 (± 12391) individuals.m^{-3} with an average of 6.8 (± 2.7) taxa.m^{-3} (Bollmohr *et al*. 2011). This meiofaunal community was considered to be significantly influenced by anthropogenic impacts including the presence of certain pesticides and nitrates in that it had lower diversity than other less-impacted estuaries nearby.

From observations of fish kills as well as limited gill netting Cliff and Grindley (1982) were able to identify seven species of fish that occurred within the estuary. During larval fish surveys between 2003-2004 four different fish species were identified in the Lourens Estuary (Montoya-Maya and Strydom 2009). The mean density of fish larva was 83 (range 0-608) per 100 m^3. Three of the four species as well as vast majority of fish larvae caught were from estuary-resident or estuary dependent marine species. The Lourens Estuary Management Plan (CCT 2014) notes that sampling by the Department of Agriculture, Forestry and Fisheries have recorded another seven marine species (bringing the total to 15 marine and estuarine fish species) and nine freshwater fish species in the Lourens River Catchment.

A total of 33 waterbird species were recorded at the Lourens Estuary in the early 1980s, including large numbers of common, Artic and sandwich terns (Cliff and Grindley 1982). The roosting area on the mouth sandbar is still utilized by several species of terns and gulls (more than 400 common terns, 50 Hartlaub's gulls, 20 black backed gulls and 10 swift terns were counted during the site visit). The continues used of this roosting site by sea birds is probably partly related to the low levels of disturbance due to the old AECI fence still extending across the beach that discourages access. Counts of waterbirds by the Animal Demography Unit at UCT have been conducted at the Lourens estuary between 2001 and 2009 (but only regularly between 2007-2009). The average number of

birds recorded at the estuary between 2007 and 2009 was 633 birds and a total of 44 species have been recorded during this time. Occasionally large numbers of common and sandwich terns were recorded (up to 5 500 and 1 500 respectively) during summer months.

2.5 Management history

Historically, the Lourens Estuary itself has seen little active management and was subject to pollution inputs from the Strand sewage works, and several chemical factories (AECI, Somchem & Triomph) for many decades. To the west of the estuary lies the old AECI site which has had security fencing preventing access to the mouth and estuary itself. This fence extends into the sea below the low water mark, however is no longer maintained.

The Strand sewage works used to be situated immediately upstream of the estuary and used to feed its biologically treated effluent into the river between 1948 and 1978. This sewage works is no longer functioning and has now been converted to a golf course. There is however, a sewage pump station located immediately adjacent to the estuary at Beach Road and this poses a risk of pollution to the estuary if the station fails due to electrical or mechanical faults. A major refurbishment / upgrade of this pump station is due to commence in the latter part of 2016 (duration 1.5 years). During the project when the pump station will not be operational, overpumping of sewage into the raising main that transports sewage to Macassar WWTW will take place.

The closure of the Strand treatment works in 1978 and the AECI chemical factory in 1990 as well as improved management of the Lourens River in recent years (the whole river was declared a Protected Natural Environment in 1997) which has resulted in improvements in the ecological health of the estuary. Given that the estuary is within the Protected Natural Environment (PNE) in terms of the P.N 161/1997, there are also obligations in terms of the PNE that will need to be complied with when undertaking maintenance activities, as per the declaration.

2.6 Current ecosystem health & sensitivity

In 2012 the estuaries of South Africa were assessed during a desktop health assessment to try to identify gaps in knowledge and shortcomings of previous assessments and provide a comprehensive consistent assessment of estuaries in South Africa. The assessment targeted a number of different areas, examining both the pressures and threats to each estuary as well as the current condition for a number of bio-physical parameters. The National Biodiversity Assessment (van Niekerk and Turpie 2012) rated the Lourens Estuary as having a "Fair" mean Estuary Health State and an Ecological category of C (Table 1).

Table 1. Results of the National Biodiversity Assessment for the Lourens Estuary (van Niekerk and Turpie 2012).

Indicator		Rating
Pressures	Change in Flow	Low
	Pollution	High
	Habitat Loss	Medium
	Mining	No
	Artificial Breaching	No
	Fishing Effort	Low
	Fishing Effort (catches in tonnes)	0.1
	Bait collection	Yes
Health Condition	Hydrology	Good
	Hydrodynamics	Good
	Water Quality	Fair
	Physical habitat	Fair
	Habitat State	Fair
	Microalgae	Fair
	Macrophytes	Fair
	Invertebrates	Fair
	Fish	Fair
	Birds	Fair
	Biological State	Fair
	Estuary Health State (Mean)	Fair
	Ecological Category	C

The threats and pressures to the system are mainly related to pollution and loss of habitat. The biotic components are all rated as “fair”. The physical parameters, with exception of hydrology and hydrodynamics which were rated “good”, were all also rated “fair”. Overall the estuary is in a reasonable state of health.

2.7 Conservation importance

Turpie and Clark (2007) rated the Lourens Estuary as having an importance score of 33.4 on a scale from 0 (totally unimportant) to 100 (critically important). It was also recommended that the Lourens

Estuary is a medium priority for restoration, that the entire estuary should have some form of protection and that at least 75% of its margin remain undeveloped (Turpie and Clark 2007). The whole river was declared a Protected Natural Environment in 1997) which has resulted in improvements in the ecological health of the estuary.

The Lourens Estuary also forms the eastern boundary of the Helderberg Marine Protected Area. As such the estuary should be considered as part of the MPA and so should consider the conservation objectives of the MPA as well.

3 REQUIRED MAINTENANCE ACTIVITIES

Nine different management/maintenance measures were identified as necessary to ensure safe functioning of the CCT stormwater system and to enhance and support environmental process within wetlands, rivers and estuaries in the greater CCT area (Table 2) (Gibb 2015). Five of these maintenance measures are required in the Lourens estuary and surrounds (Table 2). These measures are divided into more detailed sub-types and a brief description and location is provided in (Table 2) and Figure 2. Detailed method statements for these maintenance activities as undertaken by the CCT are provided in Appendix C of the Technical Assessment Report (Gibb 2014).

Table 2. Maintenance measures required for the Lourens Estuary.

MAINTENANCE/MANAGEMENT MEASURE	INTERVENTION SUB-TYPE	REQUIRED IN LOURENS ESTUARY	DESCRIPTION AND LOCATION
1. Vegetation management 1.1. Aquatic (submerged and floating) vegetation management	1.1.1 Manual removal	Yes	Management of .aquatic vegetation is required occasionally. The Lourens is a Protected Natural Area but sometimes a long boom excavator is used to avoid disturbing the river bed which could otherwise take place if other machinery is used.
	1.1.2 Mechanical removal	Yes	
	1.1.3 Biocontrol	Yes	No listed alien aquatic plant species are currently present in this system at present. If however they do occur in the future then biocontrol will be introduced if feasible.
	1.1.4 Chemical control	No	
	1.1.5 Manipulation of water levels	No	
1.2. Reedbed and indigenous emergent vegetation management	1.2.1 Manual removal	Yes	*Typha* and *Phragmites* removal at sewer outlet, below Beach Rd Bridge and at the bulk water main pipeline crossing.
	1.2.2 Mechanical removal	Yes	
	1.2.3. Chemical control	No	
	1.2.4 Burning	No	
	1.2.5 Manipulation of water levels	No	
1.3.Riparian / marginal vegetation management	1.3.1 Manual removal	Yes	Removal of alien vegetation throughout estuary.
	1.3.2 Mechanical removal.	Yes	
	1.3.3 Biocontrol.	No	
	1.3.4 Chemical control.	Yes	Herbicides and foliar sprays used when appropriate in

MAINTENANCE/MANAGEMENT MEASURE	INTERVENTION SUB-TYPE	REQUIRED IN LOURENS ESTUARY	DESCRIPTION AND LOCATION
			conjunction with manual clearing of alien vegetation.
	1.3.5 Burning.	No	
2. Erosion control	2.1 Estuary bank profile enhancement.	Yes	Maintenance of existing bank enhancements that have already been authorised in terms of the Lourens River Flood Alleviation Project. Not assessed as part of this study.
	2.2 Construction, maintenance and expansion of erosion control structures.	Yes	Maintenance of Loffelstein wall and gabion mattress near corner of Brand and De Ruyter Street. Maintenance of emergency overflow from sewage pump station as well as other stormwater culverts. Maintenance of erosion control structures around the bulk water main pipeline bridge (1927 bridge).
3. Sediment Management	3.1 Construction, maintenance and expansion of sediment traps.	No	
	3.2 Manual/mechanical sediment removal from sediment traps/retention areas.	No	
	3.3 Manual/mechanical sediment removal from canals, channels and waterbodies.	Yes	Removal of sediment from stormwater outlets, culvert inlets etc. Removal of accumulated sediment and associated reeds in stretch adjacent to De Ruyters Drive.
4. Channel Enclosure	4.1 Conversion of an open channel to an enclosed pipe / culvert system.	No	
5. Litter and debris management	5.1 Litter and debris removal using either mechanical or manual methods.	Yes	Removal of illegally dumped material as and when required e.g. rubble and old boilers on northern bank near mouth of Lourens.

MAINTENANCE/MANAGEMENT MEASURE	INTERVENTION SUB-TYPE	REQUIRED IN LOURENS ESTUARY	DESCRIPTION AND LOCATION
	5.2 Removal of structures to reduce water obstruction.	No	
	5.3 Construction, maintenance and expansion of litter management infrastructure	Yes	No litter traps currently exist. Installation of new litter traps at stormwater outlets into estuary may however be needed in the future.
6. Construction, maintenance and expansion of minor stormwater infrastructure	6.1 Stormwater outlets, dam scour valves, headwalls and culverts	Yes	Construction and repair of outlets, headwalls and culverts throughout the system as needed e.g. at base of bulk water pipeline bridge on Lourens River Rd.
7. Maintenance of attenuation infrastructure	7.1 Weirs	No	
	7.2 Retention / detention ponds and dams registered in terms of the National Water Act as dams with a Safety Risk	No	
	7.3 Flood protection embankments / berms	Yes	Maintenance of existing berms that were authorised and constructed in terms of the Lourens River Flood Alleviation Project. Not assessed as part of this study.
	7.4 SUDS facilities	Yes	Maintenance of SUDS system on Strand Golf Course which is City Land. Part of Geelsloot outlet.
	7.5 Other dams / ponds	No	
8. Recreational access	8.1 Construction, maintenance and expansion of footbridges, boardwalks or bird hides	Yes	Maintenance of recreational infrastructure (Lourens River Hiking Trail) e.g. informal foot paths, signage, benches.
9. Management of river / estuary mouth	9.1 Breaching: removal of sand bars deposited in mouth	Yes	Breaching was undertaken in the past in response to deterioration of water quality. This is not a recommended routine management response and is only required in the event of a serious pollution event.

MAINTENANCE/MANAGEMENT MEASURE	INTERVENTION SUB-TYPE	REQUIRED IN LOURENS ESTUARY	DESCRIPTION AND LOCATION
	9.2 Straightening: redirecting meandering mouth across the shortest route directly towards the sea	No	Mouth has previously migrated extensively in westerly direction. This should not be a problem as the shore is undeveloped to the west of the mouth. It is probably not desirable that the estuary connects into the Paardevlei wetland but this appears unlikely due to the height of the vegetated dunes.

Figure 2. Location of required maintenance measures within the Lourens estuary.

4 POTENTIAL IMPACTS OF THE PROPOSED MAINTENANCE ACTIVITIES

A range of potential impacts associated with each of the proposed maintenance activities on the Lourens estuarine environment and broader marine environment are identified. These along with appropriate mitigation measures are addressed separately in the tables below. Detailed assessment of the positive impacts associated with the proposed maintenance activities are provided in the Technical Assessment Report (Gibb 2014). Positive impacts of maintenance activities are expected to be the same in estuarine systems and are reiterated in the text below, but assessments of these positive impacts are not repeated here. Potential negative impacts are assessed taking cognisance of the estuary attributes, health status and conservation importance.

Best practice mitigation measures

Standard "best practice" mitigation measures that are broadly applicable to maintenance works undertaken in the vicinity of all watercourses including estuaries are described under "General Specifications" in the Environmental Management Programme (EMPr) (Appendix H of the Basic Assessment Report) (Gibb 2014). These include specifications on: Environmental Awareness, Vegetation Impacts, Biodiversity Impacts, Topsoil, Construction Plant and Material Management, Solid Waste Management, Washing and Wastewater Management, Sanitation, Fuels, Oil, other Hazardous Substances and Spills, Stormwater Management and Erosion, Air Quality, Noise Control, Concrete Batching, Trenching and Excavations, Access Roads, Road Reserves, Working Times, Health and Safety, Fire Prevention and Control, Works and Site Decommissioning, Rehabilitation, Monitoring and Compliance, Heritage and Archaeology. Mitigation measures included in these General Specifications are not repeated here, but they are fully applicable to maintenance work in estuarine environments and this impact assessment must be read in conjunction with the EMPr.

4.1 Vegetation management

4.1.1 Aquatic (Submerged and floating) vegetation management

4.1.2 Aquatic (Submerged and floating) vegetation management

The control and eradication of alien aquatic vegetation has a positive impact on ecosystem function, through removing the stresses on water and habitat quality. Alien aquatic vegetation in the Lourens Estuary is occasionally removed using a longboom excavator with water bucket from the bank to avoid damage to the estuary bed. Negative impacts associated with these methods include damage to riparian vegetation through stockpiling material on the estuary banks and damage caused by heavy machinery accessing the site. Impacts associated with the use of heavy machinery can be mitigated by using the most direct access route identified. Stockpiling of vegetation impacts can be mitigated by minimising the number of stockpiles, situating them appropriately at a sufficient distance back from the bank; and removing them promptly after dewatering to minimise damage to riparian vegetation. The impacts associated with aquatic vegetation removal are local and short term and are rated LOW with mitigation (Table 3).

Table 3. Assessment of negative impacts associated with removal of submerged and floating aquatic vegetation (mainly water hyacinth).

	Extent	Magnitude	Duration	Probability	Status	Significance
With mitigation	Local	Medium	Short-term	Probable	Negative	Low

Recommended mitigation measures:

- Where mechanical removal is required, use a long boom excavator with water bucket to avoid damage to the estuary banks and intertidal zone.
- For mechanical removal, access routes should be as direct as possible, at right angles to the channel or area to be cleared.
- Stockpile excavated/ cut material at least 10m from the HWM/ water edge for no longer than two weeks.

4.1.3 Reedbed and indigenous emergent vegetation management

Management of reeds in wetlands improves floral biodiversity and wetland structure in instances where it allows for re-establishment of a more diverse habitat and flora. Another positive impact of optimal reed management is water quality improvement of stormwater passing through filtration reedbeds (*Typha capensis* and *Phragmites australis*). Management of reeds that clog channels can also reduce erosion and alleviate potential flooding.

Potential negative impacts associated with manual removal of reedbeds and other emergent vegetation are generally considerably less than those associated with mechanical removal where the establishment of temporary access points for machinery and the use of machinery in the estuarine functional zone has additional negative impacts. For this reason, manual removal is recommended as a mitigation measure, it is however, acknowledged that scale of work required, or the depth of water in estuaries, will frequently require the use of machinery.

When clearing emergent vegetation and accessing the site, habitat may be damaged or removed, mobile biota such as birds and fish may be disturbed and biota with limited mobility (juvenile birds, amphibians, reptiles and invertebrates) may suffer mortalities. Stacking of cleared vegetation on the estuary banks for dewatering prior to removal also may have impacts on the marginal vegetation. Removal of reeds at river and stormwater outlets can result in a short to medium term loss of buffering/natural filtration and lead to decreases in estuary water quality. For these reasons indiscriminate and frequent clearing should be avoided and temporary machine access points and stockpile areas should be kept to a minimum number and footprint area.

The extent of emergent vegetation to be removed within the Lourens estuary (at the sewer outlet near the pump station and at the water main crossing) is an extremely small proportion of the habitat type that is common along much of the estuary. The impact is also short term and is reversible. With effective mitigation that includes recommendations on appropriate areas where emergent vegetation may be removed, the methods used and seasonal timing of the vegetation clearing, this impact is rated as LOW significance with mitigation (Table 4).

Table 4. Assessment of negative impacts associated with removal of emergent vegetation (reed beds).

	Extent	Magnitude	Duration	Probability	Status	Significance
With mitigation	Local	Med	Short-term	Probable	Negative	Low

Recommended mitigation measures:

- Only clear emergent vegetation in channels and at stormwater outlets to improve conveyance capacity, do not clear for aesthetic reasons in unchannelled estuary flood plains.
- Where mechanical removal is required, use a long boom excavator with water bucket to avoid damage to the estuary banks and intertidal zone.
- For mechanical removal, access routes should be as direct as possible, at right angles to the channel or area to be cleared.
- Stormwater outlets may be cleared as frequently as required, but larger scale removal of reeds (e.g. channel clearing) should only take place once every two years to allow recovery.
- Stockpile excavated/ cut material at least 10m from the HWM/ water edge and remove within two weeks.
- Use manual removal where safe and feasible; cut reeds close to ground at end of dry season.
- Unless urgently required, do not clear emergent vegetation over the period September- December. (This period includes the peak bird breeding period and peak period of juvenile marine fish recruitment to estuaries.)

4.1.4 Riparian / marginal vegetation management

Riparian or marginal vegetation management within the Lourens estuary is largely the manual / mechanical removal of alien trees, grasses and weeds, and in some cases this could be accompanied by rehabilitation with appropriate indigenous species. The positive impacts of these activities include improved biodiversity value and improvement in moisture levels in wetlands invaded by terrestrial species because of the high water use by alien woody species. Biocontrol agents can be very effective in reducing alien vegetation density and guidelines for their use are provided in the EMPr (Gibb 2014). Potential negative impacts associated with manual / mechanical removal include disturbance as a result of access roads or paths and camps; loss of estuarine habitat if felled material is stockpiled on site, bank erosion and resultant short-term deterioration in water quality due to increases in sediment load if banks are destabilised and begin to erode. The use of chemical sprays in conjunction with manual / mechanical methods is often required to prevent coppicing or re-infestation by seedlings, but these should be used with caution near estuaries where non-target plant and animal species may be harmed should active chemical agents enter the estuarine water body. Guidelines for the chemical control of vegetation are provided in the EMPr (Gibb 2014). Potential negative impacts of marginal vegetation management are rated as LOW with mitigation (Table 5).

Table 5. Assessment of negative impacts associated with riparian vegetation management.

	Extent	Magnitude	Duration	Probability	Status	Significance
With mitigation	Site specific	Med	Short-term	Possible	Negative	Low

Recommended mitigation measures:

- Heavily mechanised methods to remove alien vegetation e.g. bulldozers are not acceptable within the estuarine functional zone, manual methods or the use of chainsaws is appropriate.
- Limit workforce size when removing vegetation on banks or in muddy areas to reduce habitat degradation by trampling.
- Access routes should be as direct as possible, at right angles to the channel or area to be cleared.
- Stockpile cut material at least 10m from the HWM/ water edge for and remove within two weeks.
- Implement erosion control measures if bank stability is compromised by removal of marginal vegetation.
- Conduct follow up operations timeously to prevent re-infestation.
- Strictly follow EMPr guidelines for chemical control of vegetation in the estuarine functional zone.
- The replanting of cleared areas with appropriate indigenous vegetation should be considered if little indigenous vegetation remains.

4.2 Erosion control

4.2.1 Estuary bank profile enhancement

Estuary profile enhancement is undertaken as part of the Lourens River Flood Alleviation Programme. This programme has received an independent authorisation. This activity is therefore not assessed in this study or included in the environmental authorisation amendment application.

4.2.2 Construction, maintenance and expansion of erosion control structures

The repairs/maintenance of existing erosion control structures in the Lourens estuary are confined to the maintenance of Loffelstein wall and gabion mattress near the corner of Brand and De Ruyter Street, erosion control structures around outlets from the stormwater pump station and the pipeline bridge (built in 1927). These structures are already in place and constitute artificial habitats that have little biodiversity value themselves. The impacts associated with this work are limited to the maintenance phase only and include potential water quality deterioration associated with construction works, risks of pollution associated with the use of vehicles and equipment within the estuary functional zone, disturbance of biota, and increased sediment mobilization and turbidity. It is important that if any repairs are likely to impact the estuary water quality (i.e. if they are taking place below the high water mark) that they do not take place during the peak fish recruitment (September-December). The negative impacts are site specific, temporary and with effective mitigation measures the assessed impact is rated as LOW significance (Table 6).

Table 6. Assessment of negative impacts associated with maintenance of erosion control structures in the Lourens estuary.

	Extent	Magnitude	Duration	Probability	Status	Significance
With mitigation	Site specific	Medium	Temporary	Definite	Negative	Low

Recommended mitigation measures:

- Do not undertake repairs during peak estuarine fish recruitment period (September- December).
- Educate construction contractors and workers as to the sensitivity of the estuary and ensure that no

dumping of construction wastes into the estuary takes place.

- Maintain or reduce footprint of existing hard structures in the estuary mouth channel, do no create additional barriers to the movement of biota.

4.3 Sediment management

To maintain conveyance capacity of the stormwater network, it is necessary to remove accumulated sediments deposited in front of stormwater outlets. The environmental impacts of manual removal are low and this is a practical method in small areas (e.g. at storm water outlets). The ROD for the Lourens River Flood Alleviation Scheme has authorised upgrade work on the river in order to alleviate flooding by improving the carrying capacity of the river and also addressing erosion at various key locations. One of the cross sections at which work in terms of this ROD has already been undertaken is along De Ruyter Drive (installation of erosion control measures along the embankment). At this location the river has become silted up which has reduced the cross sectional area and there is also considerable reed growth along the banks. In order to maintain the cross sectional profile of the river it is therefore necessary to remove the accumulated silt from the river channel at this location and will require mechanical methods (long boom excavator and bucket).

Accumulated sediments typically have a high organic content (and potentially other more persistent inorganic contaminants such as trace metals, hydrocarbons, PCBs). Studies on the Lourens estuary sediments and biota indicate that pesticides are present and pollution from chemical factories took place in the past. Care should therefore be taken to test sediments, or if not possible to assume contamination and dispose in a licensed waste landfill site. As mentioned above, the establishment of reeds and other emergent vegetation at stormwater outlets provides a valuable water filtering role and has positive impacts on estuarine water quality. Removal of sediment to restore flow capacity will usually also require removal of the emergent vegetation "roots and all". The negative impacts associated with emergent vegetation removal are assessed in Table 4. The impacts associated with sediment removal from depositional areas include temporary loss of habitat and biota (associated with sediment and emergent vegetation removal as well as access to the site), and mobilization of silt, organic matter and other contaminants that can contribute to eutrophication or pollution of the estuary water body. These impacts are site specific, short term and medium intensity and are rated as LOW significance with effective mitigation that includes defining a "designated sediment removal area" and depth of sediment removal at river entrances to the estuary (Table 7).

Table 7. Assessment of negative impacts associated with sediment removal at depositional areas in the channel and stormwater outlets to the Lourens estuary.

	Extent	Magnitude	Duration	Probability	Status	Significance
With mitigation	Site specific	Medium	Short term	Definite	Negative	Low
Recommended mitigation measures:						

- Spatially define limits of sediment removal area, as a guideline removal of sediment within a radius of 20m of storm water outlets is appropriate, but at depositional/sediment retention areas, the "designated sediment removal area" should be defined, mapped and approved by the CCT environmental team.
- To avoid over-excavation and creation of artificial channels, install permanent, marked stakes to indicate the appropriate depth to which sediments should be removed.
- Access routes for machinery to be constructed at right angles to the water body. Access routes that will be used repeatedly should be permanent and maintained.
- Designate temporary sediment storage areas for dewatering of sediments at least 5m from the estuary water edge. Truck access roads should only extend to temporary storage areas.
- Remove stockpiled sediment within two weeks of completion of the operation.
- If contamination is suspected (e.g. trace metals, hydrocarbons), test dredged sediments to inform appropriate disposal, if testing is not possible, assume contamination and dispose of in an appropriate licensed waste landfill site.
- To minimise the duration and extent of disturbance to the estuary water body, start upstream and work downstream, preferably during the dry period when the mouth is closed and tidal currents are not present.
- Avoid sediment removal during peak fish recruitment period (September-December).
- Rehabilitate access routes prior to winter.
- Cover trucks transporting sediment form the site.
- Minimise frequency of sediment removal (bi-annual or longer if possible) to allow recovery of emergent vegetation that has positive effects on water quality.

4.4 Channel enclosure

This maintenance measure is not required in Lourens estuary.

4.5 Litter and debris management

4.5.1 Litter and debris removal using either mechanical or manual methods.

Impacts associated with litter and debris removal is intentionally positive. Due to the generally dispersed nature of litter items, most litter clean-up is manual and has negligible negative environmental impacts. Damage to estuary banks and marginal vegetation can, however occur where litter is removed and stockpiled, whilst the process of clearing storm water pipes or litter traps and transporting litter away from the collection point can mobilize trapped litter that then enters the estuary water body and is further dispersed by flow, tidal currents or wind. Litter, particularly plastic, released into an estuary can be widely distributed in the marine environment (regional scale impact) where it poses a serious threat to marine life that mistakenly ingests such material leading to fatalities. The estuary is the "last stop" en-route to the broader marine environment and special care must be taken to effectively collect and dispose of litter. These potential negative impacts can be effectively mitigated and are rated as VERY LOW significance with mitigation (Table 8).

Table 8. Assessment of negative impacts associated with litter and debris removal in the Lourens estuary.

	Extent	Magnitude	Duration	Probability	Status	Significance
With mitigation	Site specific	Low	Temporary	Definite	Negative	Very Low

Recommended mitigation measures:

- Clear in a downstream direction.
- Install temporary nets below pipes or outlets when cleaning to catch any dislodged litter or debris.
- Avoid temporary stockpiling of litter, if necessary locate above tidal inundation area, cover to avoid redistribution and remove with 2 says of completion of the cleaning operation.
- Cover trucks used to transport litter or rubble to disposal facility.

4.5.2 Removal of structures to reduce water obstruction

This maintenance activity is not required in the Lourens estuary.

4.5.3 Construction, maintenance and expansion of litter management infrastructure

4.5.4 Construction, maintenance and expansion of litter management infrastructure

Construction of new litter management infrastructure will have long-term positive impacts in reducing the solid waste pollution load on the estuary and the broader marine environment. Installation of infrastructure can have temporary, negative water quality and sediment impacts. Within Lourens estuary, the CCT may install new litter traps on stormwater outlets as required. These new installations and the maintenance thereof will require the use of concrete and the General Specifications in the EMPr must be adhered to, with emphasis on the section detailing best management practice for concrete batching. The negative impacts associated with construction and maintenance of litter infrastructure is assessed as VERY LOW significance with effective mitigation.

Table 9 Assessment of negative impacts associated with the construction and maintenance of litter traps.

	Extent	Magnitude	Duration	Probability	Status	Significance
With mitigation	Site specific	Low	Temporary	Definite	Negative	Very Low

Recommended mitigation measures:

- Adhere to General Specifications as described in EMPr (particularly concrete batching).
- Avoid undertaking works during peak estuarine fish recruitment period (September- December).
- Consider rehabilitation of areas impacted by construction activities.

4.6 Construction, maintenance and expansion of minor stormwater infrastructure

A properly functioning stormwater system reduces erosion and deposition in natural waterbodies downstream. Negative impacts on the estuarine environment associated with the repair and maintenance of minor stormwater infrastructure are largely confined to the construction phase when the use of machinery and cement can have negative sediment and water quality impacts and temporary, localised disturbance of estuarine biota may occur. Localised losses of marginal habitat will happen with the construction of new stormwater infrastructure and ongoing negative impacts on estuary water and sediment quality could occur especially if the new stormwater outlets drain polluted areas. Negative impacts associated with maintenance of existing stormwater infrastructure are assessed as VERY LOW significance with mitigation that is applicable to all use of machinery or construction activities within the estuarine functional zone (Table 10). Potential negative impacts due to the installation of new storm water infrastructure are permanent and are assessed as LOW significance with mitigation (Table 10). The use of Sustainable Drainage Systems (SuDS) measures to ensure that stormwater quality and quantity are managed in a manner that minimises the potential impact on the receiving estuarine environment is recommended.

Table 10. Assessment of impacts associated with the construction maintenance of minor stormwater infrastructure in the Lourens estuary.

	Extent	Magnitude	Duration	Probability	Status	Significance
With mitigation	Site specific	Low	Short term	Definite	Negative	Very Low

Recommended mitigation measures:

- Adhere to General Specifications as described in EMPr (particularly concrete batching).
- Do not undertake construction during peak bird breeding and estuarine fish recruitment period (September- December)).
- Consider rehabilitation of areas impacted by construction activities.
- Avoid creating hard structures in the estuary channel; do no create additional barriers to the movement of biota.

4.7 Maintenance of attenuation infrastructure:

These are not presently required in the Lourens estuary. Impacts associated with the repair and maintenance of the Loffelstein wall and gabion mattress near the corner of Brand and De Ruyter Street are assessed in the section dealing with repair and maintenance of erosion control structures (see Table 6).

4.8 Recreational access: construction, maintenance and expansion of footbridges, boardwalks or bird hides

The construction of recreational access infrastructure has a positive impact of directing pedestrian and light traffic to formalised crossings, controlling damage to estuary bed and banks. The Lourens

River Hiking Trail has been established by the Lourens River Conservation Society. The informal path extends along the river (Figure 3) from the sea towards the upper catchment and largely follows a route along the banks of the river (where public access is permitted). Maintenance of the path (e.g. cutting of weeds), installation and repair of signage and benches is relatively informal and undertaken by the City at the request of the Conservation Society.

Figure 3. The Lourens River Hiking trail.

Maintenance infrastructure and activities (e.g., lawn mowing), should be confined to the area at least 5 m from the high water mark to allow a natural vegetation buffer between the estuary water body and the recreational area. Negative impacts of recreational access infrastructure maintenance are assessed as LOW with mitigation (Table 11).

Table 11. Assessment of impacts associated with the construction and maintenance of recreational access infrastructure in the Sir Lowry's estuary.

	Extent	Magnitude	Duration	Probability	Status	Significance
With mitigation	Site specific	Low	Permanent	Definite	Negative	Low

Recommended mitigation measures:

- Do not construct infrastructure below the High Water Mark and allow a setback of at least 5m from the estuary water edge.
- Avoid undertaking maintenance during peak bird breeding periods (September– December).
- Where possible, use manual methods to carry materials onto site using existing access routes/paths.

4.9 Management of river / estuary mouth

4.9.1 Breaching

A possible need for breaching the Lourens Pass estuary mouth was identified during the site visit. Breaching of the estuary mouth may be required if closed mouth conditions result in potential public health risk due to a pollution event (e.g. sewage pump station malfunction). Breaching is not a recommended long-term solution to pollution problems in the catchment as it essentially transfers them to the nearshore marine environment. Breaching at low water levels (when water quality

problems normally arise) also usually leads to rapid closure of the mouth. This concentrates biota and rotting organic material in a reduced volume of estuary water and results in low oxygen conditions (causing mortalities of biota). Pollution in the catchment should rather be effectively addressed at source and breaching should only take place if no alternative solution is available and a real public health risk exists (microbiological test results are unequivocal, i.e. do not breach for nuisance odours emanating from natural decomposition of organic matter). In the event that emergency breaching is required to address a pollution event, this should occur at or shortly after spring High Tide. This will ensure maximum flow rates and scour of potentially contaminated sediments and inflow of marine waters to flush the system. The impacts associated with emergency breaching of the Lourens estuary mouth are rated as negative LOW significance.

Table 12. Assessment of impacts associated with breaching of the Sir Lowry's River mouth.

	Extent	Magnitude	Duration	Probability	Status	Significance
With mitigation	Local	Medium	Short term	Definite	Negative	Low

Recommended mitigation measures:

- Undertake breaching at Spring High tide to maximize ebb tide velocity and scour of estuary mouth.
- Do not breach if strong (>3m significant wave heights) are predicted as this will result in premature closure.
- Minimise the use of earth moving equipment above the high tide level, use the most direct route to the intertidal and avoid dunes and vegetation.
- Walk the route to be used by earthmoving equipment or vehicles during mouth opening and identify any sensitive areas or coastal bird nests to be avoided.
- Where possible, use existing access routes, minimise the impact footprint on the intertidal.

4.9.2 Straightening of estuary mouth

This management measure is unlikely to be required as the migration of the estuary takes place to the west along an undeveloped section of shore within the Helderberg MPA. This beach is also an important roosting site for terns and gulls and there appears to be no justification for using earthmoving equipment when no infrastructure is threatened.

4.10 CONCLUSION

The maintenance measures required for Lourens estuary all seek to improve the functioning of the City's stormwater system and to minimise any negative impacts on the environment (most interventions are intended to have positive impacts). Effective mitigation is available for all proposed maintenance activities and all negative impacts are assessed as being at most of LOW significance.

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