Course, Youngsfield and towards Southfield. This aquifer is a source of relatively good quality water by comparison with that received from the Lotus rivers and the inflows from the farming areas to the south-east.[4]

Rondevlei is considerably smaller than its neighbour, covering an area of approximately 0.45 square kilometres. The surface inflow is mainly via the Italian Road canals, and the outflow to the Zeekoe Canal is in the south-east corner.

Rondevlei is thought to be the remnants of an historic bay of Zeekoevlei. A natural link existed between the two vleis and, indeed, an outlet weir and connection that allowed intermittent flow between the two was still in place until 1943, when it was closed permanently and an outlet from Rondevlei was constructed to connect to the Zeekoevlei outlet canal.

Zeekoevlei and Rondevlei are almost certainly relict estuarine lagoons, which like many other of the Cape Flats vleis, dried up seasonally before the development of their surrounding catchment. Old maps show an outlet from Zeekoevlei to the sea, but this closed during the first quarter of the last century.[5] Old inhabitants reported that sea and estuarine fish had been common before the original opening closed. These included white steenbras (*Lithognathus lithognathus*), flathead mullet (*Mugil*

4 Harding (2000)
5 Bickerton (1982)

Zeekoevlei from the Environmental Centre, January 2008 (Photo: Rembu Magoba)

cephalus) and longfin eel (*Anguilla mossambica*).[6] By 1942, Zeekoevlei and Rondevlei were not directly connected to the sea, although there was a series of marshes that stretched from the south-eastern corner of Zeekoevlei and were flooded during high water levels in winter. These were later incorporated into the Cape Flats (or Strandfontein Flats) Wastewater Treatment Works.

Today, the Zeekoe Canal emerges onto the beach near Muizenburg, where it is dammed up behind the high beach bar leading to the development of a shallow, long-shore lagoon. The lagoon, because of its elevation, is not tidal and tends to overtop the beach bar. The outlet channel can meander extensively and the City of Cape Town periodically straightens the outlet seawards of the Baden Powell Bridge to prevent erosion of the road structures. To assist in maintaining a straight line from the bridge to the edge of the sea, the canal was at one time lined with concrete. Remnants of these concrete walls can still be seen near the mouth.

Details of the present-day Zeekoevlei and Rondevlei

	Zeekoevlei	Rondevlei
Catchment area	8.01×10^7 m^2	1.23×10^7 m^2
Mean annual runoff	2.01×10^7 m^3	4.26×10^6 m^3
Lake surface area	2.56×10^6 m^2	4.49×10^5 m^2
Lake volume	5.0×10^6 m^3	6.8×10^3 m^3
Lake mean depth	1.91 m	1.43 m
Mean annual precipitation minus evaporation	-0.85 m	-0.85 m

6 Harrison (1958)

Timeline: Zeekoevlei

circa	
1942	Artificial connection established from Zeekoevlei to the sea
1946	Weir constructed at the head of Zeekoe Canal. This maintained water levels in the vlei but prevented nutrient flushing
1949	Big and Little Lotus "Rivers" canalised to drain Ottery and Grassy Park
1951	Proliferation of pondweed in the vlei "controlled" through application of a chemical weedkiller, which caused an algal bloom in response to nutrients released by decaying plant matter
1962	Outflow from the Cape Flats Wastewater Treatment Works connected to the Zeekoe Canal
1964	Cape Flats Wastewater Treatment Works extended and final effluent chlorinated and discharged into the Zeekoe Canal
1970	Lotus River housing scheme built, with runoff draining into the Lotus Canal
1977	Cape Flats Wastewater Treatment Works maturation pond system unable to cope and new treatment works built, incorporating activated sludge process
1980	Large-scale developments in catchment increased hydraulic and water quality pressures on the vlei
1983	200 000 m^3 polluted sediment dredged from the vlei
1987	Lotus canals reengineered to cope with additional runoff from developed catchment. Canals lined and a few detention ponds constructed. Flooding reduced but water quality in the vlei showed little improvement
1995	Vlei regarded as the one of the most polluted inland water body in the country
1997	Weir modified to allow for manipulations in vlei water levels. First drawdown of water levels
1998	Lethal bloom of blue green algae reported. Meandering Zeekoe Canal stabilised to prevent damage to Baden Powell Drive
1999	Regular annual drawdown of the water levels in the vlei implemented, which marginally improved water quality. Zeekoevlei Environmental Forum wins Caltex award
2000	Proclamation of local authority nature reserve and vegetated reinforced dune constructed to control the meanders and protect Baden Powell Drive
2008	Cut-off drain installed along southern shore of Zeekoevlei to reduce phosphate pollution from the adjacent Cape Flats Wastewater Treatment Works

The Big Lotus "River"

It is not clear how much of the Big Lotus "River" existed in a natural state. In its original form, part of what is now the Big Lotus "River" was a string of seasonal wetlands that, in the winter months, received runoff from as far away as the area where the Ottery Hypermarket is now located.

The Big Lotus "River" was constructed to receive stormwater runoff from the airport, the growing housing schemes in Nyanga and Guguletu, and the agricultural area known as Vaderlandsche Rietvlei. The route of the canal was determined by land availability rather than hydraulic considerations and, as a result, much of it lies on a watershed.[7] By 1980, development in the catchment combined with importunate infilling of the seasonal wetlands, particularly those in the Ottery area, had significantly changed the runoff characteristics: peak rainfall and run-off increased, while water quality deteriorated. The effect on Zeekoevlei was (and is) devastating.

In 1987 additional artificial flood control measures were introduced in a project that saw the creation of a large off-line detention pond, the Edith Stephens detention pond, located in the Edith Stephens Wetland Park, which doubles as a bird sanctuary, and a few more small detention ponds. The scheme addressed flood control but did little to improve water quality in Zeekoevlei.

Cape Town's Olympic bid effort in 1997 proposed including the Big Lotus in the Olympic marathon route, which raised the exciting possibility of upgrading the canal and adjacent areas. The collapse of the bid meant that little further progress was achieved in that direction, however.

Development of the catchment is still not complete. Guguletu and Nyanga, and the formalised Crossroads Township, continue to grow, the Lansdowne – Wetton Road corridor is a major development node, and major extensions to Cape Town International Airport are underway. These will no-doubt increase the runoff into Zeekoevlei and, if the appropriate mitigation measures are not implementated, could reduce the quality of water entering the vlei.

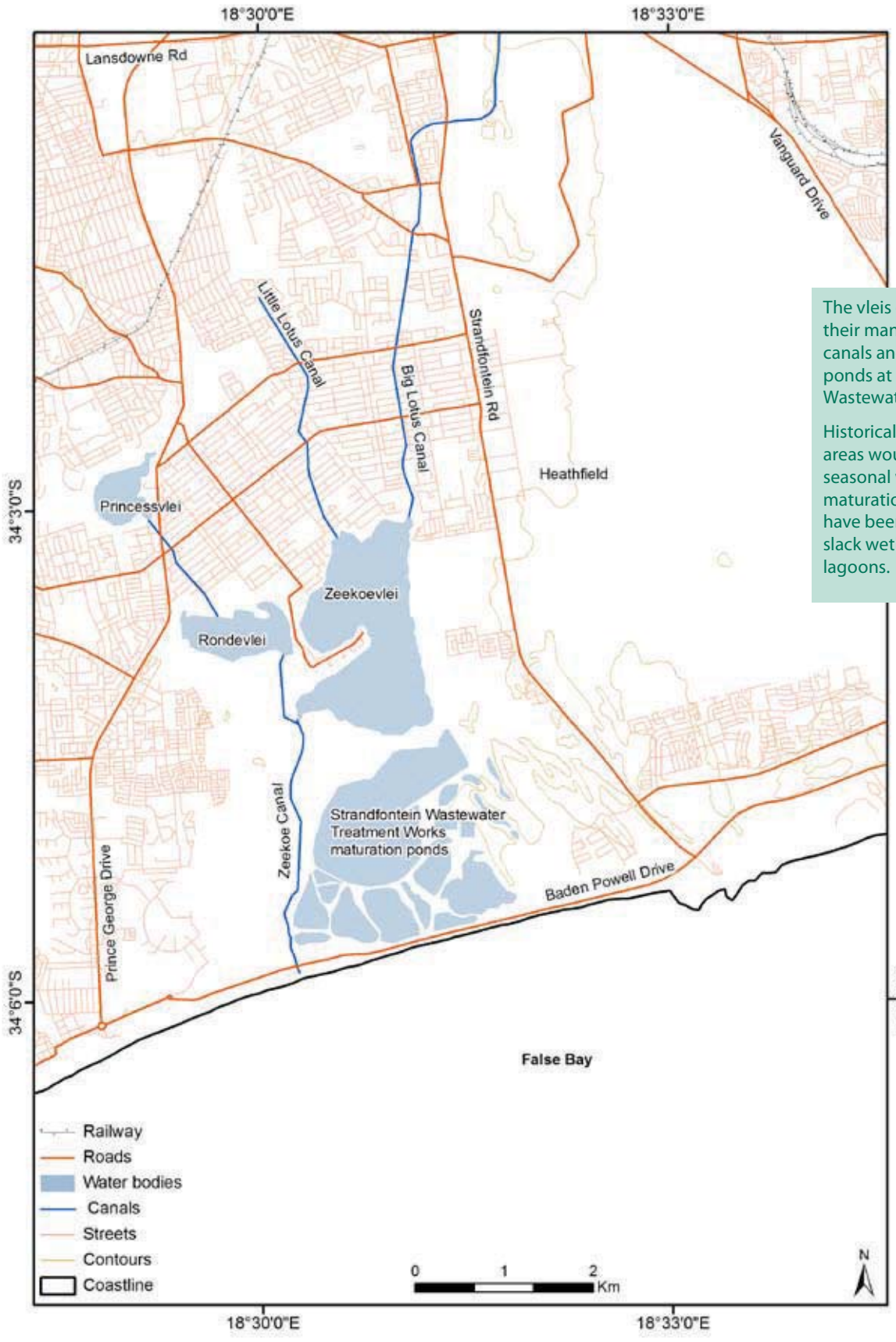
The Little Lotus "River"

The Little Lotus "River", like its larger cousin, was naturally a seasonal wetland. The canal was dug during World War II to drain the then-new Youngsfield Aerodrome and military base.

Rondevlei Nature Reserve

Rondevlei Nature Reserve was established as the Rondevlei Wild Bird Sanctuary on 1st January 1952, around the natural vlei of that name. Despite the fact that the surroundings of the vlei were at that time semi-rural, ornithologists and other bird lovers were concerned about the decline in the numbers of birds associated with the vleis of the area. With the cooperation of the then Cape Divisional Council, the

7 An elevated ridge between two catchment areas



The vleis of the Cape Flats, their man-made feeder canals and the maturation ponds at Cape Flats Wastewater Treatment Works

Historically, the canalised areas would have been seasonal wetlands, and the maturation ponds would have been seasonal dune-slack wetlands or estuarine lagoons.

The fencing of Rondevlei Nature Reserve was completed in 1995. (Photo: Rembu Magoba)

sanctuary was established to conserve a sample of this rich habitat for posterity. In 1985 the name was changed to the Rondevlei Nature Reserve. In 1997, management was taken over by the South Peninsula Municipality, and the reserve is now managed by the City of Cape Town's Environmental Resource Management Department.[8]

Soon after the Rondevlei Nature Reserve was established, rapid urban development of the surrounding land began. Several canals that were built to drain the housing developments were led directly into the vlei. In 1958, to prevent flooding of the built-up areas, the level of Rondevlei was permanently lowered through the construction of a weir its the south-eastern. (This weir was breached and sluice gates installed in 1998 in order to manipulate water levels.)

Originally, the Rondevlei Nature Reserve consisted of the vlei plus a narrow margin of land, with a total area of 100 hectares. In 1963, two small areas were added. In 1987, after considerable debate with the housing committee of the City of Cape Town, a further 98 hectares of dunes and seasonal wetlands to the south of the vlei were made available to the reserve. The fencing and incorporation of this portion of the reserve took place in 1995.

The low human disturbance levels of the Rondevlei Nature Reserve environment, together with a greater seasonal availability of shallow wading habitat (which Zeekoevlei lacks), makes the smaller vlei attractive to bird life. Rondevlei provides habitat for 10 species of birds that are of rare or indeterminate status.

Restoration projects to promote biodiversity conservation have been ongoing for

8 www.rondevlei.co.za

Rondevlei Nature Reserve with Muizenberg Mountain in the background, January 2008 (Photo: Rembu Magoba)

Rondevlei Hippos – The return of the big boys!

Twelve days after Van Riebeeck arrived in South Africa in 1652, he shot his first hippo on what is now Cape Town's Church Square. Hippos were plentiful in the Western Cape at the time and large herds inhabited wetlands on the Cape Flats, such as Rondevlei. By the 1700s, the Western Cape hippo population had been exterminated.

In 1979, *Hippopotamus amphibius* were reintroduced into Rondevlei after an absence of almost three hundred years. Two males and two females were relocated from Kwa-Zulu Natal. The population was initially brought in to control vleigras (*Paspalum vaginatum*), an alien grass, which was smothering the wetland. The Vleigras prevented many of the bird species from reaching the mud layer, thus limiting their feeding ability. The hippos swiftly ate the vleigras and opened up the reed beds, distributing nutrients throughout the system. Being bulk herbivores, capable of eating up to 100 kilograms per day, these mammals play a vital role in maintaining biodiversity in the wetland system and cannot be substituted with any other herbivore. Once the Vleigras problem was solved, the hippopotami fed on and still feed on indigenous buffalo grass and the invasive kikuyu grass. Besides their valuable ecological role hippos are also great for tourism, and visitors to Rondevlei always delight in seeing hippos.

Cliff Dorse, City of Cape Town

several years at Rondevlei. These have included clearing of alien vegetation, removal of accumulated sand and restoring the structure of the original Middelvlei wetland. In 1979, hippopotami were reintroduced into the vlei and have since bred occasionally. The hippos have succeeded in eliminating *Paspalum* grass, an alien invasive that was choking the vlei and have improved the habitat for birds by opening up channels through the reeds. They also added an interesting dimension to the life of local residents when a male hippo escaped from the Reserve and eluded recapture for some time by taking cover in the nearby Wastewater Treatment Works.

Urbanisation and the ecological functioning of Rondevlei and Zeekoevlei[9]

The ecological functioning of both Rondevlei and Zeekoevlei has been affected by the runoff and groundwater seepage they receive from the surrounding catchments. The impacts are two-fold: controlled and fairly constant water levels and nutrient enrichment, much of which is attached to sediments entering via stormwater canals or transported by groundwater from the nearby Cape Flats Wastewater Treatment Works.

In the past, water levels fluctuated greatly and in summer large marginal areas of the vlei became dry white sandflats. The water was brackish and formed a salt crust where it evaporated on the shore. The water was clear and water weeds were present in the northern corner. The development of the Grassy Park area increased peak runoff and caused flooding of houses around the vlei. The water weed (*Potamogeton)* also increased to such an extent that the Zeekoevlei Yacht Club had to maintain a weed cutter to enable yachting. In the 1950s, attempts to control the pondweed using a chemical weedkiller backfired as the nutrients released by decaying plant matter resulted in an algal bloom, which turned the water pea-soup green.[10]

Today, nutrient enrichment in Zeekoevlei is about three times greater than that of Rondevlei. The combination of high nutrient levels and controlled water levels provides an ideal situation for phytoplankton blooms. Consequently, from the late 1990s, near-permanent algal blooms plagued Zeekoevlei in particular. The dominance of algae had knock-on effects through the rest of the flood chain and the fauna consisted mainly of zooplankton and fish such as carp (*Cyprinus carpio*).

In 1997, a management scheme was initiated in Zeekoevlei that involved opening the sluice gates in the Zeekoevlei weir in late summer in order to draw down the water levels of the vlei. The previously solid weir was altered through the construction of six openings that permitted adjustment of water levels in the vlei. These openings allow for the release of up to three million of the estimated five million cubic metres of water in Zeekoevlei.[11] The contribution of low-nutrient water from the aquifer to Zeekoevlei increases during the drawdown when an approximately 1.2-meter 'head' is removed as the vlei's water level is dropped. The first drawdown improved the functioning of the vlei through a reduction in the phytoplankton and improved light penetration.

9 Harding (2000)
10 Bickerton (1982)
11 Roger Godwin, False Bay Ecology Park, personal communication

ZEEKOEVLEI YACHT CLUB

The first sails appeared on the Zeekoevlei in about 1925, when the late Greg Joyce and Leslie Gray brought a dinghy called a 'Redwing' to the vlei. Others followed rapidly, including Goodricke 16-foot racers. The Zeekoevlei Yacht Club was formed in 1932, and the first building on the vlei, called 'Pine's Bungalow' in Skippers End, became the unofficial headquarters. Vice Admiral Tweedie lent his support to the fledgling club and Lady Tweedie performed the official opening. Elkan Green, at the age of 20, was the first secretary. The first official clubhouse was built where the swimming pool is today. The Governor-General, the Earl of Claredon, opened it on February 12, 1934. A path had been cut through the bush to Peninsula Road to allow him access but then it was discovered that he could not walk that far and the path had to be widened to accommodate his car. This 'path', known as 'Governor's Walk', exists today.

www.zvyc.org.za/history.htm

A 'Juniors' regatta at Zeekoevlei Yacht Club (Photo: Roger Godwin)

The improved clarity as a result of the new management scheme also saw an increase in the numbers of fish-eating birds at Zeekoevlei. Drawdowns have taken place each year since then but the initial dramatic success in promoting a clear water phase has not been achieved again. The sluice gates on the weir have recently been upgraded. From August 2007 onwards, overflow of clean water will be prevented and drainage will comprise the more contaminated bottom water.

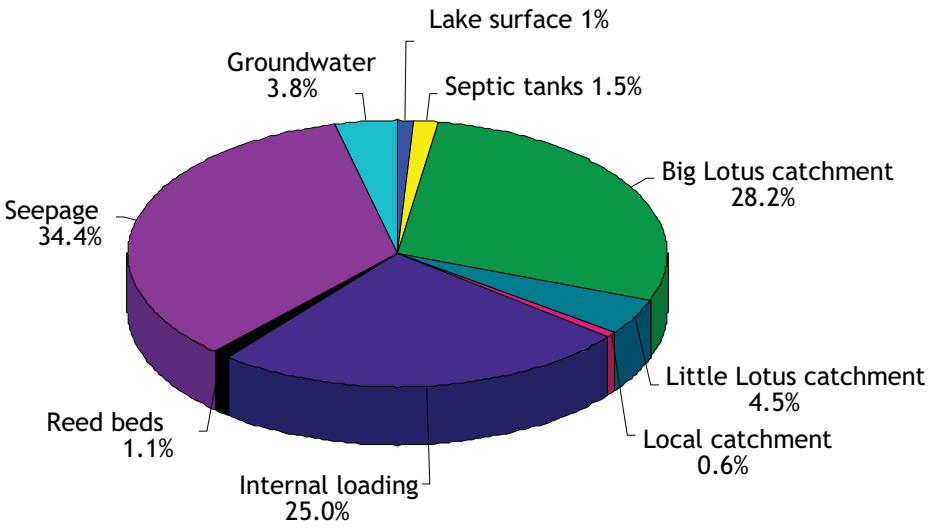
In addition, nearly R5 million has been spent on low-flow diversion weirs in the Lotus River catchment upstream of Zeekoevlei in an effort to reduce the amount of pollution entering the vlei in the summer months.

In 2008, another initiative to reduce nutrient loading to the vlei was implemented, when a cut-off drain was installed along southern shore of Zeekoevlei to reduce phosphate pollution from the Wastewater Treatment Works. The cost of this cut-off drain was in the region of R6 million. The efficiency of the drain in reducing nutrient input to the vlei will now be monitored.

Seepage from the Cape Flats Wastewater Treatment Works into Zeekoevlei, prior to 2008. The cut-off drain, completed in 2008, is designed to reduce the seepage from the WWTW. (Photo: Roger Godwin)

The excitement of the first drawdown, 1997 (Photo: City of Cape Town)

The "new" weir gates (Photo: Roger Godwin)



A breakdown of the origins of the phosphorous in Zeekoevlei seepage. The Cape Flats Wastewater Treatment Works is a major contributor, as is the runoff that washes into the Big Lotus Canal. (Harding 2000)

THE BOTTOM ROAD SANCTUARY

The Bottom Road Sanctuary, initiated by City of Cape Town Nature Conservation staff in 2005 as a partnership with residents bordering the Zeekoevlei Nature Reserve, is a flagship project where urban stewardship has taken on a very real meaning to local residents. The project started with a few residents relinquishing their ideas for a landscaped edge with the wetland and opting rather to rehabilitate the natural habitat. Bulldozers were brought in and the kikuyu lawns and play park areas made way for *Psoraleas*, restios and the rare *Erica verticillata*, which had all but disappeared from the Cape Flats. Following the lead of the Bottom Road residents, the project is now extending to other parts of the vlei and into the terrestrial parts of the residential area where open spaces are being returned to conservation nodes of indigenous vegetation.

The exit of the cut-off drain that was installed in 2008 in an effort to reduce seepage into Zeekoevlei from the Cape Flats Wastewater Treatment Works
(Photo: Roger Godwin)

Redknobbed coot and chick (Photo: Sion Stanton – www.sionstanton.com)

Flamingos at dawn on the maturation ponds at Cape Flats Wastewater Treatment Works. The Cape Flats Wastewater Treatment Works is located just south of Zeekoevlei and Rondevlei on the north coast of False Bay. (Photo: Roger Godwin)

Cape Flats Wastewater Treatment Works

Cape Flats Wastewater Treatment Works is located just south of Zeekoevlei and Rondevlei on the north coast of False Bay and covers an area of approximately 380 hectares.

Once a naturally occurring dune-slack wetland, the area was converted into a series of settling and oxidation ponds when the wastewater treatment works were developed in 1956. These were later extended in 1964, 1977 and 1997 in an effort to keep up with the rapid development of the surrounding areas.

The wastewater treatment works have attracted large numbers of migrant birds and have become a significant bird sanctuary. The ponding area currently comprises 319 hectares of aquatic habitats and 58 hectares of terrestrial habitats, and has one of the highest diversities of migrant waders in the Western Cape. Five major aquatic habitats are recognised: permanent open ponds, seasonal open ponds, canals with aquatic vegetation (mainly *Typha*, *Phragmites* and *Scirpus* spp.) reedbeds and sludgebeds. The wastewater treatment works are part of the False Bay Ecology Park, and a designated Important Bird Area.[12] The Cape Bird Club and the City of Cape Town jointly employ a

12 Kalejta-Summers and Underhill (2001)

Princessvlei, January 2008 (Photo: Rembu Magoba)

conservator to look after the biodiversity at the works; working with the Wastewater department to manipulate water levels, and other initiatives, to enhance the habitat for birds.[13]

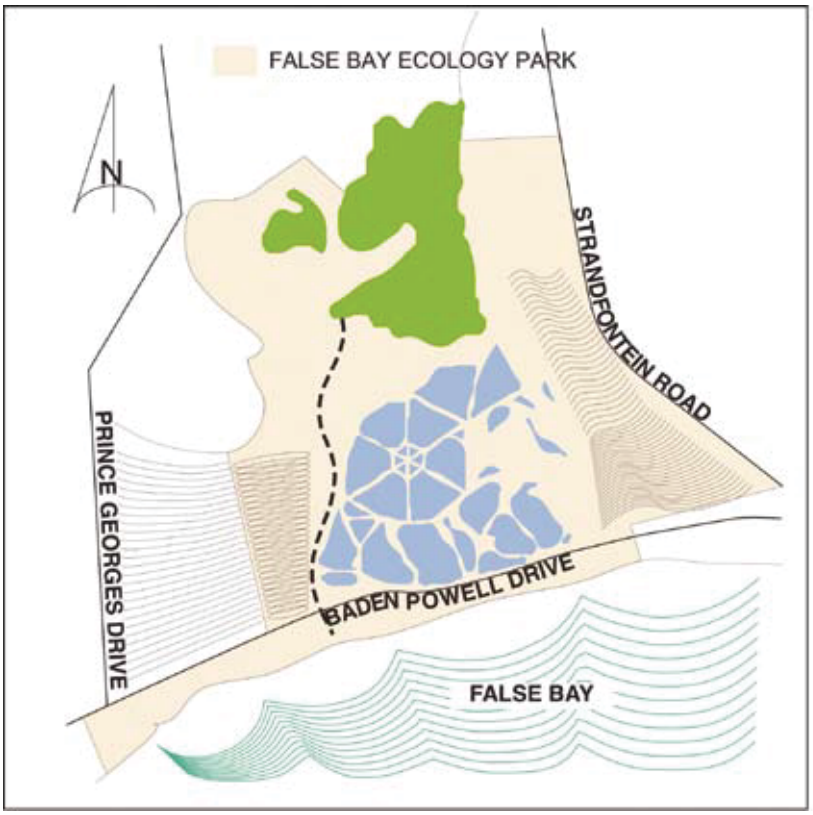
Princessvlei

Princessvlei is a small (29 hectares), shallow, eutrophic freshwater coastal vlei to the north of Rondevlei. Once, when the southern Cape Flats was a mass of dunes vleis and wetlands, it was linked to Little Princessvlei and the Diep River, but the Little Princessvlei is no longer in the same catchment. The link to the Diep River was restored in the mid-1990s so that Princessvlei could act as a flood attenuation pond for the Diep River. Up until the later 1990s, the vlei drained into Rondevlei, but to reduce pollution in Rondevlei, the outflow (along with that of the Italian Road Canal draining Grassy Park) was diverted through a system of reed beds before entering the vlei.

The name "Princess" is apparently linked to the legend of a Khoisan tribe that lived on the slopes of Constantiaberg and was ruled by a princess. While bathing in the vlei she was allegedly abducted by Portuguese sailors and taken to Europe. This rare indigenous legend is worth preserving.

In an effort to provide entertainment for the youth, Princessvlei Enviro Centre was developed on an old disused municipal caravan park adjacent to the vlei.

13 Julia Wood, City of Cape Town, personal communication



(Map: Roger Godwin)

False Bay Ecology Park

False Bay Ecology Park (FBEP) encompasses the water bodies of Zeekoevlei, Rondevlei and the Cape Flats Wastewater Treatment Works, the Coastal Park Landfill site to the west of the wastewater treatment works and a portion of the wetlands in Pelican Park. The landfill provides a southwest buffer zone between the FBEP and the Capricorn Business Park development beyond.

The landfill, which processes all the solid waste from the Southern Peninsula, has an expected lifespan of approximately 20 years, if carefully managed.

Half of the Peninsula's population of waterbirds is found in this system.

Participating organisations in the FBEP: Zandvlei Trust, Zeekoevlei Yacht Club, Friends of Zeekoevlei and Rondevlei, Zeekoevlei Environmental Forum, CAFDA, Western Cape Freshwater Angling, Zeekoevlei Civic Association, Cape Town Environmental Education Trust, Wildlife and Environmental Society of South Africa, Cape Nature, Botanical Society of South Africa, Cape Bird Club, Imvubu Tours, Table Mountain Fund, City of Cape Town.*

* Rondevlei Nature Reserve pamphlet

The Pelican Park wetlands

The Pelican Park Wetlands comprise a small area of undisturbed wetlands situated between high sickle-shaped dunes to the east of Zeekoevlei and Rondevlei. Both the extreme north and the extreme south of these wetlands have been impacted by alien invasion and bulldozing respectively, and there is some informal settlement adjacent to Cape Flats Road. The middle section, however, remains in excellent condition and contains several Red Data wetland vegetation species.[14]

AN INVALUABLE INHERITANCE

70% of greater Cape Town environmental education is conducted through the Zeekoevlei Peninsula and South Shore education centres. Application for RAMSAR status as a world environmental heritage site is currently under way. With declining water quality now reversed, the single biggest threat to the Park, the flora and fauna, the tourism potential and to the present user groups is the recently revived proposed R300 route close to the south shore.

Roger Godwin, FBEP.

14 van den Honert (1998)

"Beyond the vineyards lies False Bay, with its lines of simmering sand, … bounded on the right by the Muizenberg and Tokai ranges, and also the famous vlei of Lakeside, with its fleet of pleasure-boats …"

Somerset Playne - compiler and editor of Cape Colony. Its history, commerce, industries and resources. (1910-11)*

* Playne (1910-11)

Chapter 13

Zandvlei and its catchment

Zandvlei

Zandvlei, at 155 hectares, is the largest of eight estuaries on the False Bay coastline, and provides 80% of the estuarine area in the bay. Its estuarine characteristics include the presence of sandprawn (*Callianassa kraussi*), white steenbras (*Lithognathus lithognathus*), leervis (*Lichia amia*) and harder (*Liza richardsonii*). It is also home to more than 185 indigenous plant species (of which 10 are on the Red Data Book list),

The bird hide on Park Island at Zandvlei, 2004 (Photo: Cherry Giljam)

27 fish species – some possibly introduced, 144 bird species, 17 mammal, 16 reptile and five frog species – one of which is the Red Data species, the Western Leopard Toad (*Amietophrynus pantherinus*).[1]

Zandvlei receives the bulk of its fresh water from three river systems draining the eastern slopes of the Peninsula mountain chain. The three rivers are the Westlake, Keysers and Sand. The Sand River starts as the Diep River, which rises above Constantia, flows through a series of greenbelts and public open spaces before crossing under the M3 (van der Stel) Freeway and into Little Princessvlei and Zandvlei. Upon leaving Little Princessvlei, the river becomes known as the Sand River. The Westlake River has its source in the lower slopes of the Steenberg Mountain, after which it flows through the grounds of the new United States of America Embassy and those of the Polsmoor Prison, and the Kirstenhof Wetlands before entering Zandvlei. The Keysers River rises on Constantiaberg as a series of small streams, the most notable of which are the Grootbosch, Spaanschemat and Prinseskasteel rivers. All of these streams have been affected by urban development since World War II and have been modified in various ways.

Zandvlei, near Muizenber, is a long, shallow system. It is 2.5 kilometres long and 0.5 kilometres wide at its widest point, excluding Marina da Gama, and has a depth of between 0.7 and 1.3 metres. In its current configuration, Zandvlei can be divided into three basic components[2]: the main vlei (approximately 57 hectares), the Marina da Gama canal system (approximately 336 hectares) and the Westlake wetland (approximately 31 hectares, including about 4 hectares of open water). Although naturally a wholly estuarine system, today the system is only semi-estuarine as a result of changes to its catchment and mouth. The exit to the sea consists of a 20-metre wide, concrete channel. The water level in the estuary is controlled either by a rubble weir situated in the channel or by a sand bar which periodically closes the mouth.

1 www.zandvleitrust.org.za
2 Morant and Grindley (1982)

Zandvlei with Devil's Peak in the distance, June 2007 (Photo: Gavin Lawson)

The vlei appears to have been named Zandvlei by van Riebeeck during one of his early tours of the territory. In 1673, the VOC established a cattle post on the shores of the vlei and, in 1744, a fortified post was established there under Sergeant Wynand Willem Muys, whose name is preserved in the suburb of Muizenberg.[3]

The embankments for the railway to cross the north-western edges of the vlei were built in 1882, and the resultant ease of access led to increased use for recreation. The first rowing regatta was held in June 1884, and the Imperial Yacht Club was established in 1907. The original bridge across the mouth was replaced in 1907 with a new structure.

Interestingly, the vlei under natural conditions dried out completely at times. If, for example, the inflow into the vlei were reduced during the period when the mouth was closed, then evaporation would play a dominant role in the system. It is likely that evaporation would have caused hypersaline (salinity higher than seawater) conditions to prevail for a while and, if the drought persisted, the entire vlei would have eventually dried up (as seen from a 1944 aerial photograph). In 1866, the water level in the vlei was drastically lowered by such a drought, and a plan was put forward to drain the vlei completely and reclaim the land. The outlet to the sea was closed and attempts were made to pump the vlei dry, but the scheme failed when the winter inflow from the contributing rivers brought the efforts to nought.

3 Burman (1962)

This bench on Wildwood Island offers views of Zandvlei and Steenberg Peak. (Photo: Gavin Lawson)

Until *circa* 1920, the lower part of the vlei was influenced by high tides and there was a large area of open water, and fish such as white steenbras, leervis and flathead mullet were plentiful. After the mouth of the vlei was controlled by a weir and canalised under the Muizenberg promenade, however, the shallow lake bed gradually became a marsh, and in many summers the vlei was almost dry.[4] In 1939 plans had been put forward to dredge the vlei and stabilise the water level but World War II put these on hold. By 1946, the increased siltation and weed infestation was so bad that the yacht club had to disband. Work on dredging the vlei and stabilising its water level started in 1947 and was completed in 1961 when the western bank was reclaimed, stabilised and extensive recreation areas established. The yacht club was reconstituted and other boating organisations were established. The vlei was further modified in the 1970s when Marina da Gama was built on its eastern shores.

In its natural state, water levels in Zandvlei of 2.5 to 3.0 metres above Mean Sea Level were often reached before the level of the sand berm was breached, and in the process a large area around Zandvlei was flooded. After breachings (opening of the mouth), large amounts of sediments were flushed from the mouth region resulting in a wide, open mouth with channel depths of up to 4.0 metres below Mean Sea Level. Strong tidal exchange occurred and the mouth would have stayed open for long periods because of the greater tidal exchange, which would have also resulted in an increase in the salinity concentrations in the vlei.[5]

4 Harrison (1950)
5 CSIR (2000)

Holiday homes on the Rutter Road Pond in the 1890s. (Photo: with permission of Gavin Lawson)

Highest and lowest water levels for Zandvlei under natural and present-day conditions

	Highest water level	Lowest water level
	Metres relative to Mean Sea Level	
Natural	+2.5 to +3.0	0.0 to +0.3
Present-day	+1.3 to +1.4	+0.9 to +0.7

Today, low-lying residential developments, especially Marina da Gama, necessitate artificial mouth breaching while the water level in the vlei is only at 1.1 to 1.4 metres above Mean Sea Level. Consequently, flushing of sediments after breaching is insufficient to open the mouth properly and maintain a prolonged connection to the sea. This situation is exacerbated by the presence of the rubble weir (used to maintain a high water level in the vlei for boating), which prevents the water levels from dropping low enough to allow significant scouring and an adequate influx of seawater. The result is considerable sedimentation in the vlei, particularly directly upstream of the mouth, which has reduced the available waterway area under the

This aerial photograph of Zandvlei, taken in 1944, shows the dried-out vlei. (Photo: Mapping and Survey)

Mud cracks in Central Pan, Zandvlei Estuary Nature Reserve, in late summer, March 2005, with Muizenberg Mountain in the background. The pan is managed in such a way that replicates the functioning of many of the original wetlands of the area it and dries out in summer. This also attracts waders. (Photo: Gordon Richardson)

road bridge to pass floods. The estuarine functioning of Zandvlei has also been compromised, with only brackish salinities of about 10-15 parts per thousand being recorded under these conditions.

In an attempt to rectify the salinity gradient in Zandvlei, the City of Cape Town has recently implemented artificial breachings during high spring tides. This significantly increased the salinity gradient in the system (values of between 20 and 25 parts per thousand are now recorded after an opening) and improved estuarine conditions.

In 1984 as small portion of the vlei and the surrounding wetlands was proclaimed a nature reserve. In 1988, the Zandvlei Trust[6] was formed, with the aim of conserving the indigenous fauna and flora of Zandvlei for the benefit of all. Participants in the Zandvlei Community Monitoring Programme also measure salinities at a number of locations in the vlei on a weekly basis and supply the information needed to determine when he mouth can, or should, be opened. In 2000, the boundaries of the nature reserve were extended to include the entire vlei, Westlake Wetlands and the Sand River mouth, and renamed the Zandvlei Estuary Nature Reserve.

Marina da Gama

In 1898, a Mr J.H. Wood formed a consortium to promote a "pleasure lake" on what he called Muizenberg Vlei. The proposals included a boating course, "bathing houses" and a cycling track. The local Council was not supportive, however, and the idea lay dormant for more than 70 years.

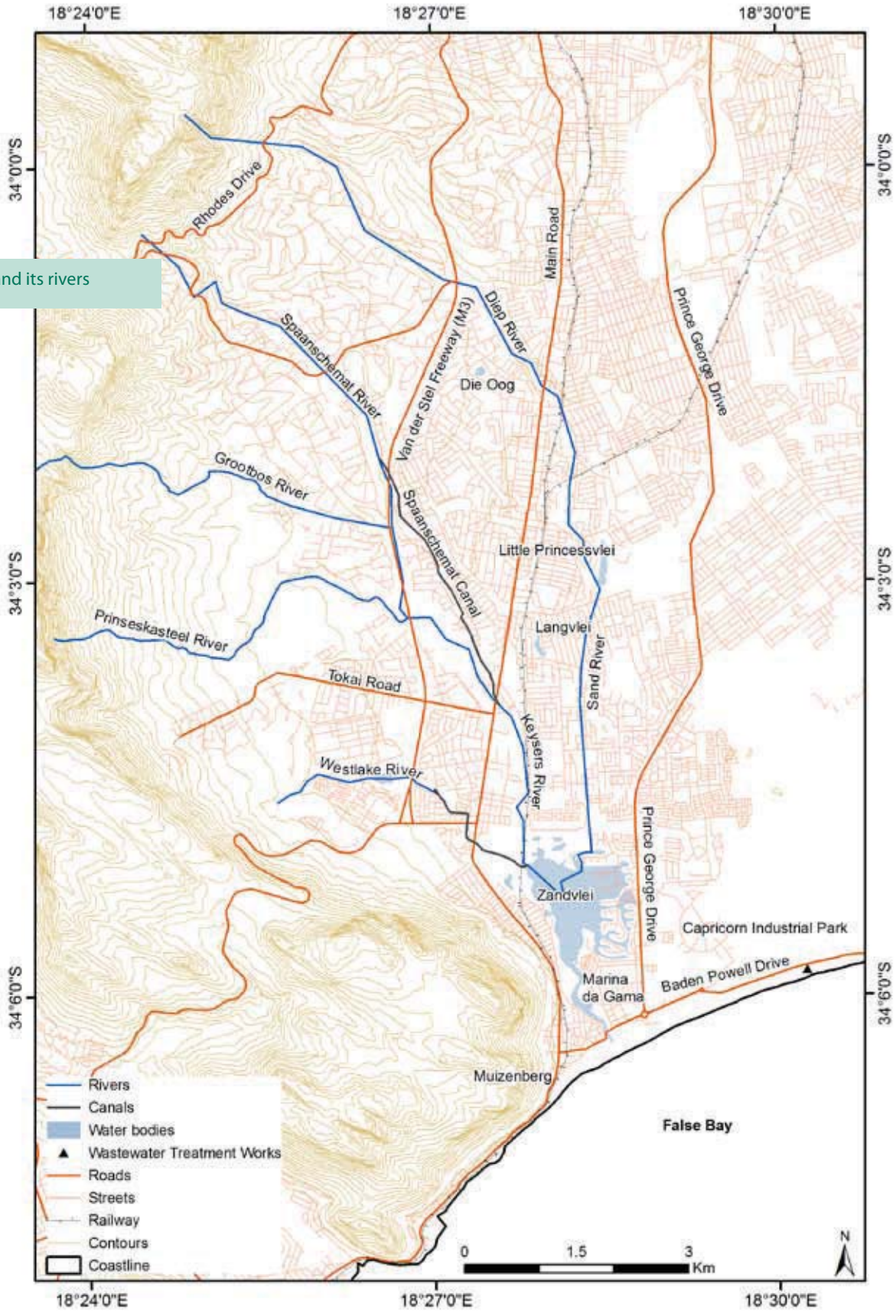
Then, in 1970, the Anglo American Corporation proposed elaborate plans to convert Zandvlei into a vast marina with an ocean harbour on the eastern side of Prince George Drive. A substantial organisation was set up to guide the development. This

6 www.zandvleitrust.org.za

Central Pan, Zandvlei Estuary Nature Reserve, in winter, June 2003, with Muizenberg Mountain in the background (Photo: Gavin Lawson)

A wetland remnant in Zandvlei Estuary Nature Reserve. There are more red data species per unit area in this habitat type than anywhere else in the world. (Photo: Zandvlei Trust)

Zandvlei and its rivers



Capricorn Lake is situated in Capricorn Park in Muizenberg. (Photo: Rembu Magoba)

Capricorn Lake[7]

Capricorn Park is a light industrial business park situated on Prince George Drive, Muizenberg. It is on the opposite side from Marina da Gama, where once there were plans for a vast marina with an ocean harbour.

Capricorn Lake is the central feature of Capricorn Park, and successfully demonstrates how the City of Cape Town's requirement that stormwater runoff be retained, treated and infiltrated on new developments, can be used to enhance the aesthetic value of the property.

The lake is currently approximately four hectares in area, but there are plans to increase this to nearer nine hectares in further phases of the park. The lake is unlined and about two metres deep and was planted with pondweed (*Potamogeton pectinatus*), which assists in maintaining a water quality acceptable to humans.

The Westlake River

Westlake River, which rises on Steenberg Mountain, is also known as the Steenberg and the Raapkraal River. It flows into Zandvlei near the intersection of Main Road and Boyes Drive just before the suburb of Lakeside.

In Kirstenhof, the Westlake River has a healthy population of Western Leopard Toad with thousands of tiny black tadpoles seen during most spring seasons. It also has very healthy populations of virtually every alien aquatic plant and animal known from the Peninsula. Fortunately, the introduction of biocontrol agents for the alien aquatic plant, parrot's feather (*Myriophyllum aquaticum*) has been very successful in curbing the spread of this pest.[8]

7 Brown (1996)
8 Candice Haskins, City of Cape Town, personal observation (2007)

This aerial view of Zandvlei, taken *circa* 1973, shows the construction of the Eastlake portion of what was to be the giant Marina da Gama. (Photo: Jenny Day)

THE SAND RIVER CATCHMENT FORUM

The Sand River Catchment Forum (SRCF) is made up of City, provincial officials and SANparks officials from the different divisions that operate in the Sand River Catchment, plus various volunteer, civil society and interest groups. The catchment extends from above Kirstenbosch in the north; west along the Peninsula Mountain range; Princessvlei area in the east; and Zandvlei in the south.

The SRCF seeks practical solutions to address issues of water quality, environmental and flood management in the catchment, and to improve processes and procedures of operational management. It is a dynamic group, which evolves as issues arise and/or new group representatives join.

The Greater Zandvlei Estuary: A local community/ local authority success story

In 2002, a landmark co-operative project centred on Zandvlei was awarded the Cape Times/Caltex Environmental Award. The project involved the:

- Marina da Gama Residents Association and Friends of Park Island,
- Zandvlei Trust,
- City of Cape Town,
- Cape Bird Club,
- local residents of Muizenberg and Lakeside,
- Institute of Plant Conservation, UCT, and
- users of the vlei.

The various local government/local community partnerships that developed as part of the process continue today and have resulted in many successful rehabilitation, monitoring and education projects, which work towards the conservation and upgrading of Zandvlei for the long-term benefit for all. The projects include:

- the rehabilitation of Park Island, the Westlake Wetland, the area upstream of Royal Road bridge and the Langvlei Canal;
- the Zandvlei Inventory and Monitoring Project (ZIMP);
- a community salinity monitoring programme; and
- the Zandvlei Environmental Education programme.

Members of the Cape Bird Club at the viewing platform, Zandvlei Estuary Nature Reserve, December 2004 (Photo: Gavin Lawson)

Diep/Sand River and Little Princessvlei

The Diep/Sand River system drains the southern end of Table Mountain and the area immediately south of Wynberg Hill. The river starts as the Diep River but downstream of Little Princessvlei is referred to as the Sand River. The upper reaches flow though wide areas of linked public open space in Constantia, but below the "Blue Route" freeway the authorities were not so generous with the river reserve. In the reach below the main suburban railway line, it originally spread out into a series of vleis separated by large sand dunes and it is not clear whether it had a clearly defined course to Zandvlei.

Keysers River

The Keysers/Spaanschemat River system drains Constantiaberg and enters Zandvlei in the north-western corner. Keysers River is the accepted name of the lower reaches. The name was in use before 1698 and apparently commemorates one Johannes Kaiser who fell into it and was drowned.

A large seasonal lake, known as Louw's Vlei, just upstream of the Main Road acted as a natural detention pond, reducing the need for artificial "improvements" to the river. The river was confined to the southern side of the vlei by agricultural engineering of the 19th century, and would overflow into the vlei in winter. When the suburb of Bergvliet was established in the years after World War II, the waters of the vlei were augmented by runoff from the new development, resulting in reduced detention

THE WESTLAKE WETLANDS REHABILITATION PROJECT

The Cape Bird Club, City of Cape Town and Zandvlei Trust funded the Westlake Wetlands Rehabilitation Project. It involved clearing alien vegetation, erecting signage and bollards, constructing footpaths, planting and creating deep-water habitats. The rehabilitation efforts not only enhanced the environment, it also improved the aesthetics of the area. One only has to travel along the Main Road in Lakeside and notice the difference. On Fridays you can also spot enthusiastic volunteers from Zandvlei Trust weeding, planting and/or watering the area.

River wardens transfer indigenous plants to "the Island" as part of the Keysers River Restoration Project. (Photo: Mandy Noffke)

capacity and a propensity towards flooding in the lower reaches of the Keysers River. The problem was exacerbated by a scheme that raised the level of Zandvlei through raising the weir at the mouth. The raised level of Zandvlei reduced the fall in the Keysers River and thus its capacity to transport water. The resultant flooding problems were eventually addressed by lowering the Zandvlei weir again and

Parapet on the culvert over the Spaanschemat River near 'Peddlar's on the Bend' restaurant (Photo: Cate Brown)

widening sections of the lower course of the Keysers River (but stopping short of formal canalisation).

From Louw's Vlei to the point where it divides near the Firgrove Way bridge, the Keysers River flows through a former wetland, which is now partially occupied by the M3 (van der Stel) Freeway. From the confluence, the western stream is known as the Grootbos River and the stream flowing from the north is known as the Spaanschemat River.

The Spaanschemat River

Burman[9] contemplates the origin of this romantic-sounding name at some length, but does not come up with a definite answer. There are suggestions that there was once a Spanish agricultural settlement near the headwaters; another that the reeds along its course were once fashioned into some form of matting, but both ideas seem improbable. An even more intriguing theory is that the name is linked to silver coins known as "Spaansche Matten" (referred to in the traditional Dutch song "Piet Hein"), and this is given some credence by the fact that there once was a silver mine in the valley below Constantia Nek where the river has its source.

The major source of the Spaanschmat River, known as the Glen Alpine Stream, originates in the steep and impenetrable valley below Constantia Nek and is joined by the Eagles Nest Stream. Originally the river flowed into a wetland known as Pagasvlei (which according to Burman is a corruption of "Padda's Vlei"[10]). However, in about 1880, the river was diverted above this point into a high-level canal known as the Spaanschemat Voor, which commanded the valley of the original river and allowed irrigation by gravity. This furrow ran through the Dreyersdal area of Bergvliet and was only abandoned in about 1970 when agriculture in the valley was overtaken

9 Burman (1969)
10 *ibid*

MUIZENBERG EAST ENVIRONMENTAL FORUM (MEEF)

MEEF was constituted in July 2007 to manage the open spaces in the area around Capricorn Park. Residential Associations working together with the City of Cape Town's Environmental Resource Management Department, hope to improve the management of these areas to the benefit of all who live and work there.

Estuarine fish

The Zandvlei Estuary has the most diverse fish fauna of all the estuaries on the False Bay coast, with 39 species having being recorded there, eight of which are introduced. The changes to the mouth have resulted in water levels that remain fairly constant, reducing the cues for juvenile fish recruiting into the system has been greatly reduced. Water quality is also problematic at times, which has affected benthic (bottom-dwelling) species such as the Gobiidae and the blackhand sole (*Solea bleekeri*). The populations of most linefish species are also greatly reduced, the exceptions being leervis (*Lichia amia*), and flathead mullet (*Mugil cephalus*) for which a substantial recreational fishery exists.

On a positive note, the recent proactive mouth management has seen the improvement of conditions for fish and the reestablishment of estuarine function in the lower reaches of the estuary. The mouth is opened during spring tide allowing the estuary to partially flush and be replenished with seawater. The mouth is closed on spring high tide. This action allows the recruitment of juvenile fish and the intrusion of saline water upstream. The population of the sand prawn (*Callianassa kraussi*), which turns over and oxygenates sediment, has expanded further upstream resulting in more food and benthic habitat becoming available to fish. Estuarine populations of white steenbras , pipefish (*Syngnathus temminckii*), blackhand sole (*Solea bleekeri*) and barehead goby (*Caffrogobius nudiceps*) have started to reappear in the system.

by residential development. The reversion of the river to its original course caused problems with erosion, and some gabion structures were inserted in the mid-1980s.

The Grootbosch Stream

The Grootbosch Stream drains Vlakkenberg and the northern end of Constantiaberg, and various branches flow through the historic wine farms of Groot Constantia, Klein Constantia and Buitenverwachting. The stream crosses Spaanschemat River Road near Welbeloond Road, and flows through public open space until it joins the Spaanschemat River near the Firgrove Way Bridge across the M3 Freeway, and is thereafter known as the Keysers River.

Prinseskasteel River

The Prinseskasteel River rises on the plateau south of Elephant's Eye Cave on Constantiaberg. The name commemorates the legend about a Khoi princess who apparently lived in the cave in the 16th century and was captured by Portuguese sailors while bathing in Princessvlei. She is also commemorated through the name of the vlei.

Groot Constantia Wine Estate is an historic wine farm situated in the Grootbosch Stream catchment. (Photo: South African Tourism)

The river descends to the valley via a waterfall and flows through Tokai Forest and the built-up area before joining the Keysers River west of the M3 Freeway.

Bergvliet Farm and Die Oog

Die Oog ("The Eye") is one of the oldest reservoirs in the Constantia Valley. Die Oog lies just below the Spaanschemat Furrow and overflows into the Keysers and Spaanschemat rivers, in one of the few nature areas remaining in the Constantia Valley. A designated local Heritage Site, Die Oog provides an important corridor and refuge for plants, birds and fish, and is one of the few remaining breeding sites of the endangered Western Leopard Toad.

Die Oog was built between 1716 and 1764 as a water storage dam for the original Bergvliet Farm. It is situated almost on top of a hill on a fonteyn (spring) and is first depicted on a Surveyor General's Map in 1764. Between 1786 and 1788, several maps show vineyards and cultivation downstream of the dam wall extending along the Spaanschemat and Keysers rivers.

In 1769, Petrus Michiel Eksteen, a Councillor and member of the Heerenraad, bought

Die Oog Bird Sanctuary and Nature Reserve was originally part of Bergvliet Farm. (Photo: Chris Roman)

Bergvliet Farm. The Eksteen family entertained lavishly with banquets, balls and shooting parties. An artificial island built in Die Oog became the site of many parties and picnics.

In 1863, the farm was sold to William Frederick Hertzog, a bachelor aged 24 who, like the Eksteens, "dispensed sumptuous hospitality in accordance with the well-established Cape tradition". An 1883 survey of Die Oog, described the "ancient dam" as "of very strong, substantial form" and "a valuable example on account of its age". After W.F. Hertzog's death in 1902, Dr W.F. Purcell, curator of the South African Museum managed the farm. He collected and identified over 1 600 plant species around the farm and Die Oog. His collection is now in the Bolus Herbarium at the University of Cape Town.

In 1981, permission was granted to then-owner, John Newman, for Bergvliet Farm to be subdivided into four portions, on condition that "Portion 4 has been allocated as a public open space and has an approximate area of 12 666 square metres (1.3 hectares). Within this area is an historic vlei, known as Die Oog." "Portion 4" is now known as the Die Oog Bird Sanctuary and Nature Reserve.

Rehabilitation of the Langvlei Canal

In 2000, the South Peninsula Administration (SPM) initiated a phased upgrading of the canal environment of Langvlei Canal in Retreat. Phase 1 of the project was part of a SPM Mayoral Project, which allowed ward councillors to determine priority needs within their own wards, and focused on a section of the canal adjacent to under-utilised public open space, close to a number of schools. The first phase saw a levelling of banks, construction of footpath and lightning to increase use and enjoyment and safety of the river corridor. Phase 2 of the project involved the breaking open of a small section of the canal, and the establishment of a small wetland adjacent to the canal, and educational initiatives to promote the use of open spaces as classrooms. A later project saw a larger section of the Sand River Canal being broken open and the diversion of the low flow into the adjacent wetland. These projects were ground breaking and showed what can be achieved. The resultant wetlands require fairly intense maintenance, however, which is not always a priority in current City budgets.

Starting work on the wetland adjacent to the Langvlei Canal on a soggy morning in August 2001 (Photo: Gavin Lawson)

The lowered wall of the Langvlei Canal in the foreground with the newly planted wetland behind it, October 2001 (Photo: Gavin Lawson)

Symbolic planting at the launch of the Langvlei Canal project in November 2001 (Photo: Gavin Lawson)

THE KEYSERS RIVER RESTORATION PROJECT

The Keysers River Restoration Project, which was initiated in 2002 focuses on the section of the river that winds through the light industrial and commercial sites of Retreat, Kirstenhof and Tokai, from the Main Road to Military Road. The project is financed by the Wildlife and Environment Society of South Africa, in partnership with the Zandvlei Trust, local government and industry, and implemented by trained River Wardens. It aims to restore and maintain the Keysers River as a safe, healthy and ecologically functioning river. To date, the project has created employment, training and skills learning, and raised awareness in the local business community. The river has been cleared of litter and dumped rubbish, and indigenous plants and animals have been reintroduced to an area that was previously dominated by alien invasive plants.*

* www.zandvleitrust.org.za

Care and rehabilitation of Die Oog

In 1989, the Bergvliet-Meadowridge Ratepayers Association formed a sub-committee known as the "Die Oog Project" to care for and improve Die Oog in association with the City of Cape Town. At that time, Die Oog had become badly overgrown and subject to toxic algal blooms. In 1992, much of the typha and pampas grass that had started to choke the reservoir were cleared, and 60 indigenous shrubs and trees were planted.

In September 2002, the "Die Oog Project" was reconstituted as the "Friends of Die Oog" and a programme of rehabilitation was started, which comprised: dredging of nutrient enriched sediments – after which there was a period of very clear water and a sustained period of low chlorophyll levels; removal of exotic fish using the piscicide, Rotenone; re-establishment of indigenous aquatic plants; and re-stocking with indigenous fish such as Cape galaxies (*Galaxias zebratus*) and Cape kurper (*Sandelia capensis*). In 2007/8, a blanket of duck weed (*Lemna* spp.) developed on the water surface, but the City and local residents worked hard to 'net' and remove the weed. The removal of this plant material also helped reduce the nutrient levels in the water.

Clearing reeds at Die Oog, August 2002 (Photo: Mandy Noffke)

Photo: Rembu Magoba

"A great quantity of water issuing from the cliff, which spreads itself along the flat of Hout Bay, in length about 3 miles, in breadth about 400 yards. It is covered in amazing strong palmities."

William Duckitt – British agricultural advisor and prominent early European resident of the Cape (1800)

Chapter 14

The Hout Bay River

The Hout Bay Valley is oriented roughly north-south on its longest dimension, and is approximately ten kilometres long and four kilometres wide. It is bounded at the northern end by the Back Table of Table Mountain, on the western side by the range known as the Twelve Apostles (with Karbonkelberg and the often photographed Sentinel at the southern end) and on the eastern side by Vlakkenberg, Skoorsteenkop and Constantiaberg, ending in the famous Chapman's Peak.

The main streams of the Hout Bay River rise on the top of Table Mountain and descend to the valley via the area known as Orange Kloof. In the upper reaches there are two main streams: the Disa Stream and the Original Disa Stream. In the 1860s,

The Disa Stream moves through Hell's Gate in Orange Kloof. (Photo: Tirmanmak Hiking Club)

one of these was known as the Back Stream. The drop to the Orange Kloof plain is steep and the Disa Stream plunges over a series of waterfalls between six and twenty metres high, through an area known as Hell's Gate.

Below the confluence of the two streams, the accepted name for the river is the Hout Bay River. In some old maps the name appears as Palmiet River, but this name has never become general. There have been some efforts to gain acceptance for the entire length of the river to be known as Disa River, but this has also not been generally supported.

Several intermittent streams join the main river from the mountains on either side. Of these the most important are the Bokkermanskloof Stream, which drains the ravine between Vlakkenberg and Skoorsteenkop, and the Baviaanskloof River, which drains the western slopes of Constantiaberg.

The effects of time

Seafarers had noted the extensive forests in the Hout Bay Valley many years before van Riebeeck landed.[1] The first written account of Hout Bay was in 1614, when Samuel Squire, the Master's Mate aboard the ship *Gift*, wrote: "Before our departure the General Nicholas Downton sent me to discover the inland country and see for tymber to mast our unbuilt pinnace or small sailing boat, the which I found on the southwest side of the table in abundance either to build or mast small shipping; with

1 Burman (1962)

IN THE BEGINNING

Remains found in a cave in Hout Bay indicate that late Stone Age people lived in the valley between 100 AD and 500 AD. They were hunter-gatherers and fishermen.

The Khoikhoi and San were descendants of these early inhabitants, and they continued to make "Hout Bay" their occasional home. Harry the Strandloper lived in and around Hout Bay at the time of van Riebeeck's arrival at the Cape. Harry could speak a little English and was a great help to van Riebeeck as an interpreter.

Hout Bay Valley, *circa* 1900 (Photo: Hout Bay Museum)

this we supplied our wants in that kind."[2] The early European settlers to the Cape ruthlessly exploited the timber from which the Hout Bay Valley got its name, until tree felling was prohibited except by permit in 1683. Permits notwithstanding, the indigenous forests in the valley continued to be cleared, and by the mid-19th century the trees on the floor of the valley had all but disappeared.

Prior to the influx of European settlers and merchants into the Hout Bay Valley, the river would probably have been unrecognisable from its present form. Historical records, dating back to John Chapman who first set foot in the valley in 1607, describe it as a wide, deep river "deep enough for rowing boats".[3] Indeed, in van Riebeeck's time the river was navigable for boats for about one kilometre from the sea. Beyond this the course became narrow and overgrown, nevertheless it was suggested around this time that timber from the upper catchment be floated down the river to the sea.[4]

The floor of the valley consists of relatively deep alluvium. In its lower reaches, the river meandered across a wide floodplain of marsh and wetland, consisting primarily of beds of palmiet (*Prionium serratum)*. A braided system of small channels, separated by reeds and palmiet, comprised the area now constituting Hout Bay Main Road and the village itself. These reed beds would have formed effective buffers against floods during peak runoff periods, by attenuating the flood peaks, restricting erosion at the upper end of the valley floor, and preventing siltation of the estuary mouth.

In 1800, the agriculturist William Duckitt, described the river as: "a great quantity of water issuing from the cliff, which spreads itself along the flat of Hout Bay, in length about three miles, in breadth about 400 yards. It is covered in amazing

2 Squire (1614), cited in Hout Bay Yesterday and Today on www.home.intekom.com
3 www.zsd.co.za
4 Thom (1954)

GETTING THERE . . .

Until the end of the 19th century, Hout Bay was relatively inaccessible except by sea. Until Thomas Bain completed the coastal Victoria road in 1888, the only land access was by "Cloof Pass", constructed over Constantia Nek in 1666 on the orders of Wagenaar who needed wood from the valley to build the castle. Simon van der Stel improved the track in 1693, although presumably it was still only a rough track. When better access became available, developers were quick to see potential in the isolated valley and some farms were subdivided into residential erven early in the 20th century.

Cyclists amongst the palmiet beds in the lower Hout Bay River, *circa* 1900 (Photo: Hout Bay Museum)

strong palmities."[5] Clearly this situation lasted into the 20th century as illustrated by a photograph taken in the early 1900s of a group of cyclists wading through beds of palmiet in the lower Hout Bay River.

In the first half of the 20th century, the valley became an important market gardening area and was one of the chief sources of supply of vegetables to Cape Town. This led to increased clearing of the indigenous vegetation from the slopes and valley floor for agricultural and residential land.

Water supply and the Hout Bay River

In the 18th century, farmers built a canal that led off from the river in the vicinity of the present Oakhurst Shopping Centre, and followed a contour around Skoorsteenkop. This canal supplied storage dams from which water was gravity fed along irrigation furrows to the lower-lying fields. A watermill built at Kronendal and used for grinding corn, was also powered by water flowing along the irrigation canal.[6]

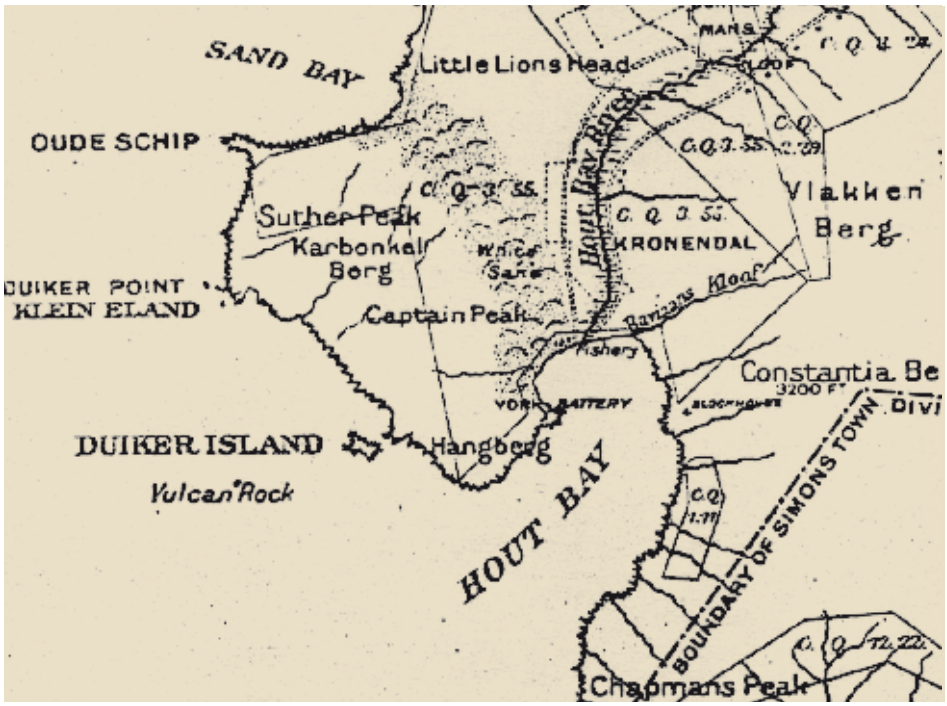
In 1887, Cape Town and Wynberg secured the rights to harness "all the water of the upper sources and tributaries of the Hout Bay River"[7] to meet the ever-increasing demand for water in the rapidly-growing urban areas. This development saw the diversion of Disa Stream through Woodhead Tunnel, which was built through the Twelve Apostles to Slangolie Gorge in 1888, and the rapid-fire construction of five reservoirs in the mountains above the valley (see Chapter 5): Woodhead (1897) and Hely-Hutchinson (1904), which supply water to the City Bowl, and Victoria (1903), Alexandra (1903) and De Villiers (1907), which supplied Wynberg. In 1906, further storage was provided at Kloof Nek, in the form of the Mocke Reservoir. A filtration

5 Anon, undated in a Hout Bay Museum pamphlet, text probably originates from Burman (1962)
6 Anon, undated in a Hout Bay Museum pamphlet
7 Internal reports to the Divisional Council, Regional Services Council and Cape Metropolitan Council

ALL GONE . . .

In 1679, Simon van der Stel wrote: "there is little accessible timber remaining apart from the great forests at Hout Bay". In 1685, 805 wagon-loads of firewood left Hout Bay for Table Bay. Simon van der Stel plotted out a new route and a new road over Constantia Nek was completed. The new road was shorter by 1 ½ hours travelling time for an ox-wagon. By now the forests were almost depleted and farming was expanding in the valley. The VOC woodcutters withdrew from the valley in 1710. Today the only remaining pockets of forests are those growing along the slopes of Grootkop adjacent to Orange Kloof, Myburghs Ravine and Myburghs Corner. There are also small patches in the ravines on the Constantiaberg and a grove of yellowwoods on the Karbonkelberg.*

* www.home.intekom.com/capevacations/history.htm



This map of the Hout Bay Valley from *circa* 1800 shows Baviaanskloof River with its own mouth to the sea. Note the "white sand" stretching continuously from Hout Bay to Sand(y) Bay. (Western Cape Archives)

Measuring flow, probably in the furrow along the east side of Hout Bay River that supplied water for fields and Kronendal Mill, *circa* 1910 (Photo: Hout Bay Museum)

plant and additional reservoir were added nearby in 1938. A new tunnel was constructed in 1960 (in Woody Ravine) as the approaches to the Woodhead Tunnel via Slangolie Gorge were decaying and had become dangerous.

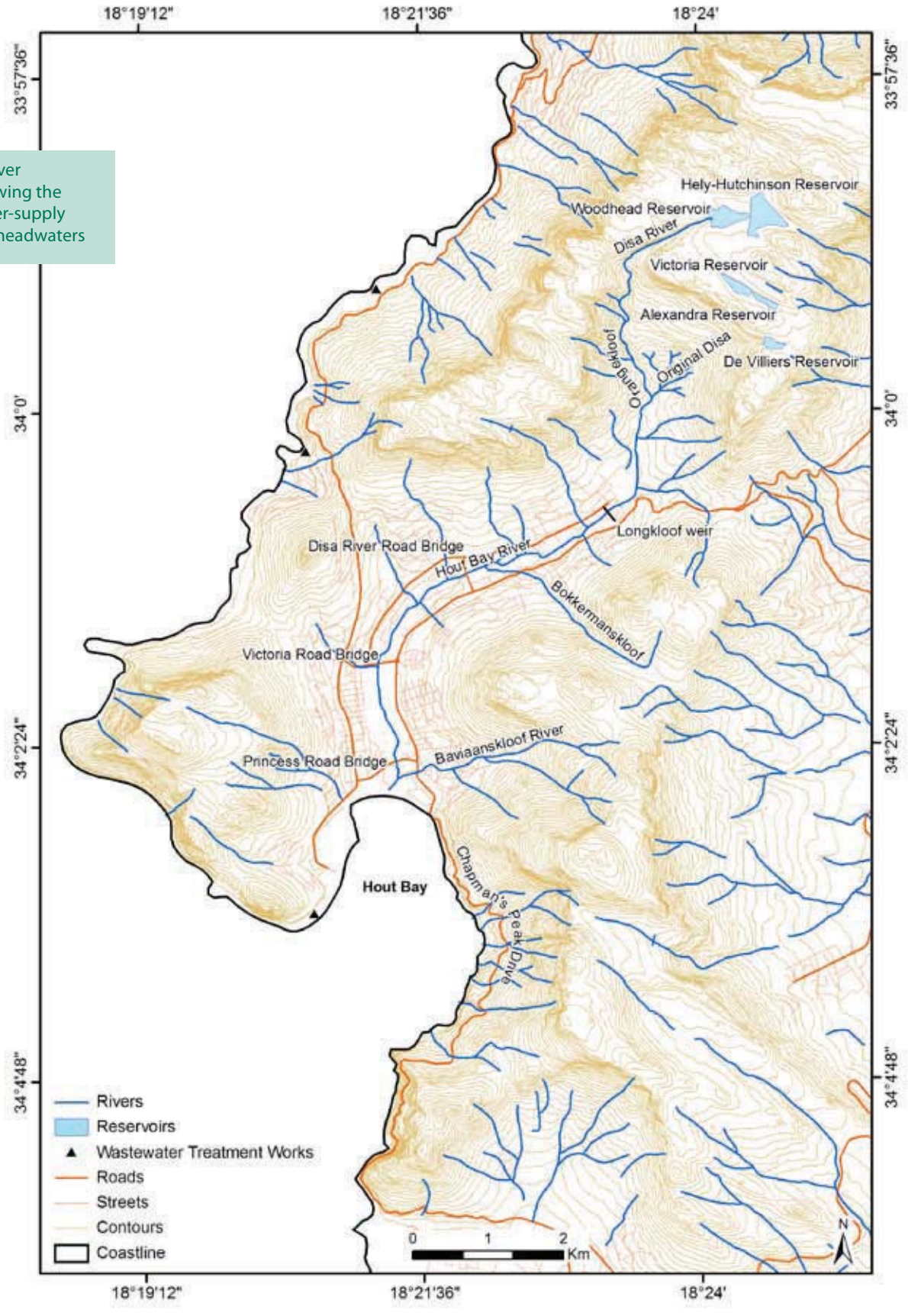
By the early to mid 1990s, the level of water in the Hout Bay River had dropped to such an extent that pumps needed to be installed on the riverbanks to irrigate the crops. The little water that was available was insufficient to sustain the remaining riparian vegetation, and gradually the original character of the river was transformed into the *Phragmites*- and *Typha*-dominated system that it is today.

NATURAL TRIBUTARY OR NOT?

There is little or no documented evidence of the natural condition of the Baviaanskloof River which drains the western slopes of Constantiaberg. Maps and photographs from the late 1800s, however, indicate that this river may have entered the sea through its own river mouth, or as one of a series of braided channels in the lower valley. Today, it joins the Hout Bay River as a single channel just downstream of the Fisherman's World Shopping Centre.*

* Fowler, *et al.* (1999)

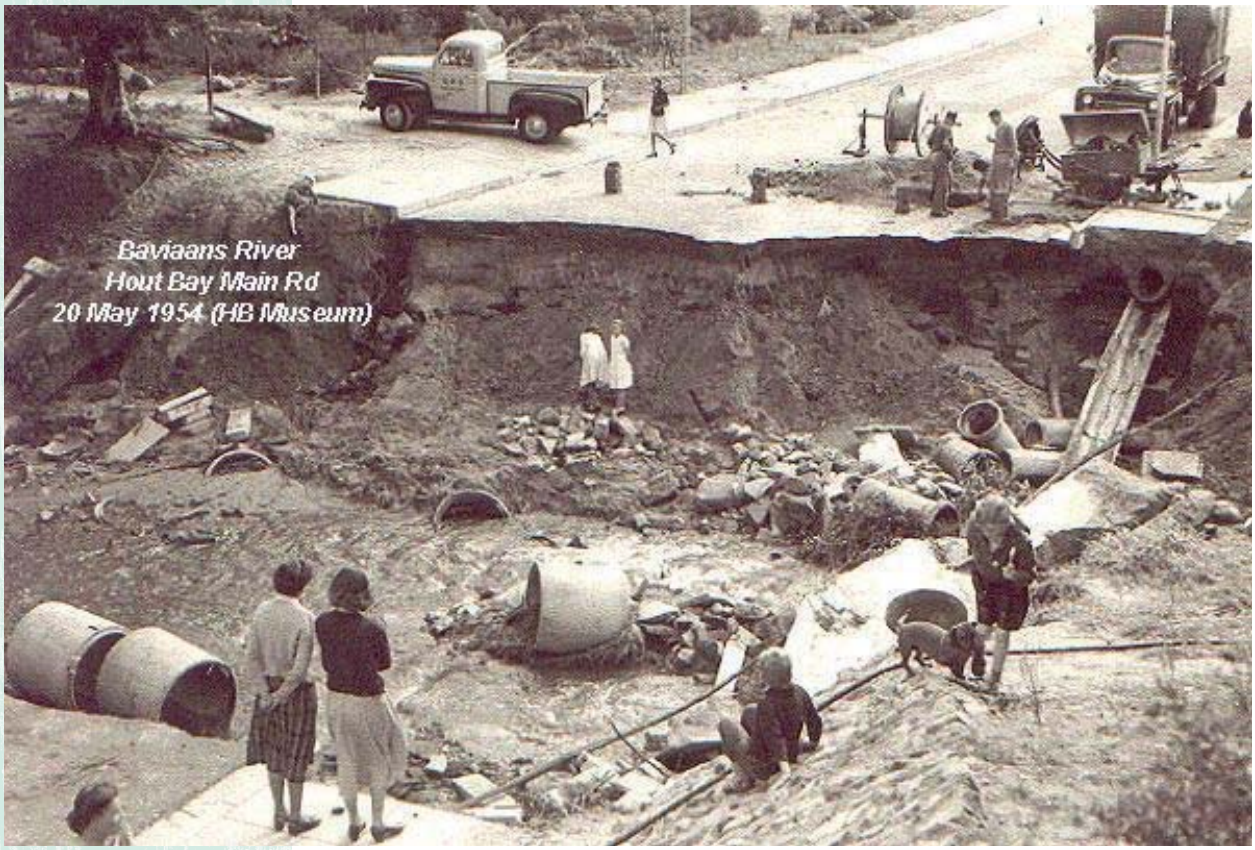
The Hout Bay River catchment, showing the plethora of water-supply reservoirs in its headwaters



The Woodhead Reservoir on Table Mountain with the Hely-Hutchinson Reservoir in the background (Photo: John Yeld)

Entrance to the Woodhead Tunnel on Table Mountain (City of Cape Town Archives)

A party on board a trolley on railway tracks visiting construction of a reservoir on the mountain top, *circa* 1904 (Photo: Hout Bay Museum)



The remains of the bridge on Hout Bay Main Road across the Baviaanskloof River, on 20 May 1954, after heavy flooding (Photo: Hout Bay Museum)

Cause and effect: flooding and erosion in the Hout Bay River

The short length of the Hout Bay River, coupled with high rainfall and the steepness of its mountain catchment, means that it has a natural propensity for flash flooding. Erosion was prevented in early times by the indigenous forests, which reduced runoff as well as stabilising the topsoil through root growth, and by extensive palmiet beds in the stream path.

Flooding in the lower parts of the Hout Bay River is a natural phenomenon, and the village of Hout Bay is situated in the natural floodplain of the river. Historically, however, floods would largely have been attenuated by the thick beds of reeds and palmiet that grew along the riverbanks and formed dense islands between braided channels of the river in the lower reaches. During floods, the river would probably have flowed in sheets across these wetland beds, resulting in little erosion.

The removal of indigenous riparian vegetation, and the once-dominant palmiet beds, and historical cultivation as close to the edges of the stream as possible, forced the stream into one single channel. In the upper valley, downstream of the Longkloof spillway, this led to gully erosion, which decreased flooding of adjoining land but increased loss of soil. In the lower valley, however, where the gradient is slight, silt

washed down from upstream was deposited and the river became even more prone to flooding adjacent lands.

Farming came to the valley as early as the 17th century but, although agriculture was a primary land-use in the Hout Bay Valley from as early as 1677, the first signs of erosion along the riverbanks did not appear until the late 1940s, when the last areas of riparian property, near Orange Kloof, were put to agricultural use. By 1958, most of the banks of palmiet had been removed from the river edges, in an attempt to increase the size of the fields, and planting of crops occurred as close as 18 metres from the river edges. This led to the gradual restriction of the river to a single, narrow channel, with immediate increases in erosion of the peat-like banks on either side, and large-scale loss of soil following flood events. Newspaper reports in the *Cape Argus*, dating back to 1957, detail erosion running as far as 4 miles (6.4 kilometres) from the upper end of the Hout Bay Valley to the sea. The *Cape Argus* of 14 August 1957 describes the occurrence of "waterfalls" (presumably points of headcut erosion) along the course of the river, beneath one of which lay "huge clumps of soil in the middle of a ravine that is now more than 200 feet wide". This erosion was attributed to "bad farming practices, veld fires, ... absent landlords who allowed cattle to stray and break down the river banks".

From the 1950s, erosion became a perpetual problem, and in 1960, a flood control structure was created at the farm Longkloof, in an effort to stem the bed erosion creeping up the river. Floodwaters in June of that same year, however, "cutting a channel ten times the width of the river" swept the unfinished structure away. The Longkloof spillway was re-built in 1961, and was successful in halting the large-scale bed erosion sweeping up the river. The drop of eight metres created enormous energy, which had to be dissipated before the flow caused further problems downstream.

By 1960, other changes in land-use had domino effects on the rate of erosion along the Hout Bay River. Farming activities dwindled, and the riparian fringes, previously

The land alongside the Hout Bay River has been infilled to ensure that it is above the level of the 1:50 year flood. This has had the effect of confining the river to its banks under flood conditions, which exacerbates the erosion problems. This photograph was taken at the corner of Main Road and Disa River Road in February 2008. (Photo: Rembu Magoba)

Controversy in the Hout Bay Valley

The Hout Bay Valley has never been a stranger to controversy, and pressure groups, action committees and unhappy ratepayers have always been in evidence. One of the first reported disagreements was not, however, between residents of the valley, but between the City of Cape Town and the State Forestry Department. In 1885, the department began with efforts to reforest the areas that had been exploited for timber since van Riebeeck's time. The preferred replacement was the cluster pine (*Pinus Pinaster)* and about 16 hectares were planted in the Back Table area of the mountain. Other varieties of pine and acacia were introduced later.

When reservoir construction began, the Cape Town City Council was up in arms that planting trees would reduce the runoff from the catchment, and that disturbance of the soil during planting would cause rapid siltation of the reservoirs.

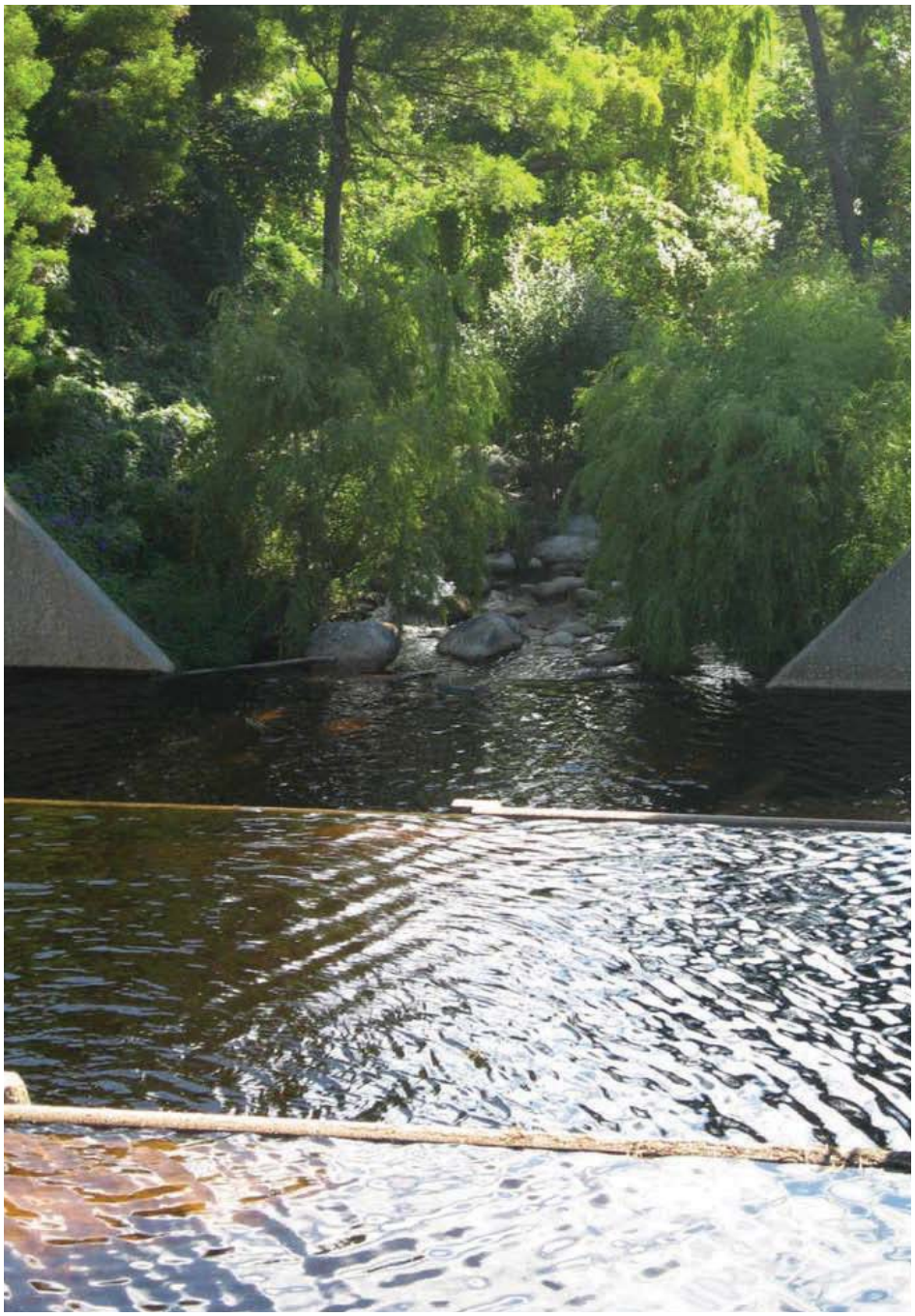
The Councillors eventually won the day. The planting of trees in the upper catchment was halted and the plantation was ceded to the Cape Town City Council in 1897. Since then, the Forestry Branch of the City of Cape Town (and now SA National Parks) has gradually been eliminating alien vegetation. It is claimed that the catchment areas are the only parts of the mountain chain that are not subject to devastating fires, because of the absence of alien vegetation in these areas.

City of Cape Town Archives

stripped of their protective borders of deep-rooted palmiet, were now vulnerable to rapid invasion by alien vegetation. The long-leaved wattle (*Acacia longifolia)* and other alien species invaded the area, resulting in increased rates of erosion relative to those experienced naturally.

The large-scale erosion in the upper and middle valley led to increased deposition of sediment in the lower reaches of the river, and siltation of the river mouth. In its lower reaches, the river was narrowed, reducing its capacity to carry and absorb floodwaters from the upstream areas. Flooding of low-lying areas in the lower valley increased, and so dredging operations were implemented in the river downstream of Victoria Road Bridge in the early to mid-1970s. The dredge spoil was deposited on the sides of the river channel resulting in the creation of levees on either side of the river in this region, which further cut the river off from its floodplain, and resulted in considerable "downcutting" of the river channel.

In 1983, a major flood cut around the Longkloof spillway, removed a swimming pool belonging to an adjacent private landowner, and created a deep erosion path that seriously undermined the foundations of the spillway. Had this collapsed, there would have been enormous damage downstream. Particular care had to be taken with the foundations to prevent a recurrence of the problem and this resulted in the design



The Longkloof Weir was rebuilt in 1994 to stem bed erosion in the upper reaches of the Hout Bay River. (Photo: Cate Brown)

of a structure known as an Amberson weir. Construction of the new Longkloof Weir took place in 1994 and apparently no further problems have been encountered.

Despite repeated lessons in the past, infilling of the floodplain of the Hout Bay River continues at a phenomenal rate, with almost all the riparian land either already developed or targeted as a dumping ground for landfill from other construction sites.

The Victoria Road Bridge, *circa* 1900 (Photo: Hout Bay Museum)

Bridges

In the early year of European habitation of Hout Bay Valley, the track from Constantia Nek crossed the river by means of a ford in the vicinity of the present-day Victoria Road Bridge. The ford was replaced by a wooden bridge, which eventually gave way to the present concrete structure.

A rustic bridge at Longkloof was first constructed by a private landowner to gain access to his property on the western side of the river. The bridge was replaced by a concrete structure with a central pier when the first Longkloof Weir was constructed in 1961. The waterway under this bridge was prone to being blocked by trees and other debris during storms, particularly because of the central pier, and was thus a big factor in causing the river to outflank the weir structure in major floods. The bridge was demolished when the new weir was built in 1994.

When Valley Road was built on the western side of the river in about 1970, residents insisted that it should not become an alternate through route to Constantia Nek. The presence of the Longkloof Bridge was thus not publicised, but the route nevertheless became a popular circular tour for cyclists, horse riders and runners, and was a convenient short-cut for motorists in the know. When plans to demolish the structure became known, there was an outcry from affected persons. The Regional Services Council was prevailed upon to provide funds for a crossing some 1 kilometre downstream at Disa River Road. The new bridge was again deliberately designed as a narrow structure to discourage through traffic. Even then there were

The Hout Bay Golf Course pont, circa 1935, near the present-day Princess Road Bridge (Photo: Hout Bay Museum)

Girls swimming and canoeing in the Hout Bay River between Princess Road and the mouth, *circa* 1900 (Photo: Hout Bay Museum)

objections and delays, and a pressure group tried to obtain a surplus Bailey bridge from the Defence Force and use this as a romantic but probably impractical solution to the crossing problem. A more conventional bridge was eventually designed[8] as a single carriageway structure with the provision of a separate walkway for horses and pedestrians.

The lowest crossing point at Princess Road has somewhat of a "sporting" beginning, as the arrangement made for a crossing there (or near there) was a pont that was used by members to reach the 18th green of the Hout Bay Golf Course, which was situated on the opposite side of the river from the rest of the course.

8 By Pat Masterson of Gibb Africa

The Hout Bay Golf Club

The Hout Bay Golf Club was founded on 10 July 1921. The course was laid out with the assistance of City Tramways, who owned the Hout Bay Hotel at the time, and on 21 September 1921, the Hout Bay Golf Club held its first competition. The first tee was on the site of the present-day Bowling Club. The Golf Club was limited to 101 members, by invitation only. During World War II, many members left to serve in the armed forces, and petrol rationing made it difficult for remaining members residing in the southern suburbs to travel to Hout Bay. In addition, in 1940, the course was reduced to nine holes when the War Department established a training camp for army recruits on the course. Then, after the war, the owners of the Hout Bay Hotel, which had changed hands in the late 1930s, decided to reclaim the land for their own purposes, and the Hout Bay Golf Club closed its doors in November 1948.

Memories of the Hout Bay Golf Club

Diane Davis, a resident of Hout Bay for many years, remembers the Golf Course and the members of the Hout Bay Golf Club. Her brother was a caddy for Bernard Muller, and Diane helped carry the clubs. She was 10 or 12 years old at the time (*circa* 1944) and was paid one or two shillings for her assistance. This was a fair price in those days as one could buy four sweets for a penny. Most of the members stayed in the southern suburbs and their arrival was awaited anxiously every Saturday and Sunday. Diane and her brother never missed a game.

The 18th green was across the river and many a ball landed in the river. Weekdays after school were spent searching the river for golf balls by wading through the reeds or, if you could swim, diving into the deep pools.

A bunker on the Hout Bay Golf Course, *circa* 1935 (Photo: Hout Bay Museum)

The same location as the bunker (above) in 1994 (Photo: Hout Bay Museum)

The Hout Bay River between Princess Road and the mouth, March 2007 (Photo: Rembu Magoba)

The Hout Bay Estuary

The Hout Bay Estuary is a small, temporarily open system that is mostly closed in summer and open during the winter when the Hout Bay River is in spate. The estuary is about 0.5 kilometres long and 20 to 40 metres wide. The average depth is less than half a metre. Like the river, the estuary is heavily impacted by sedimentation, bank stabilisation and flood levees, urban development, reduced runoff, and stormwater discharges and litter from informal settlements. The consequences of these impacts are that the estuary is becoming shallower and the water quality poorer. The poor water quality is of particular significance because the Hout Bay Estuary opens on to an important recreation beach.[9]

Rehabilitation efforts[10]

The year 2000 saw the start of the Hout Bay Upgrading Project, which is being implemented in a phased approach as part of an overall vision "to strive for the restoration and protection of the Hout Bay River as an important natural and cultural resource … linking the mountains, the sea and the community".[11]

This signage appears on the rehabilitated section of the Hout Bay River, near Fisherman's World Shopping Centre. (Photo: Cate Brown)

9 Grindley (1988)
10 Freshwater Consulting Group (2001)
11 Chittenden Nicks de Villiers (1999)

The reaches of the river downstream of Princess Road, as far as the estuary on Hout Bay Beach, were rehabilitated in 2000-2001 with the objectives of improving the aesthetic, public amenity and river/wetland functions provided by this reach of the river. The project involved the creation of a walking trail along the river between Princess Road and the beach; landscaping and planting with indigenous species; restoring connectivity between the river and the wetlands on the western side of the river by removal of parts of the levee; and grading the west bank to create improved marginal riverine habitat, facilitate passage in and out of the river by animals, and reduce erosion by improving plant cover.

Although marred by problems of theft, the project has provided residents of Hout Bay with an aesthetically pleasing public amenity, which is well utilised by local residents, and thus likely to increase public awareness of the river.

Coast Care

Coast Care is a Department of Environmental Affairs and Tourism initiative, which provides jobs and training for members of coastal communities to create and maintain a cleaner, safer coastal environment.*

Coast Care women on the Hout Bay Estuary (Photo: Cate Brown)

* www.environment.gov.za/ProjProg/CoastCare/index.htm

Photo: South African Tourism

Chapter 15

The rivers of the Southern Peninsula

For much of geological time, the Southern Peninsula was an archipelago separated from the mainland by the Fish Hoek Channel and the Cape Flats Seaway. Consequently, its rivers form a set distinct from those of the rest of Cape Town. Here the rivers tend to be fairly short and steep, with some, such as the Silvermine and Elsje rivers, characterised by valley bottom wetlands at the coast.

"The scenery past Plumstead, Retreat, Diep River, Lakeside, Fish Hoek, Glencairn and on to Simon's Town (and beyond) is grandly imposing, and as varied in feature as the most fastidious artist could desire."

Somerset Playne – compiler and editor of *Cape Colony*. Its history, commerce, industries and resources. (1910-11)*

* Playne (1910-11)

Of all the areas in Cape Town, the Southern Peninsula is perhaps most prone to fire. (Photo: Heather Howell)

Aliens, fires and flooding

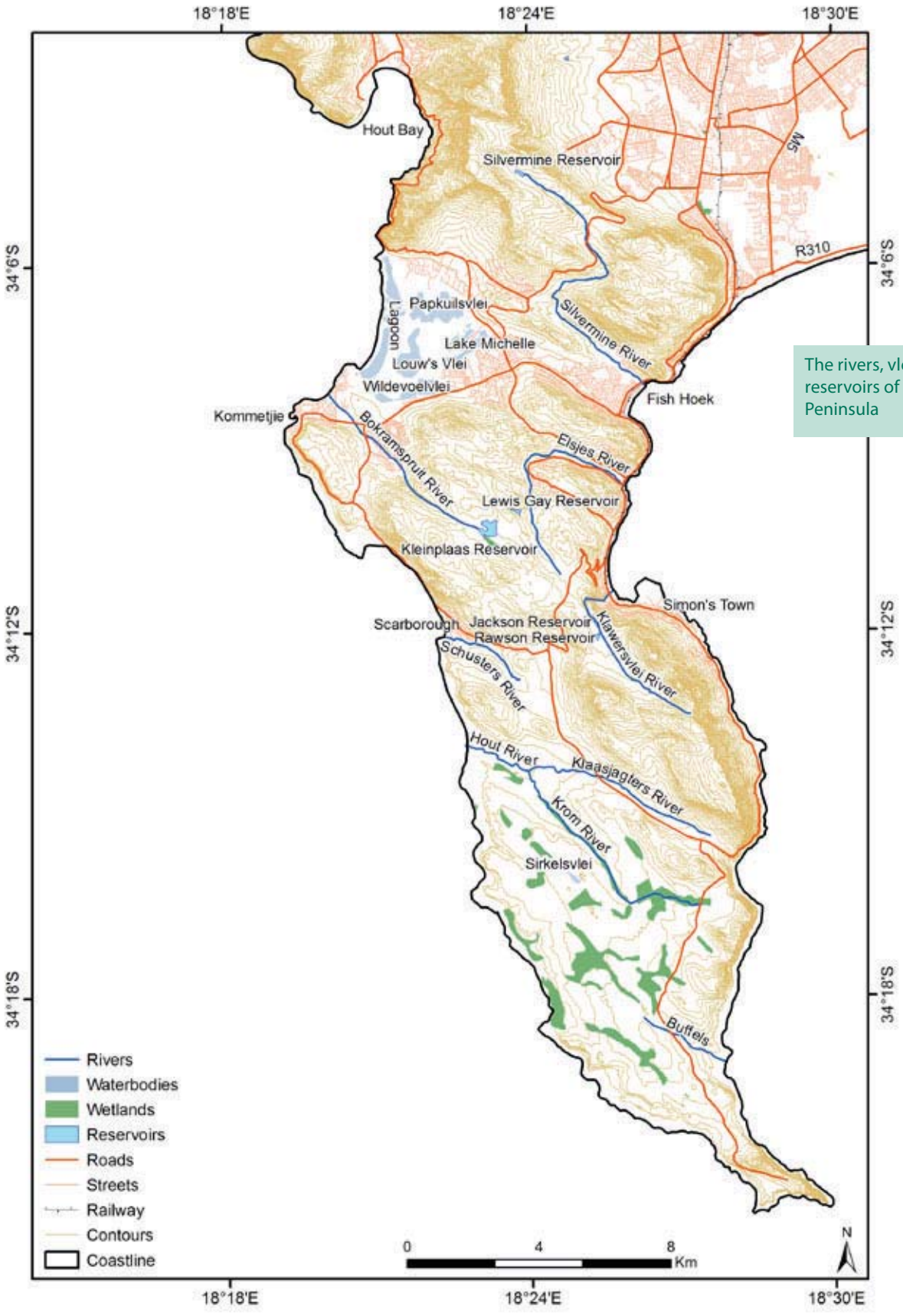
Of all the areas in Cape Town, the Southern Peninsula is perhaps the one most associated with fire. Fynbos, the dominant vegetation in the natural portions of the river catchments, is prone to fire. Naturally, fires would probably have occurred at intervals of 10 to 40 years, but these days they are far, far more frequent.

Alien vegetation, such as Port Jackson willows and rooikrans, add significantly to the fire threat. Where they have invaded the fynbos, alien plants grow in dense stands and develop large fuel loads. Fires in alien-infested areas are hotter and more intense than in natural fynbos and difficult to control. As a result, they damage soil structure, kill fynbos seed stock and slow the post-fire recovery of vegetation.

With the reduction in vegetation cover, stormwater runoff following rainfall is increased in both quantity and velocity, promoting erosion and flooding. A secondary problem is the effects of transported (eroded) material on downstream rivers and stormwater drains*, coating river beds and blocking stormwater reticulation systems, reducing conveyance and further increasing flood risk.

Slope failure, as a result of the changes in the soils and vegetation, and resultant erosion, poses an additional risk to urban areas, especially those of Glencairn and Simon's Town (and parts of Hout Bay), and to the river systems that drain them.

* SRK Consulting (2000); Euston-Brown (2000)



The rivers, vleis and reservoirs of the Southern Peninsula

The upper reaches of the Silvermine River (Photo: Toni Belcher)

Silvermine River

The Silvermine River takes its name from attempts to mine silver in the mountains between Constantia and Fish Hoek in 1680. Until at least 1741, it was known as the Esselstein Rivier, this being the original name of Simon's Bay.

The Silvermine River rises in the Steenberg Mountains at the southern end of Constantiaberg and flows across the Steenberg Plateau, then southward through the Silvermine Valley to reach the coastal plain and urbanised area, and enters the sea at Clovelly.

The river emerges from the Silvermine Valley into the broad Fish Hoek plain. Its original course is not clear and it appears that it wandered towards the centre of the valley and entered the sea somewhat further south than at present (see Silvermine Estuary). It was once joined by another river, flowing along the centre of the valley, which disappeared during the development of Fish Hoek.

Silvermine Estuary

Historically, the Silvermine Estuary comprised a series of shallow seasonal pans and vleis that formed periodically behind a low barrier dune just above the high-water mark. Old charts and photographs indicate that, at times, when sifting sand blocked the river, it would breach through the coastal barrier dune as far south as opposite the present day railway station.[1] Then the estuary would have covered an area between 50 and 60 hectares. Under these conditions, the estuary would have been a haven for estuarine biota such as fish and birds.

1 Heinecken (1982)

The mouth of the Silvermine River still has a tendency to wander, despite the curtailment of the road and railway bridge. (Photo: Steve Lamberth)

But this movement is now a threat to the railway line, and any extension of the estuary is brought under control using a bulldozer. (Photo: Steve Lamberth)

The area around the mouth of the Silvermine River was much feared by travellers to Simon's Town. An account by Admiral Stavorinus in 1774 tells how an English officer lost his horse and barely escaped with his own life from the quicksands in the estuary. The Admiral's aide-de-camp, in trying to avoid the hazard, galloped too far into the sea, lost his horse, and was forced to swim for it.[2]

The problem of crossing the mouth was only resolved when the first road and rail bridges were built at the Clovelly end of the beach in 1876 and 1890, respectively. The bridges defined the mouth, but the upstream course had to be trained to flow under

2 Walker (1999)

Fish Hoek, *circa* 2000, from the Clovelly Mountains, showing the Silvermine River mouth and estuary in the centre (Photo: South African Tourism)

the structures. The Railways built an embankment on the southern bank in 1900 to prevent flooding into the village. These bridges destabilised the coastal dunes, however, and windblown sand regularly blocked the railway line. The planting of marram grass was unsuccessful, and in 1928 all dunes were levelled and stabilised with stone chippings. Although this effectively solved the problems at the time, subsequent research on the effects of interfering with coastal dunes has shown that such solutions are not sustainable in the longer term.

The construction of railway and road bridges and the Silvermine Dam severely reduced the size of the estuary, and today a smaller seasonal lagoon stretches from about 100 metres upstream from the road bridge to the sea. It is 10 to 20 metres wide and less than 2 metres deep at its deepest point. Although the estuary is seldom tidal, overtopping of seawater aids in maintaining the salinity regime in the system. Values between 0 and 19 parts per thousand have been recorded under various flow conditions.

Although essentially confined to it present location, the mouth still attempts to follow its natural dynamics and, during periods of extended open mouth conditions, the outflow channel tends to migrate across the beach towards the embankment that protects the railway. When this happens, the City of Cape Town intervenes and uses a bulldozer to straighten the outflow channel. This action reduces the viable estuarine area by as much as 50% and severely reduces fish recruitment into the estuary.

A natural resistance to alien fish

Brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) were released into the Silvermine River in 1931 but they failed to establish themselves. Then, on 3 December 1938, the very first release of smallmouth bass (*Micropterus dolomieu*) in South Africa took place, but these also failed to establish themselves.* This was one of very few unsuccessful introductions of smallmouth bass countrywide. The same fate awaited mosquito fish (*Gambusia affinis*) that were released into the river in 1941, and bluegill sunfish (*Lepomis macrochirus*) that were released in 1944. It was intended that these fish, which are fodder for bass, would provide a platform for the successful introduction of bass, but the Silvermine River was having none of it.

Interestingly, shortly thereafter, the indigenous Cape galaxias (*Galaxias zebratus*), was successfully translocated from below to above the Silvermine Reservoir where it had not occurred previously. This was the only successful introduction of numerous attempts in the Silvermine over a 15-year period ending in 1946.

* Harrison (1963)

The very first release of smallmouth bass in South Africa, Silvermine Reservoir, 3 December 1938. Joan Harrison, John Bain, Pat Hill and A.D. Harrison (Piscator No. 56, Summer 1962/1963)

Silvermine Dam

The Silvermine Dam was built across a shallow valley on the Steenberg plateau to supply water to Muizenberg and Kalk Bay. It was constructed in 1898 at a final cost of £14 200. It was decommissioned for potable water *circa* 1920 when the coastal areas were linked to the new supply from Steenbras Dam. Currently, and in terms of a long-standing agreement, this diversion is used to transfer water to the present-day Westlake Golf Course.[3] Below the reservoir, a small weir was built at the edge of the escarpment during World War I for river gauging purposes. The pond behind this wall is known as Bachelor's, or Nellie's, Pool.

The Lower Silvermine River Flood Alleviation Scheme

Land around the lower reaches of the Silvermine River was reserved in 1969 for the Fish Hoek Northern Bypass, a freeway system that was to link Kommetjie and Fish Hoek, and included the canalisation of the Lower Silvermine River. A tunnel link from

3 Reinecke *et al.* (2007)

Silvermine Dam was constructed in 1898. (Photo: Cate Brown)

Nellie's Pool, a pond behind a weir built at the edge of the Steenberg plateau during World War I for river gauging purposes (Photo: Tirmanmak Hiking Club)

Fish Hoek to Boyes Drive was also considered and a large area of land was "frozen" from development to accommodate the proposed corridor.[4] Over the years, Fish Hoek expanded to the boundaries of this land, and the affected landowners pressured the municipality to either expropriate the land or allow development. In the end, the proposed bypass was not implemented, and the land freed for development. In the interim, however, the river course became degraded, mainly by invasion of alien trees, and irregularly flooded the adjacent lands of its old floodplain. Investigations also showed that (much as is the case in Somerset West, see Chapter 19) the Main Road Bridge was unable to accommodate the 1-in-50 year flood, and any such event would result in floodwaters running along Main Road into the centre of Fish Hoek, and inundating large areas of the town.

The environmental and drainage divisions of the South Peninsula Municipality, which came into existence in 1997, decided to do something about the unsatisfactory situation, and Julia Wood and Martin Thompson were instrumental in evoking some action. The resultant engineering works, which were subjected to extensive impact studies, included redefining the floodplain with gabion structures and earth berms, creating stilling basins to attenuate floodwaters, and filling some adjacent properties to prevent their flooding and make them available for development. These can be seen clearly in the photograph above, which was taken before the replanting of vegetation. Part of the levelled area on the top right hand of the picture has now been filled with residential developments.

4 van Zyl *et al.* (2004)

(*above*) Silvermine Flood Alleviation Scheme immediately after completion of the engineering works (Photo: Bill Harding)

(*right*) The lower Silvermine River in 2001 (Photo: City of Cape Town)

RECOGNITION OF EXCELLENCE

The Lower Silvermine River Flood Alleviation Scheme was the winner of the 2003 South African Institute of Civil Engineers Annual Award for Excellence: Western Cape, and was a finalist in the 2003 Green Trust Awards: Natural Resource Section. The attention received from two such different organisations, illustrates the change in focus and method of engineering interventions over time, with "soft", ecologically-friendly treatments becoming far more prevalent than in the past, and with the distance between engineers and ecologists closing a tad.

The project significantly upgraded the aesthetic and recreational potential of the area, turning the riverine area from an eyesore to a far more secure attraction that is mentioned as a feature when houses are sold in the area. (See Chapter 20) There was extensive planting of indigenous wetland vegetation and creation of walkways, which now provide a pleasing gateway to the valley. The 5.5-hectare wetland recreational area is now a much-used and appreciated asset to Fish Hoek and, on the whole, the area has been transformed into a major growth point in Fish Hoek.

During rehabilitation, the Friends of Silvermine River participated in ensuring that environmental goals were met. After rehabilitation, the Riverine Rovers were formed out of a sub-committee of the Friends of Silvermine and continue to play an important role in ensuring the continued conservation and sound management of the area. The group numbers approximately 12 members who are involved in activities such as alien hacking, rubbish removal, monitoring public behaviour (such as ensuring dogs are not let off their leashes in the wetland), educational projects (such as arranging school outings and other activities such as inputs to the frog census), the raising of funds for maintenance and the promotion of the area. A Silvermine River Wetlands Route pamphlet has been compiled with the help of the group and funding from the Clovelly Country Club for use by Fish Hoek Valley Tourism to promote the area and

The Elsjes River, Glencairn, taken from Elsies Peak, showing the *Typha*-dominated wetlands and Glencairn Vlei. (Photo: Carol Smith)

inform visitors. The area has also been included as a suggested stop on the "Deep South" route that covers areas in the South Peninsula relatively near to Cape Point.[5]

Elsjes River

The river and the name should not be confused with the Elsieskraal River in the Tygerberg. According to Burman,[6] the name of this river is derived from the "Els" trees that grew in the wooded valley through which it ran in earlier times. There is apparently no connection with the widow Elsie, who lent her name to the Elsieskraal River, or any other lady of that name. There are various spellings for the river name, including Elsie, Else, Els and Elsjes. We have settled on Elsjes – because we liked it.

The Elsjes River is approximately eight kilometres long, rising on the Red Hill plateau near Ocean View, and entering the sea at Glencairn Beach. In modern times, the river has been the main source of supply to Simon's Town through the construction of the Lewis Gay Dam and later the Kleinplaas Dam. The river is supplemented by flow

5 van Zyl *et al*. (2004)
6 Burman (1969)

South Peninsula Wetlands Rehabilitation Project

The South Peninsula Wetland Rehabilitation Project, a joint project of City of Cape Town, Wildlife Society of Southern Africa (WESSA), Working for Wetlands, and Santam Cape Argus Ukuvuka Operation Firestop Campaign, was initiated in December 2001 and ran until March 2002. Thereafter, the South Peninsula Wetlands Rehabilitation Project, together with a Working for Wetlands project at Edith Stephens Nature Reserve became the Peninsula Project, which is ongoing (see Chapter 20).

This poverty relief project focused on highly sensitive wetland and riverine ecosytems and comprised several components.

An alien-clearing component, which entailed removing alien vegetation on riverine and wetland areas in the Constantia greenbelt at De Hel and Diep River, at Rondevlei and Zeekoeivlei, at the Ocean View Stormwater Channel and along Elsjes River in Glencairn.

This was combined with rehabilitation of the riparian edges of various vleis and rivers throughout the South Peninsula. Local labour was used to clear riparian edges infested by invasive bulrushes (*Typha capensis*) and replant these areas with appropriate locally indigenous species, which were propagated at the Noordhoek Forestry Station by local community members. The areas targeted were Glencairn Vlei, The Lakes saltmarsh in Noordhoek, Silvermine River in Fish Hoek, Langvlei Canal in Steenberg, Zandvlei, Keysers River and Blouvlei in Retreat, Princessvlei and Baviaanskloof River in Hout Bay.

There was also a large-scale alien clearing project in the Noordhoek Wetlands. Table Mountain National Park took responsibility for follow-up alien clearing, as the area was subsequently included in the National Park.

The Noordhoek Valley Training Centre Campus of the South Peninsula College served as the base from which operations were run. Training was undertaken by WESSA: WC and aimed to furnish trainees with the skills and knowledge necessary for future employment. Training modules included life skills, environmental awareness, entrepreneurial skills, first aid techniques and HIV/Aids awareness. Trainees received a certificate at the end of the project.

from stormwater drains from the Da Gama Park estate, constructed by contractors to the South African Navy in the early 1960s and the now considerable mountainside developments along the lower reaches.

The final 1.2 kilometres of the river consists of a *Typha*-dominated wetland and vlei, known as Glencairn Vlei. The vlei and its surrounding wetland was formed when water backed up after the construction of the rail and road bridges over the Elsjes River in the early 1900s. This also reduced the tidal influence on what had previously been a small estuary. For a brief period, wastewater was discharged into the vlei from Simon's Town's Waterwater Treatment Works, but this is no longer the case. The

GEESE

GEESE is the acronym for Glencairn Education & Environmental Support Enthusiasts, and comprises local residents and businesses who care for Elsjes River. Since their inception in 2002, GEESE has:

- created a path along the river below Glen Road;
- created a check list for birds, mammals, reptiles, amphibians and some of the flora;
- organised a boardwalk over a frequently flooded pathway opposite the shopping centre (in partnership with the City of Cape Town);
- erected three snadstone block seats for resting/view places around the vlei (these came from Tulbagh Square in Cape Town City);
- erected a pictorial map of the valley on the Glen Road side of the berm that crosses the vlei; and
- organised a suspended bridge attached to the Glen Road bridge to allow people to cross the bridge more safely.

www.geeseglencairn.org

wetland is a declared Nature Conservation Area. There are a number of paths round the wetland, some being used by workers going to and from work, and all of them by walkers, many with their dogs.

The National River Health Programme surveys indicate that the Elsjes River has relatively good water quality, probably as a result of the relatively low levels of development in its catchment, and the influence of the reeds in the lower sections of the river. Well-used paths alongside the river attest to the enjoyment it provides local residents.

The Klawersvlei River

The Klawersvlei River rises in the mountains behind Miller's Point and flows north-west on the plateau above Simon's Town before turning east to make a rapid descent via a waterfall and flowing into the sea near the Simon's Town railway station. Two small reservoirs on this river, the Rawson and the Jackson, named after the admirals of the time, were built in the 1890s to supply the "brown water" needs of the Navy directly. The surplus is pumped to the Kleinplaas and Lewis Gay dams and is processed to potable standards to augment the Simon's Town water supply.

Groot Rondevlei, Spring 1998 (Photo: Jenny Day)

Schusters River (Photo: Toni Belcher)

Cape Point rivers and vleis

At Cape Point, there are numerous seasonal vleis, seeps and streams, most of which dry up in the summer. The waters of these wetlands, which include some small roadside ditches, are usually dark brown in colour, and very acid. This phenomenon is characteristic of wetlands affected by fynbos vegetation because dead fynbos litter leaches out strongly coloured organic acids into the surrounding waters. Some of these vleis, such as Groot and Klein Rondevlei, a series of remnant dune-slack wetlands, are predictable enough to appear on local maps of the area, while others remain annual surprises to all except those who know the area well[7]. Many of these vleis are artificially created, having been excavated from marshy areas to create open water for livestock watering in the later 1800s to early 1900s.

Schusters River

Schusters River drains the Red Hill and Wildeschutzbrand areas behind Scarborough, and enters the sea via a small lagoon immediately to the south of that village. Apart from runoff from roads, no development contributes to it at present.

The lower portion of the Schusters River is comprised of a large wetland area that has been considerably modified over time, not least by infilling to create stable ground on which to place the fence of the Good Hope Nature Reserve, and is under constant and increasing threat by housing developments as Scarborough property prices soar.

Klaasjagters River

Klaasjagters River has its source in the mountains inland of Miller's Point (Swartkopberge) and flows southward before taking a generally westerly direction in the vicinity of the main road between Smitswinkel Bay and Scarborough. Eventually it enters the sea through a substantial lagoon north of Olifantsbosch at Cape Point. Burman reports that the river has been known by several names including Groote, Kromme, Hout and Smitswinkel River, and it is indicated on recent road maps as the Krom River. In fact, the Krom rises on Paulsberg and flows generally northwards across the Smitswinkelvlakte to a confluence with the Klaasjagters.

7 Fraser and McMahon (1988)

Why is there water in Sirkelsvlei?

The near-perennial Sirkelsvlei, near Olifantsbosch, is the largest freshwater body at Cape Point. Sirkelsvlei is perched on a plateau and its source of replenishment is not immediately apparent, apart from some surface trickle in winter. Burman reports that the vlei is fed by numerous small springs channelled from the surrounding hills by the two sandstone ridges between which the vlei lies.* Although, these days, it usually contains water year-round, the vlei is known to have dried up regularly in the 1960s and it also dried up during the drought of 2003/2004. In the 1960s, when it was dry, people collected large quantities of cannon shells from the bottom of the vlei. It had been used for target practice during World War II.

* Fraser and McMahon (1988)

The inky and acidic water of Sirkelsvlei (Photo: Jenny Day)

Burman regarded the lagoon at the mouth as the finest stretch of water on any of the Peninsula rivers.[8] It is approximately two kilometres long. The bar at the mouth is reported to have dangerous quicksands.

The Buffels River

The Buffels River is a small, seasonal stream that rises as a spring near the old homestead and flows into False Bay at Buffels Bay.

8 Burman (1969)

Water supply to the Peninsula towns

Fish Hoek

Farmers and fishermen, operating in the Fish Hoek Valley from the early 1700s, obtained their water from various nearby springs and from the Silvermine River. By 1900, however, the population of the village had grown to the extent that a formal supply became necessary. A Mrs de Villiers, who owned the rights to the Kleintuin Spring in Clovelly, laid a pipeline from the spring to the town and duly charged householders for water. After her death in 1918, her estate granted the rights of the spring to the people of Fish Hoek who enjoyed this benefit for some thirty years. However, a more dependable supply was necessary, and the subject was discussed in many engineering reports and made a regular appearance on the agendas of the Village Management Board, which eventually became the Town Council. By 1922, the population of Fish Hoek had grown to 830 people, and a 4200-gallon distribution reservoir was built to store the Kleintuin Spring.

The Railways had a separate water supply for their steam trains. This was supplied via Kalk Bay from Cape Town's mains supply, and Fish Hoek successfully negotiated with the Railways to use this water to augment the town supply. The then Cape Town City Council castigated the Railways for reselling municipal water at a profit, however, and there were acrimonious scenes before the matter was sorted out. In the end,

The Krom River (Photo: Toni Belcher)

the entire Fish Hoek water supply was drawn from the Cape Town's scheme and the subject of the Kleintuin Spring faded from the Council agendas.

The Fish Hoek Wastewater Treatment Works, situated on the site of the present sports fields, were built in 1938. These wastewater treatment works were closed down in 1978 and the flow diverted to the Wildevoelvlei Wastewater Treatment Works in Noordhoek.

Simon's Town

Initially, the main water supply to Simon's Town was provided by piping numerous springs on the adjacent mountains to holding tanks and distribution reservoirs around the town. All the pipes in the early days were made of wood, which caused many problems.

The largest of these early distribution reservoirs is Victoria Reservoir, located on the mountainside above the Western Dockyard. It was built in about 1900 as an open reservoir sunk into the earth with the top of the walls at ground level. It is probable that the design was by Thomas Stewart. The Navy required cleaner water than could be achieved from an open tank, however, so in 1976 the reservoir was roofed over.

About the time that the Victoria Reservoir was built, a steam-driven pump station operated from a site at the foot of Dido Valley. From here, water from a small barrage, fed by springs in the valley, was pumped to the Victoria Reservoir. This scheme is also credited to Thomas Stewart, who designed an effective but unique system for

dosing the water with lime. A bicycle was used to propel the lime into the water. The machine worked for some fifty years, and years later when working on the new reservoir, Jerry Tait from Ninham Shand, was much amused but impressed when he discovered this bicycle still doing duty.

The demand for water increased due to wartime activities, and between 1938 and 1942 two open circular distribution reservoirs, named Prince George and Neptune, were built at the top end of the valley. Water was fed to these tanks from the Elsjes River after passing through lime beds for stabilisation. The prevailing winds in this area deposited a considerable amount of silt into these open structures, requiring regular removal, until both were eventually provided with floating polyethelene roofs in about 1990.

Lewis Gay Dam, named after a former Mayor of Simon's Town, was built in 1948 on the edge of the Red Hill plateau. It supplied water to the Victoria Reservoir via the Neptune and Prince George reservoirs before the wastewater treatment works were built.

Kleinplaas Dam is located higher up the river and was built in the mid-sixties. This is an earthfill dam, the wall of which was raised in the mid-seventies.

The present wastewater treatment works is just below Lewis Gay Dam and was built in 1973. It occupies the site of an earlier wastewater treatment works built in about 1952, which used a flocculation and settlement process with several sand filtration beds.

During severe droughts in the 1970s, the local sources proved to be inadequate for Simon's Town's needs, and an emergency link was laid to provide additional water from the main Cape Town supply system. In due course, this link was made permanent.

Photo: Cate Brown

Chapter 16

The Noordhoek Wetlands

According to Burman[1], the name Noordhoek does not refer to a compass direction, but is a shortened form of "Norwegian Corner". In the opinion of early travellers, the mountains to the south were said to resemble those of northern Europe. The Noordhoek catchment encompasses a vast basin area of relatively unspoilt natural beach, dunes and wetlands with great conservation and scenic value. The wetland systems, in particular, are of international significance and are also a reminder of how much of the Cape Flats used to look.

1 Burman (1969)

"If appropriate water management practices are not put into place, the vleis, lagoons and wetlands, which are currently major environmental assets could become cesspools and constitute a serious threat to ecological (and human) health."

Excerpt from the Kommetjie/Ocean View and Environs Structure Plan

Papkuilsvlei, Noordhoek Valley *circa* 2006 (Photo: Mandy Noffke)

Surprisingly, for a valley bordered on its two longer sides by mountains that enjoy a reasonable rainfall, there are no well-defined watercourses in the Noordhoek Valley, and certainly nothing that qualifies as a river. A small drainage path rises near Chapman's Peak and discharges at the northern end of Noordhoek Beach. The northern, eastern and southern catchments discharge via a series of ill-defined paths to a large seasonal wetland, Papkuilsvlei, in the centre of the area. Here there are now three permanent water bodies, Lake Michelle, developed from former saltpans, and the twin Wildevoelvleis. There are also two elongated back lagoons on Noordhoek Beach. To the south of the Wildevoelvleis, a stream known as the Bokramspruit enters the sea near Kommetjie.

The Noordhoek wetlands, in particular the relatively unspoilt natural area of beach,

Lake Michelle and the Noordhoek reedbeds, *circa* 1997. Note the encroachment of Noordhoek and Masiphumele from the south, and a portion of the Lake Michelle development on the southern shore of lake Michelle. The northern shore of the lake is now also developed with housing. (Photo: City of Cape Town)

dunes and wetlands, are of great conservation and scenic value. They also serve as a rare reminder of how the Cape Flats would once have looked. The area contains patches of unspoilt Sandplain Fynbos, dune thicket, dune pioneers, mobile dune fields, coastal zone wetlands, and seasonal and permanent wetlands. The area is one of 39 Core Botanical Sites within the boundaries of Cape Town, and the C.A.P.E. Project has identified these remnants as being irreplaceable. (See Chapter 21) Much of the wetland area is privately owned, with some 450 hectares in the hands of just two land owners. By contrast the City owns only 140 hectares.

Papkuilsvlei

The focus of the Noordhoek wetlands is an area known as Papkuilsvlei, a semi-seasonal wetland that is waterlogged in winter. This water body is separated from the beach by a range of coastal dunes through which the outflow gradually discharges. There is also some overland flow towards the Wildevoelvleis.

Lake Michelle

The former saltpans in the east have been developed into a marina known as The Lakes. This water body receives flow from the developments further east through a wetland commonly referred to as the Pick 'n Pay Reed Beds. The saltpan was seasonally inundated and, in the 1950s, was apparently used as a motor racing skid pad during the dry summer months. This practice ceased when purified effluent from the then Fish Hoek Wastewater Treatment Works was pumped into the ponds, forming a perennial system.

The Noordhoek wetlands looking towards Noordhoek beach, with the backshore lagoons shown in the middle distance, *circa* 2005 (Photo: City of Cape Town)

Noordhoek Beach backshore lagoons

Noordhoek Beach is four kilometres long, 500 metres wide and very flat. A central dune divides the north and south portions of the beach and separates two large, shallow, seasonal backshore lagoons. The southern lagoon is fed from an overflow channel from the Wildevoelvleis and the northern lagoon by stormwater from Papkuilsvlei, and washover from the sea during winter storms and high spring tides. The southern vlei is also at times filled by washover but drains perennially to the sea at its southern extremity. The foreshore is wider at the northern beach and the vlei is connected to the sea only when it is full and breaks open at its northern end.[2]

Salinities in the various water bodies fluctuate considerably according to the seasons. This can be attributed to high evaporation losses during summer and fresh water input from the catchments. The changes in salinity in the Wildevoelvleis were drastically reduced with the input of sewage effluent from the Wildevoelvlei Wastewater Treatment Works. The works, built in 1977, were modified in 1996 in an effort to reduce phosphorous discharge into the vleis.

2 Heinecken (1985)

The twin Wildevoelvleis with the Waste Water Treatment Works and Masiphumele shown in the background, *circa* 1997 (Photo: City of Cape Town)

The Wildevoelvleis

The twin Wildevoelvleis form an integral part of the water bodies in the Noordhoek basin and are situated on the old Slangkop Farm, which was given to Christina Dieman by Baron von Imhoff, a Dutch official who was sent to the Cape by the Dutch government to establish a harbour at Simon's Town. The farm's name was later changed to Imhoff's Gift in honour of von Imhoff.[3]

Originally fed by runoff from the southern mountains and sub-surface seepage, over the years flow to the vleis has been augmented by stormwater discharges from Ocean View (1970 onwards), the light industrial areas of Fish Eagle Park and Heron

3 www.turtlesa.com/ezine151.html

Park (1980 onwards), Masiphumele (1995 onwards) and Sun Valley (the latter flows through reed beds before it reaches the vleis). The most significant flow is, however, received from the adjacent Wildevoelvlei Wastewater Treatment Works, which serves Noordhoek, Kommetjie and Fish Hoek, and which discharges polished effluent into the eastern vlei.

The outflow from these vleis is a narrow channel, which reaches the sea, but in sometimes discharges into an elongated back lagoon on Noordhoek Beach, from where it gradually seeps into the sea.

Deadly blooms

The saga of the algal blooms in the Wildevoelvleis dominated newspaper headlines in the summer of 1997-1998 and again in the summer of 1998-1999. Here is the story taken from press releases from the South Peninsula Municipality from 1998 and 2001.

In May 1998, as a result of knock-on effects resulting from an unknown once-off pollution event, the natural pondweed (*Potamogeton*) in a portion of the eastern vlei died. The loss of the stabilising presence of the pondweed led to a bloom of blue-green algae, which subsequently became toxic. This in turn, affected the mussels, which inhabit an area near the outlet of the vleis and are harvested by local residents. The mussels, which are filter-feeders, accumulated the algal toxins in their systems, resulting in them also becoming toxic to humans.

"Salt-bombing" the Wildevoelvleis, May 1998. (Photo: Cape Argus)

During the weeks that followed, considerable time and money was invested in an attempt to reset the system and avert a natural and social disaster.

Two main approaches were adopted. These involved lowering the water level in the vleis and elevating their salinity levels. The water level of the vleis was lowered by mechanically deepening the outlet to the sea. The vleis started draining and in the next ten days the eastern vlei dropped by *circa* 600 millimetres.

A channel was cut between the spring tide lagoon and the outlet channel from the vleis in order to facilitate the entry of seawater into the western vlei on the spring high tides, thereby elevating the salinity in the vleis.

In the eastern vlei, the effluent from the Wildevoelvlei Wastewater Treatment Works was diverted away from the vlei and 600 tons of salt were added to the system, and the

The link between the Wildevoelvleis and the sea, on Noordhoek Beach (Photo: City of Cape Town)

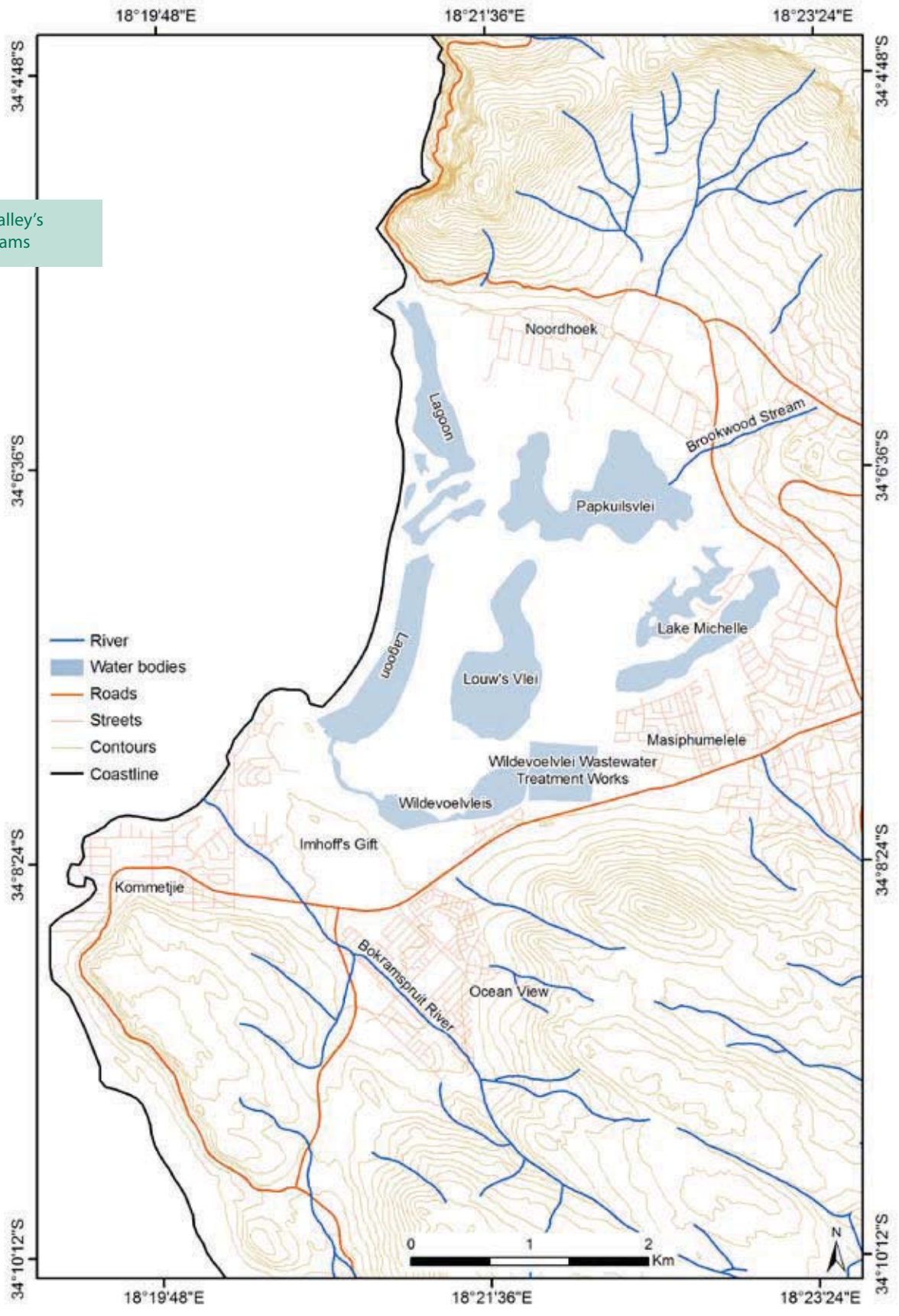
outlet from the vlei was closed off by an earth berm. After a week or so, the treated effluent was again released into the vlei.

These short-term interventions were successful. The blue-green algae were replaced by non-toxic green algae. Although the blue-green algae gave off toxins as they died, they produced less than anticipated and the bacteria in the water were able to break them down rapidly. Subsequent sampling showed that the mussels were no longer toxic and that it was safe for the public to collect shellfish in the area.

Without the pondweed, however, the ecosystem balance in the vleis could not be maintained. A blanket ban on shellfish collection ensued. Toxic blue-green algal blooms have become an almost annual occurrence, as have the knock-on effects on the shellfish and the communities of Ocean View and Masiphumelele.

Ten years down the line, despite several studies, proposals for additional interventions such as dredging the nutrient rich sediments from the vleis have not been implemented, although some reseeding with pondweed was attempted with limited success. The main community members have stopped agitating and the press has gone to find another new and exciting story, but the Wildevoelvleis continue to remind us that once a system loses its natural balance, it is difficult and expensive to remedy, even in cases where such a remedy may still be possible.

The Noordhoek Valley's wetlands and streams



Collecting mussels along the Noordhoek coastline, *circa* 1997 (Photo: City of Cape Town)

Fish of the Wildevoelvleis

The Wildevoelvleis/Noordhoek wetland system has seen an interesting response from fish. Historically, the backshore lagoons filled up with the winter rains and were continuously replenished with overwashing during high tides. Recruitment to the vleis behind was mostly during winter floods when shallow connections were established between these and the backshore lagoons. This was not necessarily an annual event and some fish are likely to have been landlocked for years on end, sometimes suffering mass mortalities when the vleis dried up. Overall, because of the ephemeral nature of the vleis under natural conditions, fish diversity is low with only three mullet and two introduced species being recorded there.

Interestingly, during the blue-green algae event in the Wildevoelvleis described below, the two mullet species in the system, the freshwater mullet (*Myxus capensis*) and the harder (*Liza richardsonii*), had been in the vleis for six years. The fish, which were feeding almost exclusively on blue-green algae, were thriving, with a high fat content. This was made possible by the fact that fish accumulate toxins in their flesh, without undue influence on their own health. Unfortunately, this protection does not extend to their predators, and neither the level of toxins accumulated in their flesh, nor the effect on the otters and birds that fed on them, was ever recorded.

Bokramspruit

Bokramspruit rises in the mountains above Ocean View, close to the sources of the Elsjes River (see Chapter 15), which flows down the opposite site of the watershed. The upper reaches of the river are mostly not impacted, and are characterised by large populations of amphipods (small crustaceans). The middle reaches, flowing

Restoration of the Noordhoek Wetlands – The Santam Cape Argus Ukuvuka Operation Firestop Campaign

The Noordhoek Wetlands Project had its headquarters at the Noordhoek Valley Training Centre and drew its labour force from the Masiphumelele, Ocean View and Red Hill Informal Settlement. Training included both hard (chainsaw operation, herbicide application) and soft (life skills, environmental awareness, entrepreneurial skills, first aid, HIV and AIDS awareness) skills. The aims of the project included poverty alleviation in the communities of Masiphumelele and Ocean View [and Red Hill]; establishing of a wider base of competent contractors that can tender on an open contract basis for alien removal projects; increasing safety awareness for contractors and workers in working with herbicides and chainsaws; strengthening of the Noordhoek Valley Training Centre; providing role model applications for other ongoing programmes; increasing integration and co-operative management of the Noordhoek Wetlands; restoring the Noordhoek Wetlands; and generating greater appreciation of the Noordhoek Wetlands (see also Chapter 20).

through Ocean View, are canalised and in poor condition, but the lower reaches are constrained within an earthen channel, which is lined with *Typha* and *Phragmites* reeds.

Brookwood Stream

All indications are that Brookwood Stream was artificially created, probably to drain the surrounding wetlands. Indeed, prior to rehabilitation activities on the stream *circa* 2000, no detailed descriptions of the Brookwood channel could be found, except for anecdotal information that it existed as an earth canal from Silvermine Main Road to Papkuilsvlei on the valley floor, overgrown with kikuyu and alien trees and shrubs.[4]

The project rehabilitation activities were aimed mainly at rerouting the channel to accommodate the 1-in-50 year flood runoff from the sub-catchment to prevent flooding of properties and soil erosion, and to consolidate runoff into the Brookwood Stream from other artificial channels such as the Bonanza, Haven and Belvedere canals.

Attempts to improve the quality of water entering Papkuilsvlei were also addressed through the installation of a pre-treatment pond just upstream of the vlei.

All of the above was achieved. In addition, soil erosion was reduced, vegetation diversity increased, a corridor link from the mountains to the wetlands was created, and a riverine habitat was provided, albeit not of a type that was natural to this system.[5]

4 J. Ball, Gibb Africa, personal communication, in Freshwater Consulting Group (2001)
5 Freshwater Consulting Group (2002)

Photo: Jackie King

*"From the heights of his airforce helicopter he (P.W. Botha) is said to have pointed his famous finger to a "desolate patch" on the Cape Flats. "There!" he commanded, and Khayelitsha was born."**

Jocelyn Newmarch – local journalist

* That "desolate patch" was the seasonal wetlands of the Kuils River.

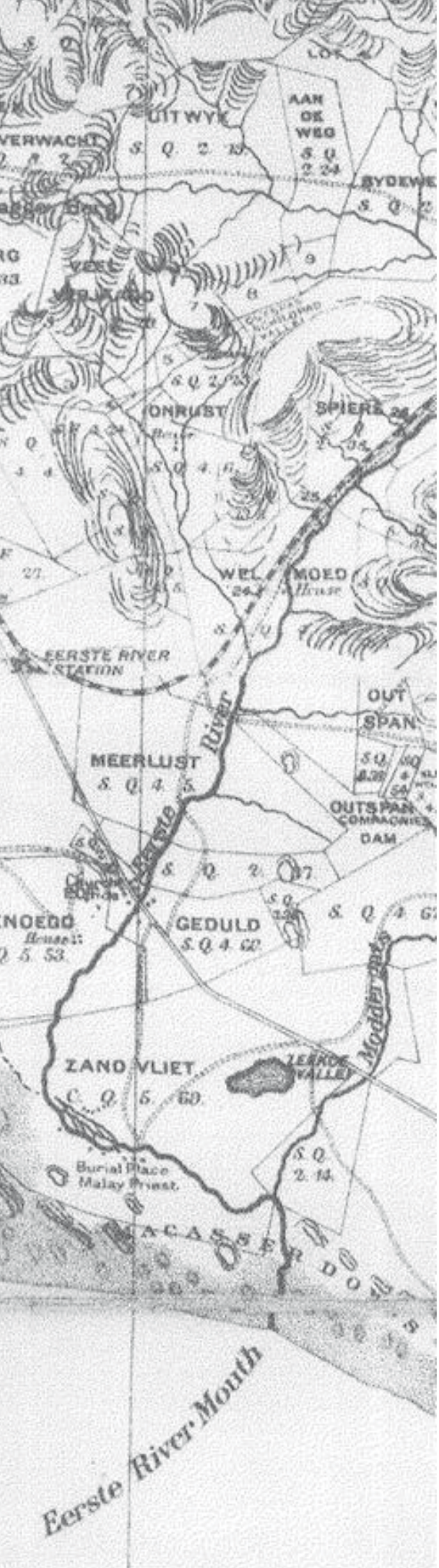
Chapter 17

The Kuils River and the drift sands

The Kuils River was historically seasonal, draining a vast area of sand dunes, and recharging the Cape Flats Aquifer before ever reaching the sea. Draining a catchment of some 240 square kilometres, the river never reached the sea, but emptied into a system of pools, or "kuils", which are now occupied by the township of Khayelitsha.

The first river of any significance encountered by early travellers across the Cape Flats


LOT DD
LOT GG
LOT II
LOT HH
LOT QQ
LOT JJ
MATROOS FONTEIN
KLAVER VLEY
LOT FF
Bontebuuvel
LOT KK
JEFTAS KRAAL
LOT EE
LOT MM
LOT NN
Drift Sand
DUINE FONTEIN
Oude Dam
Nieuwe Dam
Dam
POOLS
JOSEPH DE KOCKS KRAAL
POMPOENE KRAAL
Drift Sand
Drift Sand
LANGVERWACHT
SAXENBURG
Zwart Kl.



A portion of an old (undated) map, showing the "kuils" along the False Bay coastline at Kuils River, and a numer of other vleis that do not exist today. Today this area is Khayelitsha. The confluence between the Kuils and the Eerste River is also shown, with the Kuils River marked as an indistinct channel. (CSIR Archives)

was appropriately named the Eerste River. The explorers must have by-passed another stream, which rose in the low hills near the present town of Durbanville and disappeared in the dunes that are now Khayelitsha, with an indistinct flood channel that joined the Eerste River. More likely they travelled in the dry season when there was little appreciable flow in the shallow valley.

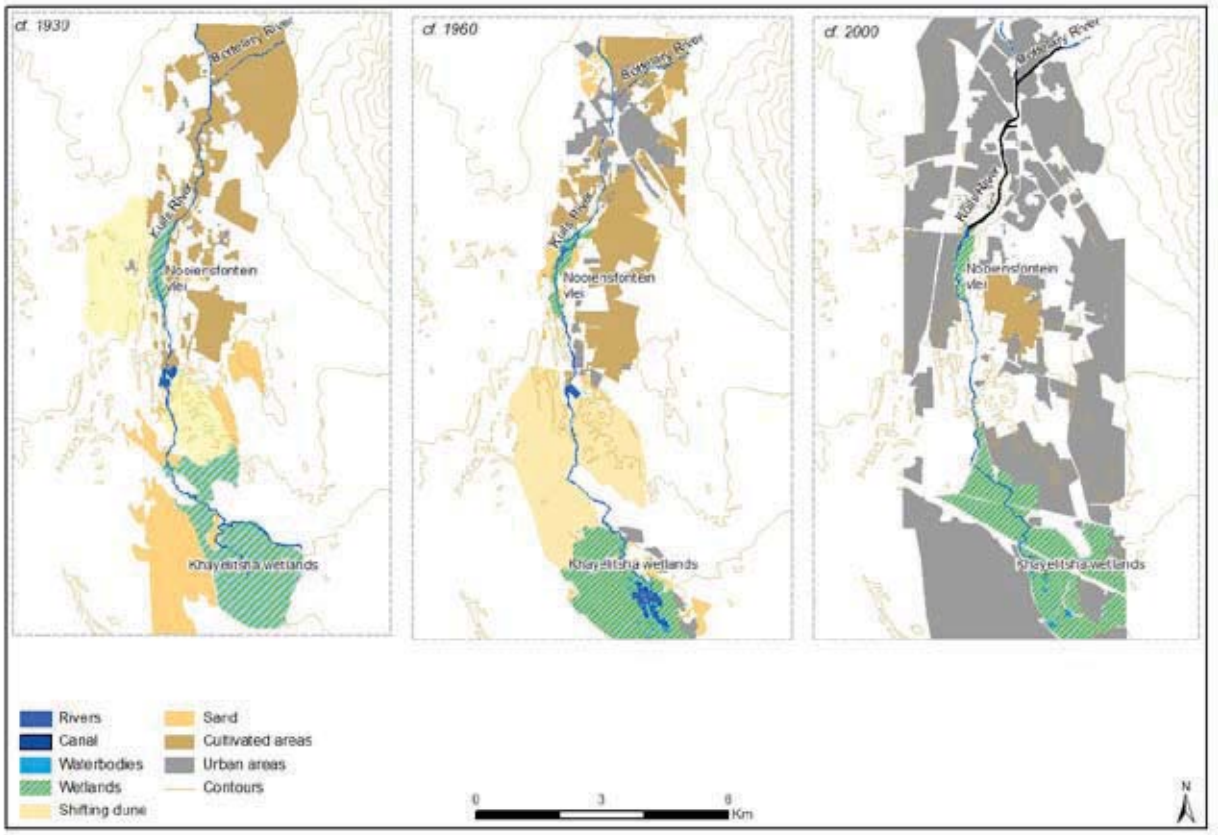
The Kuils River in its original state flowed through a flattish sandy valley from its source until it reached the Cape Flats proper, where it meandered through a series of "kuils". As the demand for formal housing in Cape Town escalated in the early 1980s, the Kuils River valley was identified for low-cost development. The extensive townships of Mfuleni, Kleinvlei, Blue Downs and Delft were built on relatively high ground but inevitably some informal development sprang up in the floodplain. More significantly, the floodplain itself was widened considerably by the change in runoff that occurred as development hardened the surfaces in the upper catchment. New industrial areas were also established, while the growth in towns such as Bellville, Brackenfell and Kuilsrivier led to the construction of new and larger wastewater treatment works. As these new areas were built, the vastly increased runoff and the outflow from the wastewater treatment works added further to the problems of a stream that was never intended to be the important urban waterway it has become.

A permanent connection to the Eerste River formed naturally to cater for the increased flow. Along this route, new wetlands were formed on what had previously been farming land, and new flood threats became apparent in the area known as Zandvliet.

By the mid-1980s, the lack of capacity to drain floodwaters away as a result of development in the floodplain had reached a point when flooding became rife. The river regularly overtopped its banks in Kuilsrivier and at several other points downstream. The new conditions

MEMORIES

The Kuils River has long been prone to flooding especially in the years since Belhar, Delft, Blue Downs and Khayelitsha were created, and indeed, the more upmarket suburbs of Durbanville have also contributed to considerably increased flows. Tony Murray can recall how, as a small boy, he was taken to see people canoeing along Main Street in Kuilsrivier Village - which in those days was little more than a general dealer's shop, a hotel, and the imposing Dutch Reformed Church. This flood event, possibly occurring in the notably wet winter of 1943, was probably caused by constrictions of the road and railway bridges adjacent to the confluence of the Kuils River and the Bottelary River.



These three maps show the progressive spread of urban areas in the Kuils River catchment. Land use in the catchment is shown for the 1930s (left), 1960s (middle) and 2000 (right).

imposed by the perennial link to the Eerste River resulted in periodic flooding of the Macassar - Zandvliet farming area, the long-established settlement around Sheik Yusuf's tomb (see Chapter 18), and parts of the newer housing estate of Macassar. Apparently the banks of the lower Eerste River were leveed to prevent back-flow from the Kuils River during periods of high runoff. This however, effectively cut off several of the riparian wetlands, further reducing the flood retention capacity and the health of the system.

Flooding was not the only problem. Some reaches of the river are infested with alien vegetation such as water hyacinth, while in other sections, increased nutrients in the waters - the result of permitted inflows of treated sewage effluent - causes indigenous plants such as the bulrush (*Typha capensis)* to flourish.

The coming of Khayelitsha

Nineteen eighty-eight marked the beginning of the end for the original Kuils River dune-slack wetlands system. The area of land now covered by Khayelitsha was once dotted with seasonal and perennial wetlands. Most of these were destroyed

Researchers from the University of Cape Town capturing the last images of the Khayelitsha wetlands as the bulldozers move in. (Photo: Jackie King)

(*above*) The "kuils" in the lower part of the Kuils River, *circa* 1987 (Photo: Jackie King)

(*right*) This extract from the *Cape Argus* of 11 September 1990 publicises the infilling of the Kuils River wetlands to create Khayelitsha. (Photo: Hout Bay Museum)

(*opposite page*) Channel erosion downstream of Driftsands Detention Dam, *circa* 2000. By 2005 the wetlands had been almost completely drained (Photo: Mike Luger)

when the dunes were bulldozed into the wetlands, and the area flattened to create Khayelitsha.

Pollution, mainly from large volumes of treated sewage effluent, and an elevated water table have fundamentally changed those wetlands that remained. In reality, the overall extent of the wetlands was little changed, as the water displaced by the infilling had to go somewhere. New, less diverse and less stable, wetlands formed in pockets around the Khayelitsha settlement, for instance, an extensive *Typha*-dominated reed bed was formed at the junction of the N2 and Baden Powell Drivel, and, to this day, rising waters in winter plague

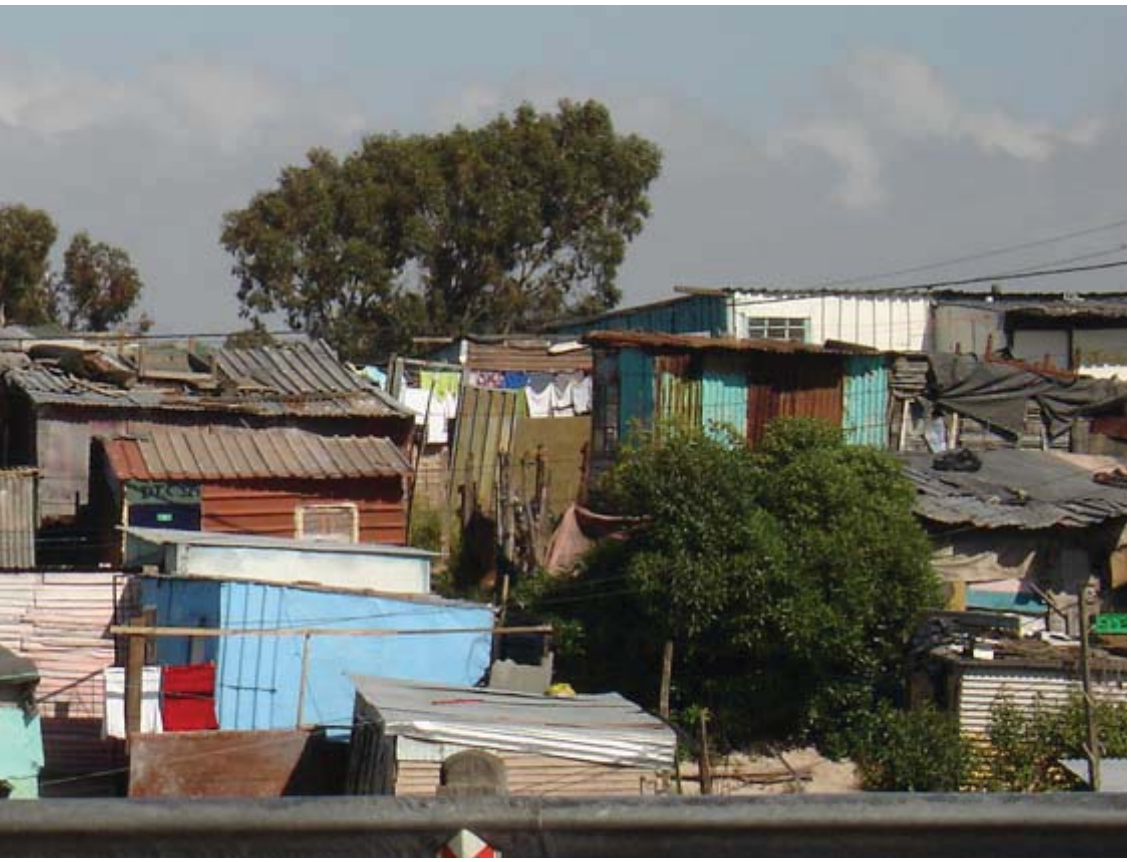
(*above*) Khayelitsha, February 1988 (Photo: Jenny Day)

the residents, adding to the abject conditions in the squatter area. Despite the altered status, these "new" wetlands still have value as a habitat for aquatic animals, for water purification and for the recharge of the Cape Flats Aquifer.

Construction of the Driftsands Detention Dam in the late 1980s reduced downstream flood peaks and initially "saved" the lower Kuils River from environmentally unfriendly channelisation and canalisation. At first, the wetlands downstream expanded significantly. By about 2000, though, the encroachment of informal urban development at Mfuleni, Khayelitsha and Macassar into the river floodplain meant that these areas were subjected to increased channel "maintenance" to prevent flooding of the shacks. The resultant excavation of the channel through the wetlands, combined with frequent burning and high grazing pressures induced large-scale channel erosion. As the bed level dropped in the channel, so the surrounding wetlands drained. Today, the wetlands are a fraction of their former extent.

Timeline: Kuils River canalisation

circa	
1970	Source canalised
1988	Kuils River wetlands bulldozed to create Khayelitsha
1990	Artificial canal built to drain new Blue Downs development to join Kuils River
1991	Detention dam constructed in the Driftsands reach. Khayelitsha reach channelised by dredging
1991-3	Kuils River business centre canalised due to restricted river reserve. First phase canalised - section of Bottelary River between Van Riebeeck and School roads
1992-4	Second phase canalised between Van Riebeeck and Rietvlei roads. The section below the railway bridge included full canalisation
1992	Runoff from Polkadraai Hill directed to Kleinvlei Canal via a subsidiary canal
1992	Span added to bridge at Macassar Wastewater Treatment Works to facilitate flow of floodwaters
1994	Macassar reach, just before Eerste River confluence, straightened and canalised
1995-7	Third phase of canalisation - a natural earth canal over last one kilometre before Nooiensfonteinvlei



Informal housing along the N2 highway, Khayelitsha (Photo: Rembu Magoba)

Resource use in the Mfuleni Wetlands

Despite the increasing urbanisation of the surrounding areas, portions of the wetlands around Mfuleni, which border the N2 highway near to Khayelitsha, are relatively intact. The wetlands are primarily used to graze livestock, but are also used for subsistence agriculture and hunting. The incomes earned from raising livestock compare favourably with those earned by other residents from different sources. These uses made of the wetlands by the residents of Mfuleni are similar to those more typically found in rural areas, and demonstrate how wetlands in an urban area can be as valuable as those in more rural settings.

Nooiensfonteinvlei

Nooiensfonteinvlei is one of the few vleis remaining on the lower Kuils River. It is located just downstream of the Stellenbosch Arterial Road and is flanked by the Westbank Housing Development. Like the Mfuleni Wetlands, Nooiensfonteinvlei has been subjected to intense urban pressure without suitable management, but nonetheless provides a livelihood-support resource for some of the local residents.[1]

1 Day and Brown (1998)

KLEINVLEI CANAL

Kleinvlei Canal is an entirely artificial watercourse, built in the 1990s to drain the eastern parts of the Blue Downs development area. The canal enters the Kuils River just upstream of Baden Powell Drive.

Daniel Bosman's original Zevenwacht Homestead. Zevenwacht Wine Farm, which is in the Bottelary hills near the source of the Bottelary River, was originally two farms, Langerwacht and Zevenfontein, and Zevenwacht was the cottage of Daniel Bosman, *circa* 1793. In 1979, the farms were combined under the name Zevenwacht and buildings on them, which had become neglected, were restored. (Photo: Dana Grobler)

The Dreamworld Wetlands

The wetlands within the proposed Dreamworld Film City development site form part of the original floodplain wetlands (kuils) of the lower reaches of the Kuils River. On the site there are remnants of the extensive seasonal braided channels, surrounded by a mosaic of seasonal dune-slack wetlands and shallowly-inundated renosterveld pans that were once a feature of the lower reaches of the river. These remnants extend westward for approximately three kilometres where they meet the now channelised main stream of the Kuils River that has been diverted south below the N2. Indeed, these extensive seasonal relicts have been largely protected from poor quality perennial flows through diversion of the main channel.

A recent investigation of the invertebrate fauna from two wetland patches within this mosaic, together with other wetlands on the Cape Flats, suggests that the animals supported by this system are unique, with a number of endemic crustacean species that are distinct from those found in other alkaline wetlands on the Cape Flats. Other animals supported by these wetlands include the Marsh Terrapin (*Pelomedusa subrufa),* the Cape Sand Toad (*Vandijkophrynus angusticeps*) and the Clicking Stream Frog (*Strongylopus grayii)*. Portions of the once-seasonally inundated floodplain wetlands along the southern boundary of the site are now permanent and invaded with *Typha capensis* due to connectivity (via balancing pipes) with the main channel

of the Kuils River below the N2 Freeway and poor quality runoff from the Kleinvlei Canal.[2]

These wetlands are, however, under enormous threat from urbanisation, and are frequently impacted by fire, invasion by acacias, illegal dumping and high-intensity stock grazing. They are, of course, also under threat from the proposed Dreamworld development.

The Bottelary River

The main tributary to the Kuils River flows in a valley between the Stellenbosch-Kraaifontein hills. The land is largely given over to viticulture and urban development is unlikely to be allowed, at least in the near future.

The Van Riebeeck Road Bridge constricted flow in the reach through Kuilsrivier Village, and regular local flooding was prevented to some extent by levees. As a result of reconstruction of the bridge, the 1-in-50 year floods can now be accommodated in the river reserve.

MEMORIES

Professor Jenny Day of UCT recalls: "I heard from City officials that PW Botha was the instigator, and that the position of Khayelitsha was established by him flying over the area in a helicopter and saying 'that area seems empty – put it there'. Apparently, the City was given three months to design the whole thing. Bryan (Professor Bryan Davies) and I were with someone from the City driving behind some of the bulldozers that were 'opening up the land', which was pretty much wall-to-wall acacias. We also watched as the bulldozers destroyed the inter-dune wetlands."

Professor Jenny Day,
Freshwater Research Unit,
UCT

2 Bird (2004), cited in Day *et al.* (2005)

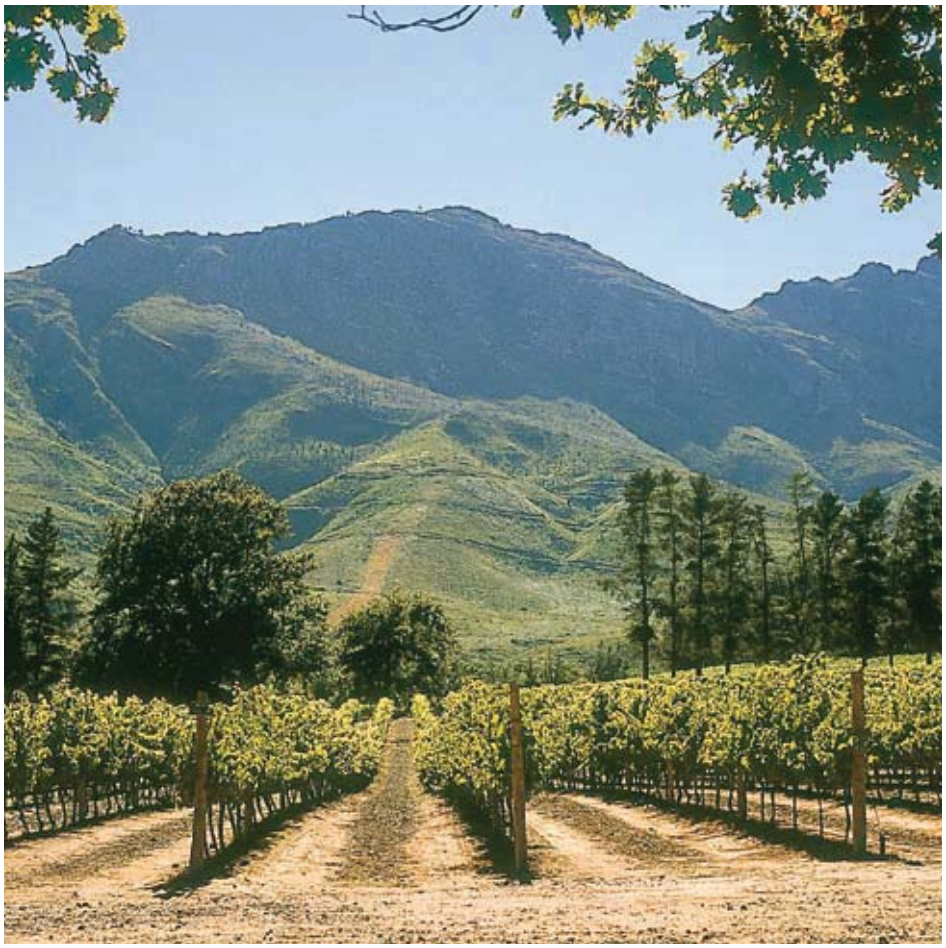


Photo: Simonsberg Ward

"On the mountain free height, in the noon bright light, at the warm force of sunshine, the nature brings out a golden wine."

Friedrich von Schiller, German author and philosopher (1759-1805)

Chapter 18

The Eerste River

The Eerste River measures only some 40 kilometres in length. It rises in the Dwarsberg to the south-east of the town of Stellenbosch, flowing in a north-westerly direction through Stellenbosch and then southerly towards False Bay near Macassar, where it ends in a small estuary.

From its source, the river flows through the Jonkershoek Valley, which forms part of the Hottentots Holland Nature Reserve. It flows out of the reserve past Cape Nature's Jonkershoek Station and down to Stellenbosch, receiving minor tributaries en route. Immediately downstream of Stellenbosch, it receives its first major tributary, the Plankenbrug River. After flowing past Stellenbosch Farmers Winery it then receives

These remnants of the original sandstone foundation pillars of the first bridge built across the Eerste River in 1838 can be seen at Kompanjiesdrif, Welmoed, Lynedoch. (Photo: Charlie Boucher)

the Veldwachters River. Thereafter, it flows through vineyards and agricultural land to the sea. Near Vlottenberg it is joined by the Sanddrif and Blouklip rivers. Immediately before entering the sea, the Eerste River receives the Kuils and Moddergat rivers. The total area of the Eerste River catchment, excluding the Kuils River, is 420 square kilometres.

The early years

Corporal Willem Muller named the river he encountered on 13 September 1655, after leaving the Fort of Good Hope at "de Caabse Vlek" to explore the territory east of the Cape Peninsula, the Eerste River.[1] Although was also known at some period as the River of Stellenbosch, the name Eerste River has endured. The river was the first of any significance encountered by the Corporal after leaving the colony (although presumably he had crossed several other less distinct streams enroute), and he crossed it at a natural low-water drift situated between Welmoed and Meerlust farms. The drift exists to this day, as do the foundation pillars of the first bridle bridge built across the Eerste River in 1838 near the drift. The abutments to the first full-sized bridge capable of bearing vehicles, located at Faure immediately downstream of the Old Main Road between Bellville and Somerset West (R102), also remain, but

1 Burman (1970)

without the teakwood spans. Today, this is the site of a Department of Water Affairs and Forestry gauging weir.

Early Stellenbosch

The town of Stellenbosch is situated on the banks of the Eerste Rivier. Stellenbosch was the second Dutch outpost at the Cape (after Somerset West) tasked with the provision of fresh produce for Dutch East India Company ships visiting the Cape. Stellenbosch was (and remains) an important neighbour of Cape Town, a fact signified by the building of the first stretch of railway line in the Colony from Cape Town to Wellington via Stellenbosch, which was started in 1859 and completed in 1965. The first trains in the Cape Colony started running on the Cape Town to Eersterivier section of this line in February 1862.[2]

Stellenbosch, or "Van der Stel's bos" as it was initially known, was named after Simon van der Stel. In 1679, van der Stel pitched his camp on a small island in the Eerste River under the shelter of a copse of trees. The indigenous trees did not survive for long, as firewood and timber were in short supply from the outset. In 1712, van der Stel recommended that 1000 young oak trees be planted in Stellenbosch to compensate for the depletion of indigenous timber resources, and the resultant wood was sold for commercial gain.

Stellenbosch's population received a boost in 1795 after the Battle of Muizenberg and the subsequent occupation of Cape Town by the British, when many Dutch families fled from Cape Town to Stellenbosch to avoid the "calamities of war".[3]

A valuable source of water

The Eerste River and its tributaries were important sources of water for Stellenbosch and surrounding areas even in those early days, although competition for water soon becoming an issue. The first large-scale abstraction/diversion from the Eerste River was affected in *circa* 1697. A dam in the river, in the vicinity of Thibault Street, supplied a millstream, which flowed through the town along Van Riebeeck Street, to the town mill on Mill Street. Regular flood damage to the dam wall resulted in its replacement with a "teak and iron" wall in 1721. When this too suffered a similar fate, a new stone dam was constructed at Mostertsdift taking water along the Drooge River (probably a dry flood channel of the Eerste River) to a new mill driven by water falling onto the wheel. Remnants of the original mill and millstream from Thibault Street have been preserved in the town centre as historic monuments.

Initially, the agricultural lands and gardens around Stellenbosch were irrigated with water from the Mill Stream. Later, as the burghers became more adept at water storage, farming moved higher onto the hill slopes, using water supplied from farm dams filled from the Eerste River and its tributaries.

2 Worden *et al.* (1998)
3 *ibid.*

A map entitled "Stellenbosch and surrounds" dated 1700, showing the rivers, main vleis and the layout of the farms in Stellenbosch, the Lourens River (here called Tweede of Laurens River), and the southern suburbs of Cape Town. The shaded areas around Stellenbosch show the settlements of "French Refugees at the Cape". Although dated 1700, the map shows some river alignments that are inconsistent with this date, such as the 1900 alignment of the Moddergat River and a confluence between the Kuils and Eerste Rivers. (Western Cape Archives)

For years, the Eerste River provided the main water supply to the expanding town of Stellenbosch, with most residents drawing water either directly from the river or from a series of "luiwater" furrows, which criss-crossed the town. By 1860, however, pollution levels in the Eerste River necessitated the installation of the first piped water supply to the town. The location of the water off-take for this supply is not clear. It was on the Eerste River but was presumably upstream of much of the human activity.

As early as 1862, farmers along the lower reaches of the Eerste River complained of insufficient water, allegedly as a result of over-abstraction by their upstream compatriots and the town. Around the turn of the 19th century, Senator Albie Faure solved this shortage, to a degree, when he arranged for the construction of a canal to take irrigation water not used in Stellenbosch town to the downstream farmers. To this day, the Lower Eerste River Irrigation Board uses the canal to distribute water to farmers. The off-take point is situated immediately above the confluence of the Plankenbrug and Eerste rivers.

A flood danger

In the early days, the Eerste River was much shallower than it is today with numerous islands and heavily wooded banks. Settlers were initially granted land to grow

The collapse of this riverbank of the Eerste River under oak and gum trees along the Noordoewer in central Stellenbosch, threatens the street. This section of the river was straightened to reduce flooding. (Photo: Charlie Boucher)

agricultural crops and for pasturing of cattle, sheep and goats. Cattle and grain farming were eventually replaced by wine, tobacco and fruit production, with the farming pattern determined by the possibilities of irrigation. Irregular flows were a natural and inevitable feature of the Eerste River that caused considerable consternation,[4] farmers having to deal with either too little water (in summer) or too much (in winter). The flooding power of the Eerste River fast became notorious, while it regularly changed its course damaging fields and buildings.

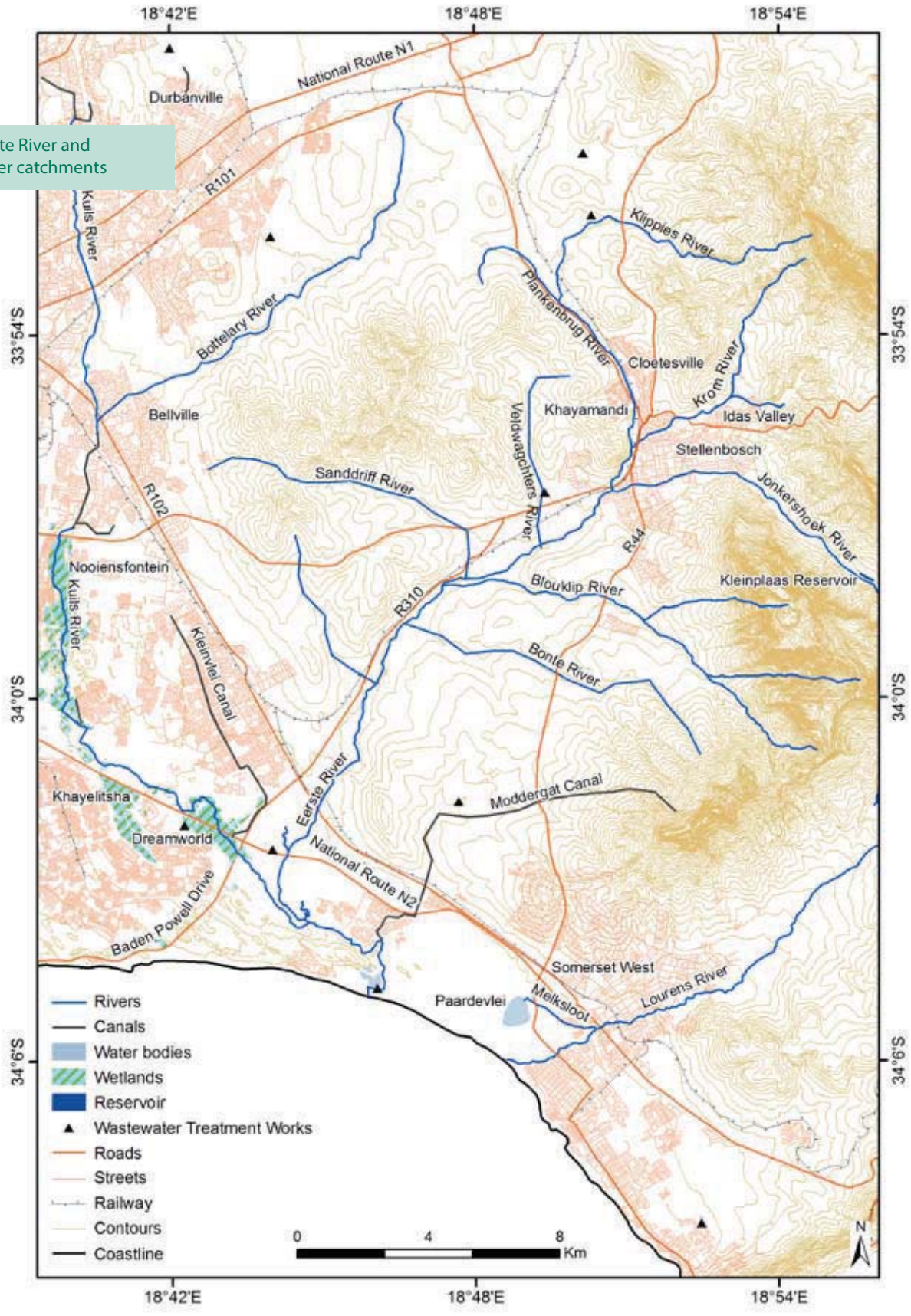
The first stage of canalisation through the town of Stellenbosch was initiated in 1731 with the construction of a wall at the upper end of Van der Stel's island (the present-day "Kweekskool"). In 1768, it was decided to straighten the bends in the river through the town and to remove heaped-up stone and sand from the river bed along its route between what are now Suidwal (at the Paul Roos Gymnasium) and Noordwal streets. To the present day, the banks here support only sparse indigenous riparian vegetation and erosion continues to occur, with regular collapsing of the riverbanks.

In 1773, the Drooge River (which had carried water to drive the mill in town) was reengineered to serve as a flood alleviation canal to reduce winter flooding and flood damage in the town. This is possibly the first example of an engineering solution applied to flood control in South Africa, and many more were to follow.

Flooding has virtually been eliminated now. The banks of the confined river through the town having being raised to about two metres above their natural levels.[5]

4 The Jonkershoek Mountains receive some of the highest levels of rainfall in South Africa.
5 Smuts (1979)

The Eerste River and
Kuils River catchments



The Plankenbrug River has the dubious distinction of being the most polluted tributary of the Eerste River. Deciduous exotic poplar and oak are the dominant trees lining the banks. (Photo: Charlie Boucher)

From source to sea

The Eerste River has its source in high-altitude marshes in the Dwarsberg. Five major rivers of the Western Cape: the Berg, Eerste, Lourens, Palmiet and Riviersonderend rivers arise in the Hottentots Holland mountain complex, which has the highest annual rainfall in the country (more than 3000 millimetres per annum).[6] From the Dwarsberg marshes, the Eerste River goes over two waterfalls before collecting into a rapidly flowing cobble-bed mountain stream. The river flows first through natural vegetation, then through pine plantations and meets with the Plankenbrug River in the lower outskirts of Stellenbosch town. Large pools between intermittent rocky outcrops are prominent from here to the boundary between Welmoed and Meerlust farms. Major tributaries in this reach are the Blouklip, Sanddrif and Veldwachters rivers. From here, the river has a sandy bed. An oxbow lake, which crossed the wine farms Klawervlei and Geduld, was bisected when the railway line to the Strand was constructed. The lower section of the lake on Geduld has now been filled in completely.

A large artificial pool extends from below the Old Main Road Bridge abutments to the Steenbras-Cape Town water pipeline weir, built in 1927 to protect the bridge carrying the Steenbras-to-Cape Town water supply pipeline. The water levels in this

6 Grindley (1982)

Typical riparian scrub along the Eerste River at Jonkershoek. The white flowered shrub on the right immediately behind a *Brabejum stellatifolium* plant is *Erica caffra*. The tall tree on the left is *Metrosideros angustifolius* with *Cunonia capensis* (dark foliage) behind.
(Photo: Charlie Boucher)

The pipeline bridge across the Eerste River at Vergenoegd. A weir below the bridge creates an extensive pool in summer when the wooden slats are in place. The pool immediately below the weir housed two species of eel before the widespread fish kill in 1950. (Photo: Charlie Boucher)

pool were controlled by the manipulation of teak sleeper slats in the weir. The slats were generally removed during winter to allow floods to pass through. An additional pipeline was added in 1950. In 1965, the river course below this weir was altered to straighten the river in order to reduce flooding at Vergenoegd.

The confluence with the Kuils River is located on Zandvliet Farm, immediately downstream of the N2 highway bridge.

The next bridge across the river is at the Kramat of Sheik Yusuf. Sheik Yusuf (also spelt Joseph). A political exile to the Cape from Ceylon, arrived in 1694 and died on Zandvliet Farm on 23 May 1699. His tomb (kramat) became a shrine and is today one of the holiest places of the Cape Malay Muslims.[7] Of noble birth, Sheik Yusuf lived in exile due to the Dutch occupation of his hometown of Macassar, where he had spearheaded resistance. He was eventually persuaded to surrender. On a broken promise, the Dutch transferred him to the Cape in 1693 and accommodated him on the farm Zandvliet. He provided refuge for fugitive slaves, and it was through his teachings that the first true Muslim community developed.[8]

The Eerste River skirts a large calcretised dune before entering False Bay at Macassar. The confluence of the Moddergat River with the Eerste River, between the Kramat and the mouth, is now also the location of a pipeline bridge taking wastewater to Macassar Wastewater Treatment Works, located on the estuary floodplain. Nowadays, the Eerste River receives considerable discharges from wastewater treatment works located at Stellenbosch, Belville, Zandvliet and Macassar. Together with agricultural releases from Kleinplaas Dam in Jonkershoek, inflow of these discharges makes the river largely perennial, so that flows are less variable than would have been the case naturally.

7 Botha (1926); Burman (1970)
8 www.capetourism.co.za/cmm_kramats.htm

KRAMATS

Kramats, the holy shrines of Islam, mark the graves of holy men of the Muslim faith. There are more than 20 recognised kramats in Cape Town and its environs. Their positioning is said to fulfil a 250-year-old prophecy that a "circle of Islam" will be formed around Cape Town. This circle starts at Signal Hill with four separate kramats, continues to a site at Oude Kraal, then Constantia, and further to the Kramat of Sheikh Yusuf. The old kramat on Robben Island completes the circle.

www.capetourism.co.za/cmm_kramats.htm

Interbasin transfer

The largest reservoir in the Eerste River today is the Kleinplaas Dam, a balancing and diversionary dam built in 1981 in Jonkershoek. It forms part of an interbasin transfer scheme connected by means of a system of tunnels through the Hottentots Holland and Franschhoek mountain complexes. Water is abstracted from the Berg and Eerste river systems in winter and stored in Theewaterskloof Dam at Villiersdorp. In the summer, the water is released from Theewaterskloof Dam back into the Berg and Eerste rivers to supply irrigation needs.

Biologically, this interbasin transfer system is unfortunate, as it results in mixing of the clear white waters of the Eerste and Berg rivers with the brown-stained waters of the Riviersonderend River, which includes mud from the Theewaterskloof Dam basin. The water that is released back into the Eerste River is thus turbid. The lack of clarity in the water, the sedimentary film deposited on the rocks, and the constant release levels all have negative effects on the downstream biotas of rivers.

TROUT HATCHERIES AND TROUT FARMING

In 1893, the Cape Government first rented part of the farm Jonkershoek and appointed a professional pisciculturalist, Ernest Latour, to construct ponds for breeding trout. This hatchery became the leading source of trout for stocking southern African rivers.

The Eerste River was, for a time, renowned as one of the top trout fishing rivers in South Africa. A massive pollution event on 26 November 1950, which killed a wide spectrum of biota from Stellenbosch to the Kramat,* led to the river losing its renown for trout fishing.

Pollution remains a problem in the river, such that the reach upstream of Kleinplaas Dam is now the only section where trout are caught regularly these days. Trout are still bred at the Jonkershoek Hatchery and the Kleinplaas Dam is used for commercial trout farming. The University of Stellenbosch also uses breeding facilities at the Jonkershoek Hatchery to develop fish farming techniques for the commercial production of both exotic and indigenous fish.

* Nico Myburgh , Klawervlei, personal communication

Tributaries of the Eerste River

Plankenbrug River

The Plankenbrug River, together with its tributary the Krom River, is about 14 kilometres in total length. The Plankenbrug and Krom rivers drain the northern side of the Stellenbosch Valley running through farmlands, the suburbs of Cloetesville, Ida's Valley and Kayamandi, and past an industrial area skirting the foot of Papegaaiberg. Two water storage dams for Stellenbosch that receive Eerste River water are located on the Krom River in Ida's Valley. The Plankenbrug River has the ignominious distinction of having been identified as the primary source of pollution entering the Eerste River.[9] Very high concentrations of faecal coliforms[10] in the Plankenbrug River are an ongoing health hazard, particularly during low-flow conditions, and despite numerous attempts to remedy the situation, for instance, by constructing artificial wetlands to filter the water.

Veldwachters and Sanddrif rivers

The Veldwachters and Sanddrif rivers are both seasonal rivers that rise in the granitic Bottelary Hills. A number of farm dams on them capture all of the summer flow, although the Veldwachters River in the Devon Valley receives additional irrigation water from the Theewaterskloof IBT system. The Stellenbosch Wastewater Treatment Works on the Veldwachters River receives leachates from the adjacent rubbish dump before releasing its effluent into the river.[11] The municipality has been granted a licence from the Department of Water Affairs and Forestry to release

9 Petitjean (1987)
10 From the informal parts of Kyamandi.
11 Petitjean (1987); Wiseman and Simpson (1989)

This artificial wetland along the Plankenbrug River below Kayamandi was planted in December 2003. It was designed to filter pollution from the settlement. (Photo: Charlie Boucher)

general standard effluent into this river, but ageing equipment and lack of capacity reportedly resulted in numerous raw sewage overflows into the system during 2005–2007. These intermittent sewage spills are a real cause for concern for downstream riparian occupants.

The Blouklip and Bonte rivers

The Blouklip and Bonte rivers drain the western sandstone slopes and foothills of Stellenbosch Mountain, mainly passing through farmlands on weathered Cape granites on the plains, and enter the Eerste River at Vlottenburg and Lynedoch, respectively. The Blouklip River is a perennial stream, although summer flows are low. The small Bonte River is seasonal. The Blouklip River meanders through occasional small rocky outcrops, but generally both rivers flow through sandy alluvial deposits. Flows are largely modified by farm reservoirs in the upper reaches and by direct abstraction by pumping throughout. Some farms supplement their water needs from the Theewaterskloof Dam, via Kleinplaas Dam, so some of that water also finds its way into these rivers and supplements their flow, as does some drainage from Stellenbosch Golf Course and the De Zalze Golfing Estate development.

The vegetation along these streams is disturbed. These days the vegetation consists of wild olives with alien woody invasive species usually being dominant.

A separate stream drains the area of Eerste River village, and is detained in a small pond in the loop of the interchange between the main roads to Somerset West and Stellenbosch. The outlet makes its way via the historic Vergenoegd Farm to join the Eerste River near its confluence with the Kuils River.

MEMORIES

On 21 December (1944), when I went to (the river near) the Kramat, I found that the water had got very low during the last few days. Above the Kramat bridge there were two places to fish, the hind-leg pool and the top pool. I spent three hours in a gum tree near third bend, with two bulls walking around it. Their presence much hindered my fishing, and I only had two rainbows (trout).

Later . . .

On 2 January 1945, I went down to the Kramat and found the flow was fresh. I fished very badly, missed seven offers and took only one. I was looking out for bulls, particularly since their owner told me he did not trust one of them.

"Kingfisher" – the late Fred Bowker (1950)

A dam on Middelvlei Farm on the Veldwachters River, which is used to store water to irrigate vineyards. (Photo: Charlie Boucher)

The Moddergat River

The area where the Moddergat River now flows used to be a large swamp and wetland that drained into the Lourens River. About a hundred years ago, Cecil John Rhodes bought land in the area and had a channel dug to drain the swamp into the Eerste River. This artificial channel now forms the lower section of the Moddergat River.

The residential areas of Firgrove and Macassar, and farming areas between the N2 and R102 roads, are prone to flooding by the Moddergat River, largely as a result of draining of the wetlands, manipulation of the floodplain and riverbanks and constriction of the channel. A flood-alleviation/restoration project, initiated in 2000, involved the modification of the lower section of the Moddergat River as well as the modification of some of the bridges crossing it so as to reduce damage to the residential areas next to the river.[12] A "soft" treatment, with a low-flow channel lined with loose river boulders and macro-channel capacity designed to accommodate the estimated 1-in-50 year flood volume, was used. Much of South Africa's worst erosion occurs along riverbanks[13] and anti-erosion measures were introduced to protect the banks where necessary. The people living in the area requested that re-vegetation exclude trees and large shrubs as these would potentially provide hiding places for

12 Tharme and Brown (1998); Zimmerman and Boucher (1999)
13 McCann (1998)

The Blouklip River meanders through low granite outcrops (left bank centre) on Kleine Zalze Estate. Notice the undercutting of the invasive oak resulting from the inhibition of protective indigenous herbaceous undergrowth and the infilling of the opposite bank. (Photo: Charlie Boucher)

socially unwanted lawless elements.[14] The upgrade has proven to be of immense amenity value, with children playing on the grassed base, adults walking along the riverbank and families picnicking and braaing on the upper bank looking down onto the river and the high-flow channel. In 2001, the project was the recipient of a Certificate of Excellence from the Impumelelo Innovations Award Trust.

The Eerste River estuary

The Eerste River estuary, located at the eastern end of the large calcrete dune at Macassar and adjacent to the old Somchem and AECI properties at Firgrove, is one of eight estuaries in False Bay.[15] The estuary forms the boundaries of a restricted zone and a proposed Marine Protected Area.

The Eerste River estuary is naturally a small temporarily open system and, because of its size, tidal flows do not play a significant role in the dynamics of the mouth. Consequently, the state of the mouth is dominated by river flow. Under natural mouth and river flow conditions, intrusion of seawater maintained an estuarine ecosystem. When the mouth did close, it caused the Eerste River to back up past the Kramat to Zandvliet Farm. Observations made by trout fisherman in 1950–1960 tell us that the

14 Geustyn Loubser and Streicher (2001)
15 Grindley (1982)

Restoration work in full swing on the Moddergat River in Macassar in February 2000 (Photo: Cate Brown)

estuary formed a water body 0.8 to 2.5 kilometres long in the summer following mouth closure.[16] With the first winter rains, flooding at Zandvliet Farm used to be the stimulus to open the estuary artificially.

The estuary was once a valuable nursery area for inshore and estuarine fish, as well as supporting extensive beds of prawns and other estuarine invertebrates. However, trout fisherman began observing a steady deterioration in the water quality of the lower Eerste River from 1940 onwards. At the time, this was attributed to uncontrolled water abstraction, discharges of effluent from wineries (cellars) and increased turbidity resulting from poor land-use practices. Complete drying out of the Eerste River from Lynedoch to the sea became a regular feature from 1943 and resulted in prolonged mouth closure. The combination of poor water quality and closed mouth conditions proved fatal, and fish kills in the estuary occurred regularly.[17] In February 1959, all fish life in the estuary was destroyed by pollution at a time when the river was dry. Freshwater flow was restored to the estuary in April of that year but contained high levels of winery and distillery pollution, which hampered its recovery.[18] In fact, there was so little regard for effluent standards that the manager of the Chemical Defence Factory warned local fisherman against fishing in the Eerste River on account of the dangerous effluent that was being released into the river. Believe it or not, a temporary installation at the factory produced mustard gas for a few months towards the end of World War II, and even this discharged its effluent directly into the river.[19]

In more recent years, the flow into the Eerste River estuary has been significantly

16 Piscator (1947)
17 Kingma (1956)
18 Harrison (1978) in Grindley (1982)
19 Bowker (1950)

The Moddergat River in Macassar after rehabilitation. The landscaping has still to become established, but the potential is clear, and the improvement undeniable. (Photo: Geustyn Loubser and Streicher)

increased, despite some winter abstraction in the upper catchment. In addition to water from Theewaterskloof Dam, which is released into Kleinplaas Dam and discharged into the upper reaches of the Eerste River during the summer to supply downstream irrigators, treated sewage effluent from the Stellenbosch Wastewater Treatment Works is discharged into the Veldwachters River and Macassar Wastewater Treatment Works discharges effluent directly into the estuary. The flow regime of the Kuils River, now the major tributary to the Eerste River, has also been changed from seasonal to perennial due to the discharge of treated sewage effluent from the Scottsdene, Bellville and Zandvliet Wastewater Treatment Works. The additional flows mean that mouth closure seldom occurs, and even if it did the mouth would have to be artificially breached to prevent flooding of the Macassar Wastewater Treatment Works.

The flow changes and high pollutant levels have resulted in the loss of the once-dense prawn beds and the river's erstwhile function as a nursery to numerous inshore marine biota. The water being discharged to the sea via the river is highly enriched with industrial effluents, including traces of heavy metals,[20] to the detriment of False Bay's biotic environment. Total ammonia levels, particularly from the Macassar Wastewater Treatment Works, are toxic to aquatic organisms, and the estuarine sediments are almost entirely anoxic throughout due to the accumulation of organic material.[21] The high faecal coliform and *E. coli* counts measured in the river and the effluent entering the estuary also effectively negate any recreational use of the area.

Where once the estuary flooded an extensive inter-dune area behind the present

20 Mdlazi (2007)
21 GIBB Africa (2000)

The Eerste River estuary remains open in recent years because of increased flows from continuous wastewater treatment works releases. This photograph taken in 1997 shows the westward erosion of the Eerste River lagoon that has damaged the parking area and associated structures. (Photo: Charlie Boucher)

Somchem factory, and the mouth migrated between its present position and at least a kilometre eastward, the channel is now confined and incised with heavy invasions of woody alien species of gums (*Eucalyptus* spp.) and poplars (*Populus x canescens*).[22] Meanwhile, the bridge carrying the sewage to the Macassar Wastewater Treatment Works has allowed access to a previously inaccessible area and the indigenous thicket vegetation, including milkwoods (*Sideroxylon inerme*), along the western banks has been heavily exploited for firewood.

Estuarine fish

Twenty three species of fish have been recorded in the Eerste Rver estuary, of which three were introduced. The estuary was a prime angling spot until the early 1970s. Angling diaries published in the journal *Piscator* from 1905 onwards regularly referred to mixed catches of leervis (*Lichia amia*), elf (*Pomatomus saltatrix*), Cape moony (*Monodactylus falciformis*) and rainbow trout (*Oncorhynchus mykiss*) from the estuary. The Eerste River once had the only known sea-run population of introduced rainbow trout in the world. These fish continued to be caught in commercial beach-seine nets from Macassar to Muizenberg up until the mid-1970s. The fish assemblage even survived the release of mustard gas effluent into the Eerste River in the 1940s.

The Eerste River estuary historically closed during summer. Most fish recruitment would have occurred during spring and early summer, and springtides and evaporation would have maintained salinities at favourable levels. Sometime after 1970, however, development on the upstream river and on the estuary itself, such as the wastewater treatment works at Macassar and curtailment of the inter-dune flooding, started to impact on the viability of the estuary for fish, and today there are only a few hardy species that frequent the estuary.

22 Mdlazi (2007)

Western Cape Archives

"They told of a very beautiful river, on both sides of which bitter almond trees grew in abundance. So fertile was the valley that the soil at the Cape did not compare with it."

Jose Burman - Waters of the Western Cape (1970)

Chapter 19

The Lourens River (and two other rivers on the way to the interior)

The Lourens River has its source in Diepgat Ravine (also known as Watervalkloof), in the Hottentots Holland Mountain Range. In its upper reaches, it is joined by several minor tributaries arising in Landdroskloof and Sneeukopkloof. The river is only about 20 kilometres long and flows in a south-westerly direction through the town of

Sir Lowry's Pass was built in 1830 as a wagon road over the Hottentots Holland Mountains to the "interior". (Western Cape Archives)

Somerset West to the coast at False Bay. At its mouth, just west of Strand, the river forms a small estuary.

The effects of time

The early settlement (and later fortunes) of the Eerste and Tweede (Lourens) river valleys were driven, as their names unintentionally suggest, by father and son. The settlement along the Eerste River was Governor Simon van der Stel's personal project and he had helped and encouraged farmers along its banks. His son, Governor Willem Adriaan van der Stel, did the same on the Lourens River but, unlike Daddy, he annexed much of the land for himself.

In the early days of the Dutch occupation of the Cape, Van Riebeeck's outriders made a sortie in the direction of the Lourens River, and found a fertile valley with plentiful water, inhabited by the Khoikhoi Chief Sousoa and his family. They named the valley "Hottentot's Holland" and established a VOC outpost there.

The river was first known as Tweede Rivier as it was the second major river encountered on the trip from Cape Town to the interior via a wagon road over the Hottentots

Holland Mountains. In 1671, it was renamed the Breitenbach River, after Lieutenant Coenraad Breitenbach, but the name did not survive. In 1673, the commander of the outpost, one Laurens Visser, reputedly drowned in the river, which was renamed the Laurens River in his memory. Eventually, it became known as the Lourens River.

Some 50 years later, the controversial governor Willem van der Stel persuaded a visiting commissioner of the Dutch East India Company to grant him 400 morgen of land in the valley where he set up his showpiece farm, Vergelegen, on the banks of the Lourens River. He constructed reservoirs, dug irrigation canals and instituted controls on the Lourens River. Van der Stel Jnr was dismissed by the Directors of the VOC in 1706 and ordered to return to Holland. Three years later, on the instructions of the VOC, Vergelegen was sold and divided into four separate farms. The present Vergelegen homestead is built on the ruins of the van der Stel homestead and ruins of an original wheat-grinding mill on the river still exist today.[1] In 1813, the four owners of the original Vergelegen land bought ground at Cloetenburg to erect a church. In 1821, the church was dedicated, and the village of Somerset West came into being in 1822.[2]

Prior to the onset of urban development, the lower reaches of the river, downstream of the present-day N2, were associated with a wide floodplain and riparian wetlands. The lower reaches of the river probably displayed a tendency to form oxbow lakes, evidence of which remains in the open ground adjacent to the river between the N2 and Broadway Road. This tendency of the river to meander has been curbed by urban development in the floodplain of the river and channelisation of the river.

Flooding and flood alleviation initiatives in the Lourens River

The orientation of the mountains surrounding the Lourens River catchment is liable to cause orographic[3] rain in a south-west wind. This factor, combined with bare mountain slopes, will cause a very short time of concentration for floods, with consequences that are extremely important. The 1-in-50 year flood in the vicinity of the historic bridge on Main Road is estimated at 350 cubic metres per second, the 1-in-20 year flood at about 240 cubic metres per second, and the 1-in-5 year flood at 120 cubic metres per second. These are big, big floods, even for the Western Cape, and they are most likely to arrive in the summer.

Despite its historical significance, until recently the Lourens River has fared poorly in the hands of engineers. Engineering works appear to be have been on an *ad hoc* basis, and developments (and infilling) within the floodplain of the river are routine. By the 1990s, it became apparent that something was amiss, and in 1995 a team led by Prof. Albert Rooseboom of Stellenbosch University was appointed to do a proper flood study.

Their preliminary report was alarming. Although the survey information was limited,

1 www.somersetwest.com
2 The National Monuments of South Africa
3 Rain that occurs when an airstream crosses a mountain barrier

PROTECTED NATURAL ENVIRONMENT

In 1997, the entire Lourens River, from its headwaters to the sea, was declared a Protected Natural Environment (PNE). It is currently one of only five declared PNEs in South Africa, and the only river. The Lourens River PNE covers the area that falls 45 metres on either side of the centre line of the river.

it appeared that large areas of Somerset West were liable to be inundated in a 1-in-50 year flood. The estimated costs of remedial measures were considerably higher than the City of Cape Town had previously contemplated, and while not disbelieving the report, a second opinion was necessary. They commissioned a study by Dr Bill Pitman of the firm Stewart Scott, which confirmed the calculations and presented a frightening picture of the devastation that would be caused in Somerset West by a flood of any significant magnitude. According to Dr Pittman, the 1-in-20-year flood would inundate some 700 metres of Main Street, and water velocities in urban streets would approach five metres per second. Any such event would result in considerable loss of life and damage to property, and it was clear that the local authority had to act rapidly. Knowledgeable local people were sceptical about the severity of the predicted floods, as it was felt that anecdotal evidence did not corroborate the hydrological estimates. The capacity of the historic bridge was a primary concern, since its portals were not large enough to convey a flood of the magnitude predicted by Prof. Rooseboom. In 1999, a third authority, Prof. Geoff Pegram of the University of Natal, was called in and he again confirmed that the estimates were realistic.

This map of the Lourens River, *circa* 1750, indicates a split in the Lourens River into two distributaries upstream of the town of Somerset West and two mouths to the sea. The road across the river and up what was to become Sir Lowry's Pass is also shown. Note too, the large coastal lagoons between the two river mouths and to the north of the Lourens River. (Western Cape Archives)

Maps dated as late as 1900 clearly indicate a split in the Lourens River into two distributaries, upstream of the town of Somerset West. The course of one of these approximated that of the modern-day Lourens River, while the second, which probably only flowed when the river was in flood, flowed in a north-westerly direction and entered the sea on the other side of Strand. (The Soete River discussed in this chapter is possibly a remnant of the second "flood" channel of the Lourens River.) Much of the present-day confusion surrounding the Lourens River Bridge in Somerset West (built in 1844), which can pass a flood of 70 cubic metres per second, being unable to cope with the massive floods generated in the upstream catchment can be answered by the simple fact that,

River boulders unearthed during construction along the alignment of the second flood channel of the Lourens River provide proof that large river flows had come this way in the past. (Photo: Bill Harding)

when the bridge was designed and built, not all of the river passed beneath it during floods.

The second flood channel had not gone unnoticed by the engineers, and the 1995 team led by Prof. Rooseboom had earmarked a route for a flood alleviation canal for the Lourens River, which followed the course of the original channel for some of its way.[4] Unfortunately, however, the land was never reserved and by 2000, a Medi-Clinic and an old age home occupied the space where the Lourens River flood channel originally ran and the scheme could not be implemented.

In view of the protected status of the river, canalisation was impossible and the flood alleviation measures eventually proposed, after several revisions in 2002, focused on four main areas:

- Modifications to the entire urbanised reach of the river, in particular between the historic bridge and the N2. This included reconstruction of the Sargeant Street Bridge, and focused on environmentally sensitive earth works and revegetation with indigenous species. The river in this reach would then be able to accommodate 120 cubic metres per second. Considerable thought was given to the treatment of the old bridge and eventually it was recommended that two additional culverts be constructed on one side. (A proposal to dismantle the bridge and re-erect it at a less critical location was seriously considered.)
- An attenuation dam in the sports field area known as Radloff Park, which would absorb half the 1-in-20 year flood and only pass 120 cubic metres per second downstream. This option would not help for a storm greater than a 1-in-20 year return period.
- A diversion canal. As already mentioned, the most favourable routes had been

4 Stewart Scott Inc. (1999)

blocked by development, and less suitable routes would still require extensive expropriation.

- Use of the Strand golf course as a flood attenuation area.

Quite obviously these proposals were very expensive to implement, and indeed only partially addressed the danger of flooding in the valley. In recognition of the urgency, the City of Cape Town made funds available for the first, relatively inexpensive, stage and this was completed in 2004. In view of the potential danger and disaster, it is likely that funds will have to be found for the other phases. Hopefully no threatening flood will occur before the measures are in place.

The need for proper catchment management, restrictions on building in floodplains, river buffer corridors and an early understanding of potential problems is nowhere better illustrated than in the Lourens River.

The historic Lourens River Bridge, *circa* 1900 (Western Cape Archives)

The historic bridge

The bridge across the Lourens River at Somerset West is one of the oldest existing bridges in the country and, as a proclaimed National Monument, is now protected under the Heritage Resources Act. It is also the central feature of the coat-of-arms of the South African Institute of Civil Engineers.

When the Cape began to expand under British rule and farms were established in the Overberg, the British governors attended to the lack of infrastructure as a matter of policy. Sir Lowry's Pass was built in 1830 and a hard road across the Cape Flats was constructed between 1843 and 1845. The river crossings were addressed at the same time and in 1844 an architect, W.S. Chauncey, was appointed to design and supervise the construction of bridges across the Eerste River at Faure, the Lourens River, the Palmiet River and the Bot River.

The Lourens Bridge is built of Table Mountain Sandstone and consists of two arches, each 17 foot 6 inches long carrying a single 12-foot carriageway, and can pass a flood of about 70 cubic metres per second. The bridge carried the traffic to the east until 1938, when it was replaced by a new concrete structure just downstream. During the van Riebeeck tercentenary celebrations in 1952, the bridge was temporarily reopened. After reinforcement with a layer of concrete, a wagon and horses was driven over it, and hoof marks were left in the wet plaster.

The Lourens River estuary

The Lourens River estuary is one of eight estuaries in False Bay. It is a small estuary of approximately 7.1 hectares in extent, opening into False Bay some six kilometres to the east of the Eerste River.[5] The coastal area between the Lourens River and the Eerste River estuaries is a proposed Marine Protected Area.

The mouth of the Lourens River does open to the sea but for much of the time the estuary is only connected to the sea via a small western overflow channel. The estuary may close completely during the summer months and is characterised by a backshore lagoon that varies in size. Mouth position and the size of the backshore lagoon vary according to the size of the sand berm at the mouth, which dams the water resulting in the lagoon, and the size of floods in the river, which determines the position of breaching.

The Strand Wastewater Treatment Works were built on the northern side of the mouth of the Lourens River in 1948 but were closed in 1978 when the flow was diverted to Macassar. Today, there are no formal sewage discharges into the Lourens River. There were some reports of sewage discharges and other seepage from the AECI, Somchem and Triomf Fertilizer factories but these no longer occur.[6] (see Paardevlei) Current sources of pollutants are urban runoff and agriculture in the upper catchment, as well as a sewage pump station close to the mouth, which occasionally spills during power failures.[7] The quality of river inflow into the Lourens River estuary is considerably better than that into the Eerste River estuary, although no recent data are available to confirm its suitability for recreation.[8]

5 Cliff and Grindley (1982)
6 Lochner and Brown-Rossouw (1999)
7 *ibid.*
8 CSIR (1991 and 2000)

The Lourens River estuary on a gloomy day in January 2002. The roof of the sewage pump station is just visible in the right of the picture. (Photo: Cate Brown)

Paardevlei

Paardevlei lies on the site of a natural, shallow, seasonal vlei and was probably known as Paardevlei from as early as 1670. The first references to the vlei occur in the records of the Dutch East India Company, in relation to fishing rights. In the early part of the 18th century, the occupier of the farm, "Paarde Vlei" attempted to excavate a canal from the Lourens River to the vlei, without success. When Martin Melck purchased the farm Paardevlei in *circa* 1760, he too proceeded to "improve" the temporary vlei on the property. As part of this project, he successfully dug a furrow, the "Melcksloot" to deliver water from the Lourens River to the vlei to increase its size. He cleared the vlei of reeds and water plants and stocked the resultant permanent water body with fish, probably flathead mullet (*Mugil cephalus*). No mention is made of any outflow to the sea. It seems probable that some channel existed, but no traces are left. Melcksloot survives to this day.[9]

Prior to 1899, the land around Paardevlei was used for farming, but in the late 1800s Paardevlei Farm was sub-divided into Groot Paardevlei, Lower Paardevlei and Klein Paardevlei. Lower Paardevlei and Klein Paardevlei were acquired by De Beers Consolidated Mines, Ltd. (then under the leadership of Cecil John Rhodes) for the purposes of establishing an explosives factory. A provisional licence for the factory was granted in 1900. Building commenced immediately and the factory was completed in 1901. During the building phase for the factory, the vlei was pumped and drained, leaving a three-foot layer of mud in which the roots of plants

9 Harrison (1953)

Setting a precedent …

In the mid-1930s the Lourens River was the subject of an important case in the annals of South African water law. De Beers dynamite factory, at the sea end of the river, had asked for clarity about how much water it was entitled to abstract from the river for its industrial purposes. Apart from the municipal areas of Strand and Somerset West, the properties that could potentially have been deprived of their centuries-old water rights included the historic farms of Lourensford and Vergelegen, owned by Duncan Baxter and Sir Lionel and Lady Phillips. The case set the whole district alight and involved some of the most notable legal personalities in South Africa.

It was held that a farm was entitled to use all the water that came from sources on that property, and Lourensford and Vergelegen thus had full rights to all such water. The judgment formed part of South African case law, and was often quoted in similar cases, until the Water Act of 1998 redefined water rights.

The De Beer's Bridge over the lower Lourens River in the early 1900s (Western Cape Archives)

were imbedded. The vlei remained dry for two years, during which time three light railway tracks were laid across its surface, and the mud and vegetation cleared away completely, leaving a bed of clay.

To refill the vlei, a concrete pipe was laid from an off-channel dam known as Voor Baai, situated a few hundred yards north of the Lourens River, to the vlei. Before entering the vlei, the water was diverted in a wooden pipe mounted on a gravel ridge that ran across the vlei to a sump that overflowed into the vlei. The pipe was later demolished but the remains of the gravel ridge were visible for many years at low water. After the pipe was destroyed, water was still diverted into Voor Baai to deposit silt, and then into Melcksloot to the vlei. In 1927, an earthen embankment was added to provide a reservoir for water for the factory, and an outlet, which was controlled by a series of valves, was added. From this, water was pumped to the factory as required and the

MEMORIES

"The most striking feature of the plant life in Paarde Vlei is the beautiful carpet of *Nitella hyaline*, which covers the bottom of the permanent portion of the vlei. This soft, moss-like growth varies in height with the depth of the vlei, from several inches to a couple of feet. This plant is not a common one, and this is the only locality, as far as I know, in which it occurs in the south-western Cape".

Miss Edith L. Stephens, *circa* 1934, cited in Harrison (1953)

Dr Charlie Boucher at the Lourens River entrance to the Melcksloot in January 2002 (Photo: Cate Brown)

surplus flowed into the main factory drain, which discharged into the Lourens River estuary.

From 1922 to 1934, the vlei was doused with copper sulphate from time to time, to remove organic "impurities" from the water, which caused complications in the manufacture of explosives. This also produced a clear water lake, which flourished for a while, reaching its "best" in 1933-34. The level of the vlei was raised again in 1934.[10]

From 1937, reports from fishermen of poor water clarity and occasional algal blooms in Paardevlei became commonplace and, by 1943, the *Nitella* that had so delighted Edith Stephens had disappeared from the vlei. The willows skirting the vlei were even cut down in 1948 to reduce fertilization of the water from bird droppings, but were replanted in 1953.[11]

Gradually, partly because of the water quality problems and partly because of the increased security surrounding the De Beers, and later AECI's, explosive factories, Paardevlei became hidden from the public view. We could find very little written about it between 1955 and the 1990s. AECI stopped making explosives at Paardevlei and closed down in 1996, and several parts of the 1000 hectares property have been sold off for development – most notably to the developers of the vast Somerset Mall and its surrounding mini-malls, and an upmarket housing estate is proposed for the area around Paardevlei.

10 Harrison (1953)
11 Harrison (1954b)

*There was an old woman who swallowed a fly …**

The first known stocking of fish into Paardevlei was in the 1790s, when Martin Melck had it stocked with mullet.

After the draining and refilling of the vlei in 1902, until 1934, Paardevlei became renowned for its extraordinary abundance of the indigenous Cape kurper (*Sandelia capensis*). These fish do not provide good angling, however, and were thus not in favour with the fishing fraternity. So, various attempts were made over the years to stock the vlei with "more worthy" fish.

Several attempts were made to introduce trout, but they did not flourish. Possibly as a result of the copper-sulphate dosing that started in *circa* 1920.

In 1928, ten European perch (*Perca fluviatilis*) were brought to Paardevlei from the Jonkershoek Hatchery and released into the vlei. A further batch of 16 was released in 1931, and a small perch population became established in the vlei. But the fishermen were after bass!

On 30 July 1930, 21 largemouth bass (*Micropterus salmoides*) fingerlings were released into Paardevlei. A second batch of 24 was released the following year, on fears that the first lot had escaped. In fact, they had not, and a large population of bass was soon established in the vlei.

By 1933, the bass had completely exterminated the indigenous *Sandelia* and three dozen tench (*Tinca vulgaris*) were successfully introduced into the vlei (again from Jonkershoek) to provide food for the rampant bass. It was not enough. In 1940, more fodder fish for bass, this time 20 bluegill sunfish (*Lepomis macrochirus*) were released and, within months, had started breeding profusely.

Then in 1946, the vlei was stocked with 600 smallmouth bass (*Micropterus dolomieu*) and 700 spotted bass (*Micropterus punctulatus*) fingerlings, so that they could help control the bluegill sunfish!

Carp (*Cyprinus carpio*) were never purposefully introduced to Paardevlei. Nonetheless, by 1947, they were definitely present, probably as a result of escapees from private ponds finding their way to the vlei via the Melcksloot.**

P.S. In recent years, Paardevlei has been subjected to several rehabilitation activities aimed at reinstating the indigenous biota of the vlei, specifically the indigenous Cape kurper, which required the controversial application of the poison, Rotenone, to kill off all the introduced species.

* There was an old woman who swallowed a fly, I don't know why she swallowed a fly, perhaps she'll die. There was an old woman who swallowed a spider, that wriggled and jiggled and tickled inside her, she swallowed the spider to catch the fly, I don't know why she swallowed the fly, perhaps she'll die. There was an old woman who swallowed a bird, how absurd to swallow a bird! She swallowed the bird to catch the spider, that wriggled and jiggled and tickled inside her, she swallowed the spider to catch the fly, I don't know why she swallowed the fly, perhaps she'll die. (Children's song written by Alan Mills, with lyrics by Rose Bonne, 1953)

** Harrison (1954a)

The Soete River

It is not known why or when this little stream acquired the name Soete River, but it probably would not attract the same name today. The Soete River rises on the Schapenberg, a not very prominent hill that separates the Lourens River and the Sir Lowry's River catchments. It makes its way to the sea through Lwandle. The reach between the main Strand/Gordon's Bay road and the sea had been landscaped through the then golf course, and is now a feature of an upmarket housing development.

It is sometimes difficult to appreciate that a small stream can become a raging torrent in a relatively small storm, or that the power of that flood can remove property and threaten the lives of the unwary. Certainly the good councillors of the RSC Priorities Committee were unimpressed when, in 1989, an application was made for funds to canalise what appeared to be a tiny furrow flowing down Naomi Street in Gustrouw Village, Strand. Surely the engineers were exaggerating when they claimed that a little sloot was a regular source of discomfort, expense, and even danger.

Fritz Scheffler, the Chief Engineer of Strand Municipality knew that, because of its location, Naomi Street was in danger of flooding, even in a one- or two-year flood event – and to prove it, he went out in a heavy storm and took photographs of the Soete River in full spate, showing how cars and houses were under water, and making it quite evident that anyone caught in the torrent was liable to end up in False Bay. And when the weather returned to normal, he took more photographs from the same spot, showing the "spruit" in its usual innocent form.

Fritz's photographs did the trick. In fact, not only did he get his allocation to canalise the Soete River, but many other stormwater projects also received their funding. Indeed the attitude of the committee changed so radically that they agreed to allocate a minimum of R20 million per annum to undertake flood alleviation works in the city.

The Naomi Street section of the Soete River now lies in a covered canal beneath the street.

Sir Lowry's River

The Sir Lowry's River catchment has been aptly described as a catchment looking for a river. The catchment is relatively substantial and well defined and, being bounded by the Hottentots Holland Mountains, not short of rainfall. The Sir Lowry's River itself is a fairly small stream, with an impressive ability to flood.

The river rises near a peak with the unprepossessing name of Moordenaarskop, (the adjacent peak is apparently Landdroskop, which may commemorate some long-forgotten court case in the district) and flows out to sea through Gordon's Bay.

In the dry summer months, flow in the middle reaches of the river, i.e., between the N2 and Gordon's Bay Wastewater Treatment Works, is extremely low, partly as a result

Pictures that changed a policy … These pictures show the dramatic difference in the Soete River before and during a storm event. The photographs so impressed the RSC Committee that the policy of allocating funds for stormwater projects was modified. (Photos: Fritz Scheffler)

of numerous off-channel dams. Activities in this section of the catchment include smallholdings (chickens, lawns, etc.), but large areas are being developed into mixed-use residential complexes.

Winter in the Sir Lowry's is, however, a very different story. The flashy nature of the Sir Lowry's River was presumably not appreciated by the local authority when planning permission was given for the development of the township of Anchorage Park, and the residents were no doubt unpleasantly surprised when they found their newly-built properties knee-deep in water after a moderate storm in 1989. Brief investigations after cries for relief showed that quite a large part of the growing Municipality of Gordon's Bay was within the 1-in-50-year floodplain of the Sir Lowry's River, meaning more traumatic disasters might have occurred in a larger flood.

The diversion canal

In 1993, to reduce the flooding threat to Gordon's Bay, a canal was built around the populated areas to discharge on the western side of the Harbour Island development. The canal leaves the river some two kilometres upstream of the mouth, and is directed towards an old farm dam, which was remodelled to act as a detention dam. Thereafter it is an open canal until it reaches a partly built-up area, where a closed culvert was used to complete the route to the sea. This culvert flows beneath

Fuchsia Street, under the main Strand/Gordon's Bay road and enters the sea some two kilometres west of the mouth of the Sir Lowry's River. It also receives water from the Gordon's Bay Wastewater Treatment Works. The canal was landscaped to provide a community asset and not just a stormwater conduit.

Meanwhile, some of the ecological integrity of the original course of the Sir Lowry's River is maintained by routing flows of up to 12 cubic metres per second along it. This flow is controlled so that the heavily polluted "first flush" at the beginning of winter is kept out of the river.

"Rivers are important references. Instead of hiding them from view or burying them in concrete, cities should establish riverbanks as valuable territories."

The Honourable Jaime Lerner, Former Governor of Paraná, Brazil, and former Mayor of Curitiba
(Foreword "State of the World – Our Urban Future")

Chapter 20

The economics of the rehabilitation of rivers and wetlands

Freshwater ecosystems in general, and wetlands in particular, have a high social and economic value arising from the numerous services that they provide, which range from provision of recreational and aesthetic benefits to water treatment. Rivers are also vital corridors, enabling the movement of animals between mountains and

Cape Town Central Business District (Photo: South African Tourism)

seas. Aquatic ecosystems within urban areas can be particularly valuable because of their urban location. Furthermore, the interconnectivity of the river and wetland systems of an area like Cape Town means that planning and management decisions made in one area affect management costs and ecosystem values in other areas. The degradation and reclamation of rivers and wetlands are thus of great concern from an economic perspective.

Urbanisation has changed our rivers and wetlands considerably (see Chapter 5). Some systems have become more permanent as a result of the increased urban runoff and inputs from wastewater treatment works. Others have been encroached upon, and still others have been drained to make way for urban and agricultural development. Most have been subject to increased pollution loads. These changes have affected their hydrological and ecological functioning, necessitating increasing management interventions in order to manage flows, water quality and recreational environments. In some cases, these interventions have been injudicious or insufficient, leading to further deterioration of downstream systems, and resulting in unnecessary costs.

Managing the rivers and wetlands of Cape Town carries an economic cost related to the activities and equipment required to keep them in an "acceptable" state, as well as an opportunity cost in terms of the "lost" opportunities for development of the land they occupy. As population growth and urbanisation proceed, however, people become increasingly reliant on the services (such as flood protection and

Louis and Pancake, Zandvlei, March 2007 (Photo: Gavin Lawson)

purification of water) provided by those systems that remain and substantial benefits of maintaining the systems accrue.

In this chapter we describe the services provided by rivers and wetlands, and summarise the way in which these have been impacted by urbanisation and related interventions. We outline the costs of managing our urban rivers and wetlands, and demonstrate how the benefits have been increased through investment in more holistic engineering solutions that make better use of the potential for provision of ecosystem services.

The preceding chapters have outlined the major engineering interventions on the rivers, wetlands and estuaries of Cape Town and, in some cases, the associated capital costs of these interventions. It is neither easy, nor particularly helpful to this discussion, to calculate the exact amount of money spent on these activities over the years. Suffice it to say, it was a lot of money! It is, however, worth noting that the nature of these interventions has changed substantially over the years, and there is now a much greater focus on soft-engineering options, such as using vegetation to stablise riverbanks, than in the past. Indeed, several of the engineering interventions undertaken on rivers over the past decade could also be classified as rehabilitation initiatives. The activities on the lower Silvermine River (see Chapter 15), the middle reaches of the Lourens River (see Chapter 19), and on the lower Moddergat River (see Chapter 11) being cases in point.

Themba the Edutrain

There can be no doubt that the educational value of Cape Town's rivers and vleis is immense. There is hardly a river or wetland in Cape Town that has not, at some time, been used as an outdoor classroom. Thousands of children visit Zandvlei, Rondevlei, Zeekoevlei and Rietvlei each year, but not all are fortunate enough to come by train.

The Metrorail Edutrain called "Themba" is a purpose built classroom on wheels that takes children from Cape Town and surrounding areas, some as far away as Tulbagh and Wellington, to visit the Greater Zandvlei Estuary Nature Reserve. The visits are sponsored by the City of Cape Town and, in 2008, "Themba" visited the Reserve every term for the first time.

Zandvlei is the only Nature Reserve in the Metropole that has a railway station in close proximity and the children walk 150 metres from the Steenberg Railway Station to the Reserve. Many have never before seen such a large waterbody, been in a conservation environment or seen the Peninsula mountain range up close. A variety of programmes are offered, and the live animal demonstrations are always a highlight.

Themba the Edutrain, July 2008 (Photo: Gavin Lawson)

The economic value of aquatic ecosystems

The benefits offered by ecosystems, known as ecosystem services, include provisioning services, regulating services and cultural services. Provisioning services refer to the provision of resources that are harvested, such as fish, reeds or arum lilies. For instance, as mentioned in Chapter 3, if all the estuaries in Cape Town were healthy and fulfilling their estuarine nursery function for fish, they would annually contribute at least R20 million to the value of the coastal commercial and recreational line fisheries.[1] Regulating services refer to the functions that are carried out by ecosystems that generate income elsewhere, or that save on engineering costs. In the case of rivers and wetlands, these include services such as flood attenuation, stormwater storage, wastewater removal and water treatment. Cultural services

1 Lamberth and Turpie (2003)

Kids fooling around for the camera, World Wetlands Day, 2004 (Photo: Gavin Lawson)

include the values derived from cultural use, including religious and recreational use of these areas. They also include educational and scientific value, and the sense of well-being that people derive from knowing that biodiversity is conserved and will be enjoyed by future generations.

Many of these benefits are so-called "intangible" values that are extremely difficult to quantify in economic terms. However, methods have been developed that can be used to estimate the contribution these services make to society in monetary terms. For instance, the income generated is used to estimate the value of resources harvested from wetlands; the value of regulating services is estimated in terms of the cost of replacing them using engineering solutions, such as the cost of building wastewater treatment works to replace the water-treatment function; recreational and aesthetic values are estimated using the premium paid for properties with river or wetland frontage/access, the amount spent by people on visiting a river or wetland, their willingness to pay to retain or improve a river or wetland, or their willingness to accept compensation for loss of a river or wetland.

Considerable effort has been made to value the ecosystem services provided by rivers and wetlands globally, possibly reflecting the concern about the level of threat that these systems face. In 1997, one worldwide synopsis estimated that rivers, wetlands and estuaries were worth some US$8500 (R60 000), US$19 580 (R140 000) and US$9990 (R70 000) per hectare per year, respectively.[2]

2 Costanza *et al.* (1997)

Examples of the ecosystem services provided by aquatic ecosystems in Cape Town, and their relative importance in the area (adapted from Costanza *et al.*, 1997, and the Millennium Ecosystem Assessment, 2003)

	Type of value	Explanation	Importance in Cape Town
Provisioning services	Natural resource harvesting	Provision of natural resources for harvest, such as reeds, medicinal plants and food plants	Low
	Water supply	Provision of water for consumption and other activities such as washing clothes	Moderate
	Agriculture	Provision of land for cultivation and/or grazing	Low
Regulating services	Flood attenuation (stormwater control)	Wetland vegetation and soils slow water velocity and channel water to relatively predictable locations, vleis capture and store flood peaks, and rivers act as conduits to transport stormwater	High
	Wastewater transport and treatment	Wetland and river soils and vegetation trap, absorb, neutralize and dilute certain contaminants	High
	Flow maintenance	Wetland soils hold water from rainfall events and release the water slowly throughout the year, augmenting flows in the dry season	Low
	Carbon-sequestration	Certain types of wetlands store carbon in their soils and vegetation	Low
	Refugia and nursery areas	Wetlands and rivers provide critical habitats for aquatic and semi-aquatic organisms such as semi-aquatic mammals, waterfowl, frogs and fish	Moderate
Cultural services	Aesthetics and recreation	Provision of open space for residents and tourists	High
	Spiritual/religious/ cultural value	Provision of opportunities for spiritual experience and religious ceremonies such as baptisms and cleansing ceremonies	Moderate
	Education/research value	Sites for environmental education and scientific research	High
	Existence/bequest value	The value that certain ecosystems exist now and are protected for future generations	Moderate
	Option value	The unknown value that rivers or wetlands may provide in the future	Moderate

Waterbirds at the Zandvlei outlet weir (Photo: Gordon Richardson)

In urban areas, however, a large portion of the value of wetlands and rivers is linked to their effect on property prices, which are usually significantly enhanced by proximity, preferably (but not necessarily) with frontage, to rivers or wetlands. A recent study for the City of Cape Town on the economics of open spaces showed that water-related spaces were amongst those with the greatest potential to influence property values,[3] particularly if those spaces were well maintained. For instance, waterfront properties in Marina da Gama on Zandvlei attract prices up to 35% higher than those of similar properties that lack water frontage.[4] Of course, the marina was constructed to maximise the private benefits of waterfront homeowners. Interestingly, however, private ownership does not appear to be a prerequisite for increased value. A 2004 study that examined the relationship between property values and privately- and publicly-owned open spaces in Oregon, USA, demonstrated that a 1% increase in the extent of public wetlands and rivers within a quarter of a mile of properties increases their value by approximately 0.7%, while the same increase for private wetlands result in a 1.57% decrease in values. Increases in the area covered by public streams also results in significant increases in value while increases of private streams do not. This finding seems to highlight the importance of public access to areas and not just their aesthetic appeal.[5]

3 Turpie *et al.* (2001)
4 van Zyl and Leiman (2002)
5 Netusil (2004),cited in van Zyl *et al.* (2004)

The remaining wetlands and rivers of Cape Town have a potential value of R180 to R200 million per annum

What are the rivers and wetlands of Cape Town worth?

Researchers have begun to estimate the value of the aquatic ecosystems of Cape Town, with interesting results. Wetlands located in poorer suburbs, such as the Kuils River wetlands near Khayelitsha, are used for harvesting raw materials, flowers, medicinal plants, and for growing vegetables and grazing cattle. Across the city, wetlands are important for cultural and recreational use, particularly where safety is not a concern. The value derived from their presence is evident from the general willingness of residents to pay for their maintenance, even among people in the lower income brackets. One study showed that residents of Metro South and Metro South East had a collective willingness to pay a once-off amount of about R1900 and R4300 per hectare for the maintenance of wetlands, respectively.[6] Another study, conducted in 2007, suggested that the Mfuleni wetlands along the Kuils River are worth over R13 000 per hectare per year in terms of the provisioning services they provide to surrounding households.[7]

Where they are well maintained, rivers and wetlands provide significant recreational value. For instance, residents from all over the city visit Zandvlei and Zeekoevlei. Indeed, the money that people spend in travelling to Zandvlei suggests that the estuary is worth at least R700 000 per annum to visitors (this is equivalent to R4500 per hectare).[8] In addition, many people pay a premium to live close to well-maintained rivers or wetlands. At Zandvlei, in 2001, the premiums paid for water frontage amounted to about R84.25 million, or some R543 500 per hectare.[9]

The value derived from water quality enhancement (removal of phosphorus, faecal bacteria, nitrogen and suspended solids) and water storage (flood attenuation) is also considerable. Based on our understanding of their functional capacity, the value of vleis such as Langevlei, Little Princessvlei and Zeekoevlei has been estimated at about R18 000–20 000 per hectare.[10] Using only these values, a back-of-the-envelope calculation suggests that the roughly 10 000 hectares[11] of wetlands remaining in Cape Town could be worth R180 to R200 million per annum. However, such a calculation belies the loss of value that has occurred as a result of ecosystem degradation. It also does not account for money spent on maintaining degraded ecosystems, which, in fairness, would still need to be spent on maintaining ecosystems were they to be rehabilitated.

Historic changes in value

The impacts of urbanisation on the rivers and wetlands of Cape Town have changed their character and influenced their management. They have also resulted in an increase in the value of some ecosystem services and the total loss of others.

As the number of people in Cape Town increased, wetlands and rivers were lost

6 Turpie *et al.* (2001)
7 Lannas (In prep)
8 Turpie *et al.* (2001)
9 *ibid.*
10 *ibid.*
11 City of Cape Town Wetlands GIS data (2008), personal communication

Trying to get a handle on the numbers

In Cape Town, the management of river systems has been very much influenced by the management structure of the Council. In the past, the area was managed by over 50 independent municipalities, until their amalgamation into six municipalities in 1994 and finally into the Unicity in 2000. With the recent improvement in co-ordination and organisation of management interventions, it is now somewhat easier than it used to be to estimate the total amount of money that is spent by the major contributing departments on open space and ecosystem management in Cape Town. There are still some complicating factors, however, such as some of the provincial and national expenditures may be for areas that extend beyond the borders of Cape Town, and rivers and wetlands make up only part of an area for which a budget is specified. For instance, nature reserves that comprise rivers, wetlands or vleis, also have terrestrial areas that are managed out of the same budget. Moreover, because rivers and wetlands are part of a broader ecological landscape, environmental management interventions not directed at aquatic ecosystems, such as clearing of invasive alien vegetation through Ukuvuka, may still have a positive impact through the effects on their catchments. These complicating factors mean that we needed to rely to a certain extent on the professional opinion of staff in the relevant departments and organisations. These factors also mean that the numbers provided are not exact.

when they were reclaimed for residential and other developments, or drained for agriculture. In some cases, new wetlands formed when the natural ones were filled in, limiting development in those areas. Indeed, it is mainly by virtue of the risks associated with developing in wet areas that some locales were spared, with the result that many of the remaining open spaces, apart from the mountain chain, are dominated by aquatic ecosystems.

Perhaps the most important impact of urbanisation has been the increase in runoff, as a result of two main factors. Firstly, water for domestic and industrial purposes is now sourced from outside Cape Town, but it still needs to be disposed of in Cape Town. Much of this water finds its way into the rivers and wetlands, turning formally seasonal vleis into perennial ones, and reducing their ability to absorb peak floodwaters. Secondly, the hardening of the catchments by buildings, roads and other non-permeable surfaces has increased peak stormwater runoff during rainstorms way beyond natural levels.

The combination of a loss of floodplains and wetlands, the more perennial nature of the remaining systems, and the vastly increased stormwater runoff meant that the remaining systems were unable to transport or attenuate floodwaters, and flooding in Cape Town became common. In order to reduce the flood risks, rivers and wetlands were channelised or canalised, at great expense, to improve the efficiency with which water is transported to the sea. In many instances, these engineering solutions created other problems, with their associated costs, such as transferring the flood risk

The tranquillity of Zandvlei – worth paying towards? (Photo: Gordon Richardson)

to downstream areas, and reducing the ability of aquatic systems to render services such as water treatment.

Of course, pollution from Cape Town is also discharged or washed into the rivers and wetlands, including heavy metals and chemical wastes from the industrial areas, organic pollutants from agricultural areas, litter, and, significantly, bacteria and nutrients from human and livestock waste. Apart from affecting human contact and aesthetic appeal, many of the systems are now also eutrophic.

The combination of the reduced functioning of the rivers and wetlands, and increased nutrient loading, means that rooted and floating weeds, specifically alien species such as water hyacinth and water fern, now proliferate. These weeds, together with solid wastes and soil washed off the catchments, clog river channels which increases the risk of flooding as well as the cost of maintenance.[12]

Infilling, channelisation and canalisation have also had a profound effect on the aesthetic and amenity value of river systems, with knock-on social and economic costs. Apart from being unattractive, canalised systems pose a threat for people and animals. (Remember, the grachts in Caapse Vlek were covered over because people fell into them.) Polluted systems also pose a risk to human health. The impact on safety and aesthetic values is reflected in the fact that property values alongside poorly maintained canals or wetlands (or indeed any poorly-maintained open space)

12 Harding and Brown (2001)

have been found to be about 10% lower than those further away.[13] This is opposite to the trend that is found for properties alongside well-maintained systems.

And so the economic and ecological repercussions continue …

Expenditure on routine aquatic ecosystem management in Cape Town

The responsibility for managing the rivers and wetlands of Cape Town is shared by various organisations, as are the costs. The bulk of the money used is derived from government at various levels. The Council provides the greatest amount, but provincial and national government also make substantial contributions. Private owners, public interest groups and volunteer organisations also make significant (and increasing) investments, mainly for rehabilitation. Often several organisations focus on the same river or wetland, and public-private partnerships are increasingly common across Cape Town, although expenditures may be sporadic.

In 2007, the approximated expenditure on the maintenance of rivers and wetlands in Cape Town by different organisations exceeded R18 million.[14] Two thirds (about R12 million) was spent on dealing with problems created by urbanisation and the externalities generated by engineering solutions. Conservation (in protected areas) constituted about a third of the expenditure, but much of this involved dealing with problems generated by poor water quality entering the protected areas. Of all the areas of expenditure, money spent on rehabilitation is the most difficult to quantify. From the information that we gathered, about R2.4 million was spent directly on rehabilitation initiatives in 2007, but this is very likely a gross underestimate as we did not have the resources to include the money invested by many non-governmental organisations, schools, residents and businesses in the many initiatives that have sprung up in Cape Town in recent years.

Conservation of rivers and wetlands in protected areas

A substantial amount of money is spent each year on the management of rivers and wetlands in protected areas within Cape Town. Often the costs of maintaining these areas far exceeds that of maintaining similar areas outside of urban areas, simply because the pressures and threats to urban protected areas are often greater than those in rural areas.

The City of Cape Town's Environmental Resource Management Department (Strategy and Planning Cluster) is charged with ensuring the implementation of the Council's Integrated Metropolitan Environmental Policy. Within the Department there are a number of focus areas, including Biodiversity Management. The Biodiversity Management Branch is tasked with managing the Council's biodiversity initiatives (excluding the mountain chain, which falls under South African National Parks), which

13 Turpie *et al.* (2001)
14 This study, based on various sources

include management of the 23 Nature Reserves that fall within its borders. Of these, those with substantial aquatic ecosystems components include:

- Edith Stephens Wetland Park
- Rietvlei Wetland Reserve
- Rondevlei Nature Reserve
- Zandvlei Estuary Nature Reserve and
- Zeekoevlei Nature Reserve.

In 2007, the total budget for the Nature Reserves is R22 to R24 million per annum. Capital investment, such as construction of education centres, makes up a considerable portion of this. Other costs include the construction of access routes, habitat rehabilitation, ecological monitoring and weed removal. The latter is significant enough to warrant the recent purchase of a mechanical weed harvester, at a cost of approximately R700 000.

It is difficult to estimate the amount that is spent on aquatic ecosystems alone, as budgets are not broken down by reserve, but it is estimated that R100 000 to R200 000 is spent on management of each of the vleis annually (excluding staff costs).[15] While these figures provide an indication of the costs, they certainly do not give the full picture. Obviously, annual budgets vary from year to year depending on a variety of factors, ranging from a genuine saving in management costs to a change in management and/or funding structures. Even taking that into account, average annual costs are not always the best indicator of expenditure as, in some cases, money is spent on once-off interventions. The money spent by the Biodiversity Branch on the management of Zeekoevlei and Rondevlei (including infrastructure and staff costs) from 1990 to 2004 illustrates the point. Funding at Rondevlei increased from R500 000 to R1 million between 1993 and 2004, whereas expenditure at Zeekoevlei decreased from R1.2 million per annum during 1990–1998, to about R40 000 per annum thereafter. It then increased again in 2008, when the cut-off drain was installed.

Exact amounts aside, the Nature Reserves are substantially under-funded and have been for a long time.[16] In all likelihood, the situation is getting worse rather than better, as in some cases management areas and developmental pressures are increasing, without commensurate increases in the budgets for management.

Since 1998, South African National Parks has contributed to the management of the rivers and wetlands of Cape Town through its management of the Table Mountain National Park, which was formed through the amalgamation of several Nature Reserves. Their contribution includes investment in aquatic ecosystems that fall within the park, such as the headwaters of most of the rivers, several vleis (such as those at Cape Point), several impoundments and many high-altitude wetlands. These costs were not included in the estimates presented here. In addition, approximately 5000 hectares of public land in Cape Town was cleared of invasive alien vegetation under the Ukuvuka Campaign. This was a four-year public-private partnership to ensure

15 Julia Wood, City of Cape Town, personal communication
16 Julia Wood, City of Cape Town, personal communication

Weed harvester purchased in 2007 by the City of Cape Town's Environmental Resource Management Department (Photo: Julia Woods)

improved fire management. Ukuvuka had a total budget of R63.5 million from the City of Cape Town (R30 million contribution), Table Mountain National Park, Working for Water and Working for Wetlands (R7.3 million contribution), private partners (R25 million) and others.

Flood control and water quality maintenance

The City's Catchment, Stormwater and River Management Branch, which falls under the Roads and Stormwater Department, is responsible for flood control maintenance, the main aim of which is to facilitate flood control and the flow of water from built-up areas. They are also tasked with managing water quality and ecological integrity in rivers, wetlands and estuaries. Maintenance activities focus on the repair of infrastructure such as stormwater pipes, and the clearing of channels and canals. Sediment and sludge removal, and the clearing of aquatic weeds from channels and canals comprise the majority of the workload. This is most important downstream of wastewater treatment works where nutrient-rich effluent enhances vegetation productivity. The Catchment, Stormwater and River Management Branch is also responsible for keeping the waterways clear of litter.

Expenditure on the cleaning of flood retention ponds has increased dramatically over the last few years, and in 2007/2008 was approximately R9 million per annum. The estimated total *required* expenditure on these activities is almost R125 million per annum.[17] This means that the available budget is only about seven percent of the "optimal" required budget. Based on this, the Catchment, Stormwater and River

17 Catchment, Stormwater and River Management Branch, City of Cape Town

The Catchment, Stormwater and River Management Branch's annual maintenance budgets for flood control maintenance, 2004 to 2007

Year (July – June)	Budget
2004/5	R 4.75 million
2005/6	R 6.25 million
2006/7	R 8.00 million
2007/8	R 9.25 million

Management Branch has determined a compromise target budget of nearly R15 million, or approximately 12% of the optimal, but more than 60% above current funds.

The Catchment, Stormwater and River Management Branch maintenance programme recognises five types of water bodies: un-maintained systems, lined channels, unlined channels, maintained water courses (rivers that are maintained for flow), wetlands and vleis. No maintenance is undertaken in "un-maintained" (natural) rivers and the other types are attended to in proportion to perceived need rather than their extent. This is based on input from contractors and officials on the required cleaning frequency and corresponding expenditure needed to keep the infrastructure clear of sediment, silt and debris. Expenditure per kilometre on unlined channels and maintained watercourses is similar, but these costs are roughly three times as much as is spent on lined channels.

Importantly, much of the maintenance done on unlined channels and maintained watercourses to facilitate flood control and the flow of water is to the detriment of the ecosystems themselves.[18] In an effort to reduce the associated impacts, the City has developed River Maintenance Guidelines to assist those involved in maintenance activities to approach them in a more ecologically-friendly manner.

A breakdown of the Catchment, Stormwater and River Management Branch's annual maintenance budgets for different types of water bodies

Type of water body	Total extent	Approximate percentage of budget
"Un-maintained" systems	Unknown	0
Lined channels	360 km	23
Unlined channels	60 km	12
Maintained watercourses	300 km	55
Wetlands and vleis	950 ha	10

General maintenance

The Council's City Parks Department is responsible for general maintenance in a large number of small parks, cemeteries, and open space areas. These activities, which include maintaining the banks of rivers and wetlands, may not contribute to ecosystem health, but they serve to enhance their aesthetic and recreational value, for example by mowing and litter removal. These days they also remove vegetation that can conceal criminal activities.

18 River maintenance guidelines have been developed for the City in an effort to minimise the impacts of maintenance activities on the ecosystems.

As of the end of May 2007, City Parks claimed 6958 individual assets. Because of the high number of (often small) properties, City Parks does not assign specific budgets to each one, but instead allocates funds where they are deemed most necessary. Politics dictate that annual expenditures are fairly capricious and change substantially from year to year. Many of the assets controlled by City Parks have components with water bodies. These include, but are not limited to:

- Princessvlei
- Little Princessvlei
- Two Rivers Urban Park
- Lourens River Protected Natural Environment
- Die Oog
- Glencairn Vlei
- The Khayelitsha Wetlands
- The Kuils River Corridor
- The Blomvlei Canal

Perhaps the most significant recent general maintenance project is the River Clean and Green Project, which involved a partnership between the Council and the Department of Environmental Affairs and Development Planning (DEADP), and was managed by the City Parks Department. The project, which aimed to improve the condition of the rivers and wetlands of Cape Town, saw a substantial injection of funds into the City Parks Department's annual budget between 2005/6 and 2007/8.

Financial year	River Clean and Green Project Budget	Operational budget
2003/4	0	R39 000
2004/5	0	R43 000
2005/6*	R3 500 000	R49 000
2006/7	R2 500 000	R54 000
2007/8	R4 000 000	R60 000

* First year of DEADP funding

The River Clean and Green Project was implemented in the Khayelitsha Wetlands Park, the Blomvlei Canal (Athlone) and the Lotus River (Hanover Park). The project concentrated on the removal of alien vegetation, reshaping and dredging channels, improving the riffles that aerate the water and other interventions to re-introduce a healthy ecosystem. Subsequent phases of the project are envisaged continuing until at least the 2009/10 financial year. However, funding beyond 2007/8 is uncertain.

Costs and benefits		Silvermine (recommended premium)	Silvermine (reduced premium)	Kuils River	Westlake River
2004 value of benefits	Aesthetic and recreational	R45 013 500	R28 819 500	R1 389 083	R10 259 000
	Flood attenuation	R1 364 624	R1 364 624	R1 374 350	-
	Total	R46 378 124	R30 184 124	R 2 763 434	R10 259 000
2004 value of costs (adjusted)		R10 126 207	R10 126 207	R6 915 736	R4 296 956
Net Present Value (as at 2004)		R36 251 916	R20 057 916	-R4 152 303	R5 962 044
Benefit/Cost ratio		4.58	2.98	0.40	2.39

Results of cost-benefit analysis for the Lower Silvermine River Upgrade (with a sensitivity analysis), Kuils River and Westlake River rehabilitation projects (van Zyl *et al.* 2004)

Is this enough?

To summarise, using the 2007 estimates, just under R18 million was spent on maintenance of the rivers and wetlands in Cape Town. Of this, about 66% (R12 million) was spent on activities that potentially damage the ecological integrity of these systems. This leaves a probably-overestimated R6 million spent on either ecologically-friendly maintenance or rehabilitation initiatives, or both. By all accounts, this level of expenditure is insufficient to maintain these values in the face of the stress placed on them by activities in their urbanised catchments, which is why many of the systems are in poor condition (see Chapter 4). From a purely economic perspective, however, this is hardly surprising, the R6 million in 2007 was the sum total of the funds made available for managing, protecting, maintaining and restoring hundreds of kilometres of river, 10 000 hectares of wetlands, and four major estuaries, which between them could generate hundreds of millions of rands in ecosystem services. This is clearly an under investment in the natural capital of Cape Town.

Does rehabilitation of urban rivers and wetlands make economic sense?

In 2004, a cost-benefit analysis was undertaken of three major river/wetland rehabilitation projects that had recently been completed in Cape Town.[19] These were:

- the Lower Silvermine River upgrade (see Chapter 15)
- the Kuils River canalisation and rehabilitation (see Chapter 17), and

19 van Zyl *et al.* (2004)

- the Westlake River rehabilitation in Kirstenhof (see Chapter 13).

For each of these projects they estimated the costs of rehabilitation and calculated the benefits of rehabilitation based on analysis of property market impacts, recreational uses and ecosystem services. The costs were obtained from Council officials. Benefits accruing to residents in proximity to the rehabilitated areas, in terms of increased property value resulting from either improved aesthetics or access to recreational areas, or both, were estimated through interviews with estate agents and residents. The value of ecosystem services focused mainly on flood attenuation and used standard flood data from the Council.

In the cases of the Silvermine River and Westlake River projects, they found that the economic benefits that accrued from the rehabilitation significantly outweighed the costs of the project itself. For the Silvermine River project, the economic benefits were over four times greater than the costs when the property premiums recommended by experienced estate agents were used in the analysis and, even when these were discounted by 30 to 40%, the benefits outweighed the costs by a factor of two. For the Westlake River project, the economic benefits were twice the costs.

The Kuils River project showed a negative net present value (2004) of –R4.15 million and a benefit cost ratio of 0.4:1. In other words, the costs outweighed the benefits. However, the analysis did indicate that although the focus of the project was flood attenuation, and consequently roughly 75% of the costs were engineering costs associated with that aspect, the aesthetic and recreational benefits were equivalent to the flood attenuation benefits. Similarly, in the Silvermine River project, while most of the costs were for flood attenuation, most of the benefits were aesthetic and recreational. This indicates that measures aimed at the creation and maintenance of an aesthetically pleasing area have a relatively higher benefit/cost ratio than pure flood-alleviation measures. Thus, if the relatively meagre aesthetic and recreational measures had not been implemented at the Kuils River, the project would have had an even less favourable benefit/cost ratio.[20]

These projects also all generated benefits in terms of job creation, particularly for casual and unskilled labourers and subcontractors drawn from the local community.

There are numerous other examples where the rehabilitation of rivers and wetlands has yielded considerable economic benefit. At Century City, for instance, the developers were obliged to retain the natural Blouvlei wetland that existed on the property (see Chapter 9). Although initially seen as a setback, the opportunities created by a healthy wetland were soon realised. Property around the wetland now commands a premium and the nature reserve is a draw-card for visitors to the development. Furthermore, much of the original diversity of waterfowl still remains at the wetland, fulfilling a conservation objective.

Even if the desirability, economic or otherwise, of rehabilitation has been conclusively established, its funding is often uncertain. These days, with the rise in awareness of the impacts of past practices on the environment, there are far more organisations than ever before who are willing to invest in the rehabilitation of the rivers and wetlands of Cape Town. Significant funders of the rehabilitation of rivers and

20 van Zyl *et al*. (2004)

The Peninsula Project

Working for Wetlands is a poverty-relief programme funded by the Department of Environmental Affairs and Tourism that uses unskilled, unemployed people to undertake wetland rehabilitation.

The Peninsula Project, which is just one of some 42 different projects that form part of the programme, has been actively involved in rehabilitating urban wetlands in the Cape Town area since 2001. It is a merger between two wetland rehabilitation projects, the greater Noordhoek Wetlands Rehabilitation Project, which was implemented jointly by Ukuvuka, City of Cape Town and WESSA (Wildlife and Environment Society of South Africa); and a SANBI (South African National Botanical Institute) initiative in the Cape Flats at Edith Stephens Wetland Park and the adjacent Lotus River.

To date, the project (in partnership with local government and other organisations) has undertaken wetland rehabilitation, which involves alien clearing, rubble removal, replanting of indigenous vegetation and chemical treatment of water bodies, in the Noordhoek Wetlands, Glencairn Vlei, Edith Stephens Wetland Park, the Silvermine River, Die Oog, Grootboskloof, the Liebeek River, the Rondebosch Common, and the Prinseskasteel-Keysers River catchment (including the Soetvlei Wetland in the lower Tokai Plantation).

A Management and Rehabilitation Action Plan, aimed at guiding rehabilitation efforts in the Prinseskasteel-Keysers River catchment, has also been drawn up with co-funding from the Table Mountain Fund and Working for Wetlands.

A major element of the success of the Peninsula Project has been attributed to partnerships with the City of Cape Town, local non-governmental and volunteer organisations, and local residents.

wetlands in Cape Town include the city councils of Cape Town and Stellenbosch, the Department of Environmental Affairs and Tourism (through South African National Parks and Working for Wetlands), the Department of Roads and private enterprise. A number of non-governmental organisations also spend money on improving water bodies in Cape Town. These include friends groups, conservation groups and corporate partners.

Increasingly, public and private partnerships are being seen as a major element for the success of rehabilitation projects (between the councils and local NGO or volunteer organisations, and local businesses and residents). These are particularly important in the on-going maintenance of projects, which are only sustainable if they can tap into the joint resources offered within varied partnerships represented by both public and private sectors. Some examples where this sort of endeavour has been successful are Soetvlei, Die Oog, Grootboskloof, the Liebeek River, Rondebosch

The annual International Kite Festival at Zandvlei, 2002. (Photo: Gavin Lawson)

Common, Keysers River, Hout Bay River, Elsjes River, Zandvlei, Rietvlei and the Bottom Road Sanctuary in Zeekoevlei.

There is no doubt, however, that some large capital outlays will be required in the short-to-medium term in order to reverse the already significant losses of river and wetland value, and to avert major environmental disasters precipitated by the pressure of urbanisation. For instance, it has been estimated that roughly R100 million and R50 million is needed for remedial actions to rehabilitate the functionality of Zeekoevlei and the Wildevoelvleis, respectively.[21]

Also, while hard engineering options such as lined canals are generally costly to implement, ecologically-friendly options are not necessarily cheaper. The difference between them is that the ecologically-friendly options support a wider suite of benefits. Most notably, some of the measures adopted, such as vegetated river buffer zones, help to address water quality and sedimentation, which are among the most serious problems associated with the river systems of Cape Town, and are responsible for the bulk of the maintenance costs. There are also the health benefits of improved water quality. The ecologically-friendly options also tend to be more aesthetically

21 2007 estimates

pleasing. They result in areas that are more suitable for recreational use, and support the animals and plants thereby contributing to biodiversity conservation.

It is important to note that "ecologically-friendly" does not necessarily mean wholly natural nor does it focus on conservation of these systems. In many cases, minor adjustments to the engineering design (preferably during planning but also post-construction) can result in increased ecological or social benefits (and hence value) while still meeting the original objectives. The Lourens River Flood Alleviation Project (see Chapter 19) is an excellent example of an initial engineering design being adjusted to incorporate ecological considerations, without prejudice to the primary aims of the project. Indeed, there is general consensus that the adjustments made enhanced both the engineering and the ecological outcomes. The flood alleviation work done on the Moddergat River in 2000 provides a slightly different example, where the adjustments to the engineering design were mainly to increase the social rather than ecological benefits of the project. Here, a multilevel earth channel was used in preference to a lined canal (which improved both the social and ecological value), and the vegetation on the margins was mainly lawns with no large trees. Although more densely vegetated margins would have been preferable from an ecological perspective, these were not adopted because of the social concern that they might provide a hiding place for criminals.

In conclusion, while substantial capital investment is required to rehabilitate and manage all the rivers, wetlands and estuaries of Cape Town, failure to make this investment would be reckless, if not downright dangerous, from a social, economic and ecological perspective. Without this investment, the values of river systems will erode further, generating negative externalities and costs that will be borne by society. Investment in rehabilitation and ongoing maintenance of the integrity of river systems is more than likely to result in positive economic returns. Indeed, as the population grows and pressures intensify, the role of these systems will become more critical, and the returns on any investment made can only increase over time.

Photo: Rembu Magoba

"If we do not change our direction, we are likely to end up where we are headed."

Chinese Proverb

Chapter 21

Looking to the future

Worldwide, the view that greater environmental, social and economic success can be achieved if urban riverfronts and wetlands are designed with ecological principles in mind is gaining increasing acceptance. In any city, a healthy river is a valuable resource in improving the quality of life and attractiveness of an urban area, and providing benefits for public health, recreation and economic growth.

Whatever the objectives of past interventions, there can be little doubt that urbanisation has resulted in the degradation of the rivers, wetlands and estuaries of Cape Town and its environs, reducing their water quality and precipitating massive loss of ecological resources, in some cases, irreversibly.

Looking down on Hout Bay with the Table Mountain reservoirs in the foreground (Photo: Gordon Richardson)

Environmentally sensitive management of urban waters requires that we evaluate the effectiveness of various management actions from a new perspective. This perspective needs to include consideration of the ecological benefits accrued or lost, and a greater understanding than before of the relative importance of the principal boundary conditions (flow, water quality and physical habitat) in determining the biotic integrity of urban rivers and wetlands.[1] It also needs to consider the socio-economic implications of management options, particularly as these pertain to flooding and recreation.

This final chapter looks at some of these issues from the perspective of improving river and wetland functioning, and protecting these systems from the sort of abuse they have suffered in the past, albeit for sound and noble reasons. We have tried not to replace the mistakes of the past with vagaries for the future, but rather to make a few practical suggestions for improvement. We also do not claim to have addressed all the possible options.

Not the beginning, nor the end

The most compelling reason for the protection and rehabilitation of the river corridors, wetlands and estuaries of Cape Town and its environs is that it is in the best interests of all residents and visitors. However, effecting the changes that are needed is a multi-goaled, multi-disciplined challenge that affects everyone at every level. These

1 www.cwr.bham.ac.uk

Poor refuse removal services are a major threat to urban waterways. The drainage canal between the Noordhoek wetlands and Masiphumele *circa* 2000 is a case in point. (Photo: City of Cape Town)

systems are complex and their relationship with the surrounding urban environment is, at best, convoluted. They require space if they are to function optimally within their urban setting, and much of that space needs to be in public hands, with public access. They require high-level protection from the threat of development and from upstream influences in their catchments that affect the quality, quantity and pattern of water that enters them. Much more needs to be done to address the issue of alien control, as it will not go away, and the threat posed to system functioning and

Planning frameworks in the City of Cape Town

In the early 1990s what was then the Cape Metropolitan Council prepared a Metropolitan Spatial Development Framework (MSDF). Since then, developmental trends (and legal requirements) have changed in Cape Town. The City's Spatial and Urban Design Department is therefore preparing an updated Spatial Development Framework (SDF; using the MSDF recommendations) as well as individual spatial development plans for the eight planning districts. The SDF will include an Environmental Management Framework (EMF) that will identify areas and activities in terms of the National environmental Management Act (NEMA) regulations (GN 385 of 21 April 2006). The SDF and EMF have provided an ideal opportunity to incorporate wetlands, vleis, rivers, floodlines and ecological buffer zones for the City in the future planning. This will assist to guide development from floodrisk areas and wetlands of biodiversity importance.

The Integrated Metropolitan Environmental Policy (IMEP) was adopted by Council on 31 October 2001. This policy recognised and committed the City to conserving Cape Town's unique biodiversity for both present and future generations. Arising out of this Policy, on 29 October 2003, Council adopted the Biodiversity Strategy, one of IMEP's Sectoral Strategies.

The Strategy has resulted in the identification of a network of sites (called the Biodiversity Network) that need to be secured to conserve a representative sample of the City of Cape Town's unique biodiversity and thus promote sustainable development. Once the information has been ground-truthed and biodiversity areas prioritised, the Biodiversity Network map will be finalised. The City is currently exploring declaring the Biodiversity Network a bioregional plan under the National Environmental Management: Biodiversity Act 10 of 2004. This would further assist with the conservation and protection of wetlands.

The Environmental Resource Management Department of the City is compiling a coastal climate change model. This spatial model illustrates how the effects of climate change are expected to impact the floodlines of the City's rivers and wetlands, and the character of the estuaries along the coast.

biodiversity by alien plants and animals is escalating. Moreover, the rivers, wetlands and estuaries of Cape Town and Stellenbosch require sufficient funds to enable them to be managed, maintained and rehabilitated.

The City of Cape Town has numerous progressive policies, by-laws and strategies aimed at better management of its natural resources. These cannot all be addressed in detail here.[2] Suffice it to say that, over the years, the City's management of its waterways and water bodies has metamorphosed, and much of the new legislation includes consideration of many of the issues we will touch on, such as ecological

2 See Appendix C

condition and flooding. The rampant canalisation described in some of the preceding chapters is all but a thing of the past and, as is evidenced by the numerous rehabilitation initiatives described, and there is growing awareness of the need to realise the existing and potential positive impact of rivers and vleis on the urban landscape. Let us not forget that the vast majority of rehabilitation projects that have been undertaken have either been initiated or paid for by the City, or have benefited from partnerships with the City. In a nutshell, much has been done, more needs to be done, but it is easier said than done.

Safeguarding waterways and water bodies at all levels

Progressive policies and strategies will have little or no effect on the ground if they are not integrated into local government decision-making, particularly if their implementation is likely to impact on other areas of endeavour, as will be the case for aquatic ecosystems. Thus, the implications of these overarching ideals must be translated for the sectors that will be affected, and then incorporated into detailed sectoral plans.

City officials responsible for the key policies and strategies affecting rivers, wetlands and estuaries began this process in 2001 and, as far as we could ascertain, still have some distance to go before these issues are integrated into decision making at all levels. Ultimately, "non-negotiable" space for rivers, wetlands and estuaries and their protection needs to be demarcated as mapping units in the spatial development plans for Cape Town, at all relevant scales. In this regard, four simple provisions will greatly enhance the future state of our freshwater ecosystems, in that they will assist in limiting further degradation, and allow the focus to shift to rehabilitation of what remains. These are:

- a catalogue of remaining rivers and wetlands,
- urban river and wetland buffer zones,
- realistic budgets, and
- compliance enforcement.

WHY SHOULD ROADS GET MORE THAN RIVERS?

"If a road width is 16 metres in towns, then surely the reserved width of a river (which contains living organisms and provides irreplaceable services to humans) should be greater not less. After all, you can rebuild a road."

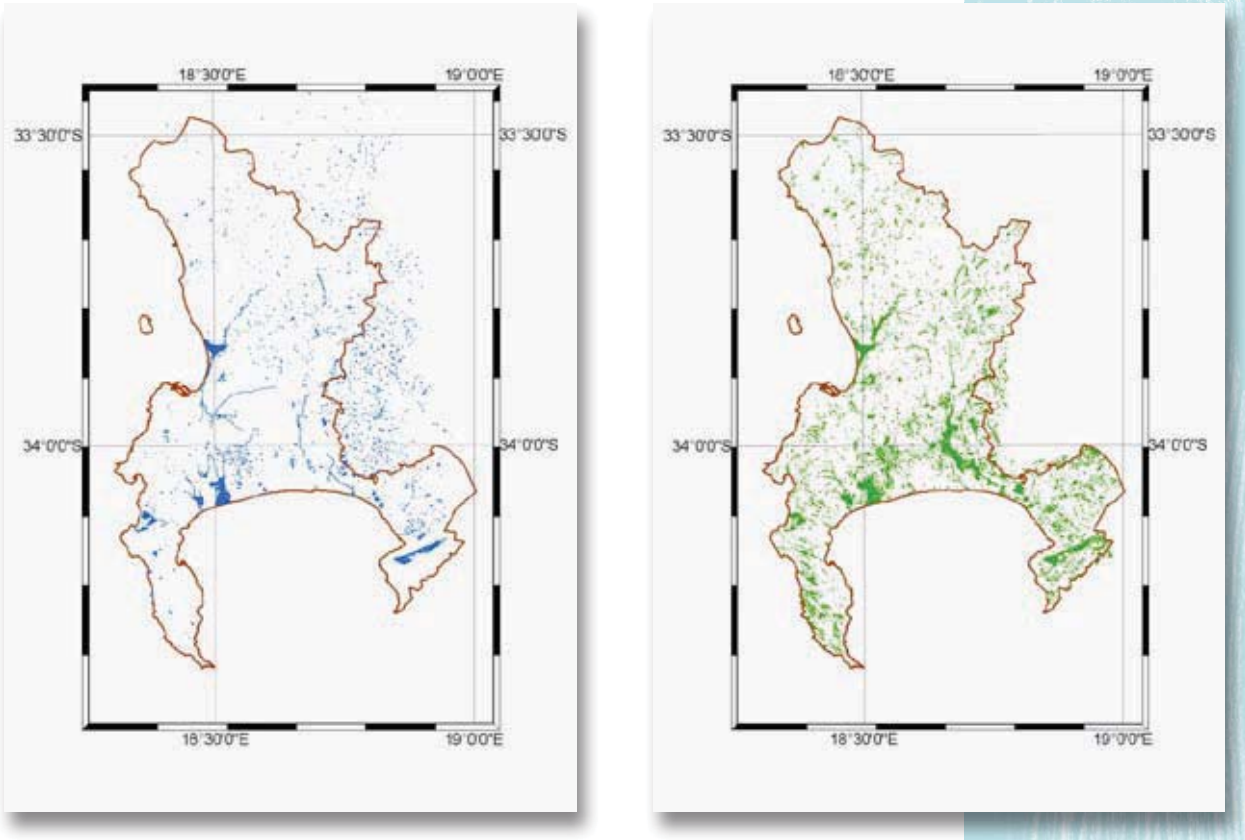
Professor Jenny Day. Director: Freshwater Research Unit, UCT

Pelicans in flight, Zeekoevlei (Photo: Theo Stock)

A catalogue of rivers and wetlands

It is a simple, yet oft-forgotten fact, that you cannot protect or manage what you do not know is there. In 2006, the City of Cape Town commissioned a study to map the known wetlands in the Unicity. The information gathered in this exercise is an invaluable contribution towards the City's Biodiversity Network (see *Planning frameworks in the City of Cape Town*). The accompanying figure shows the wetland coverage for the Cape Town area – before the mapping exercise (left) and after the mapping exercise (right).[3] Basically, we have a lot more wetlands remaining than were originally captured on the records. The project not only identified the location and spatial extent of wetlands but also classified each wetland according to the South African National Wetlands Classification System. The next step will be to determine the ecological condition of these wetlands, so that they can be incorporated into the Biodiversity Network and managed appropriately. If we are serious about protecting biodiversity and about managing floods, then these areas should be demarcated as "no-go" zones for any development, roads included. Obviously, "roads (and houses) have to be built, but they should avoid wetlands."[4]

3 Ractliffe *et al.* (2007)
4 Marius Burgers, Frog Atlas Project, personal communication



You cannot manage or protect what you do not know is there. The wetland coverage for the Cape Town area – before the mapping exercise (left) and after the mapping exercise (right). (Ractliffe *et al.* 2007)

Urban river and wetland buffer zones

Rivers run through central business districts, industrial areas and a whole range of residential areas. Over the years Cape Town has treated its rivers in a number of different ways. Some have been canalised to enable them to transport floodwaters as efficiently as possible, with little or no thought given to the environment, while others have been protected, by setting back property boundaries, acquiring adjacent open space and registering servitudes.

There can be little doubt that the latter approach has given rise to a greater amenity value, better flood protection and healthier, more biologically diverse river systems. Planning for such protection is obviously much easier in areas where development has not yet encroached unduly on the rivers, such as some of the soon-to-be-urbanised areas of the west coast, but could also be achieved over time through the proclamation of urban river reserves in areas of higher density. The acquisition of property, where this is needed, could take the form of future setbacks of boundaries (in exchange for increased development rights) or outright acquisition (where the major portion of a property is required) and could take place over many years (i.e. even exceeding 50 years or more as is the case with the acquisition of some Main Road reserves).

The absolute width of buffers could vary depending on ecological, hydraulic and social criteria. The important issues are that, once determined, the required river reserves would be locked in to future developments in an area and the general trend

What are buffer zones?

River and wetland buffer zones refer to the protection of the riparian zone of rivers and wetlands, at the interface between land and the aquatic ecosystem, which under natural circumstances would be colonised by indigenous riparian plants. These zones are important parts of these systems because they stabilise riverbanks, supply food and shelter for many aquatic and terrestrial animals, and provide shade that is important in regulating water and land temperatures. In cities, the compelling reasons for river buffer zones is that they provide flood storage capacity and attenuate floodwaters. Healthy vegetation along riverbanks also acts as a buffer, protecting the river from sediments, fertilisers and pesticides moving downhill from the surrounding land.* Narrow, poorly vegetated riparian zones leave the river vulnerable to pollution and other disturbances.

* Harding *et al.* (2002)

would be towards sustainable river systems instead of away from them. Also, in some areas, the space is already there, and the buffer zones can be re-established simply by reinstating vegetation.

The same holds true for urban wetlands. As is the case for rivers, these areas buffer the systems against the urban environment surrounding them. They also provide refuge, cover and habitat essential for animals moving between the wetland and upland environments, or for aquatic animals with an aerial or terrestrial life cycle stage. They are also essential for shade provision, roosting or breeding sites.[5]

For both rivers and wetlands, it is worth bearing in mind that while these areas appear suited to pedestrian or other access and picnic and recreational activity, these reduce the ecological benefits of buffers. Hence, buffer zones should be designed carefully to optimize the benefits to all the residents of an area, human and otherwise.

Most developed countries of the world are reinstating river buffer zones. The width of these buffers varies between 20 and 50 metres. The City of Cape Town has included provision for buffer zones in its guidelines for new developments, but these are yet to be made law. Once they are, the idea is that buffers zones of between 10 and 50 metres will be instated for all Cape Town's rivers and wetlands. The City's development control policy and guidelines consider both flood risk and ecological buffers and requires that the greater of the two setback requirements is used to determine the overall setback for new developments, rezoning, subdivisions and consent-use applications. The City has recently consolidated existing information relating to minimum buffer widths for river and wetland systems, and furthermore will stipulate that developers should determine buffer widths in cases where such information does not exist. Clarification of issues that resulted in ecological buffer requirements being poorly understood and regulated are being addressed in an update of the aforementioned policy and guidelines.

5 after Harding *et al.* (2002)

Realistic budgets

The Biodiversity Management Branch, which is responsible for the management of the 23 nature reserves in Cape Town, and for the implementation of the Biodiversity Strategy and Network is considered to be substantially under-funded and has been for a long time. This situation appears to be getting worse rather than better, as the budgets are not increasing commensurate with the increased management responsibility. Similarly, while funds for cleaning water bodies (including detention/ retention ponds) have increased dramatically over the last few years, to over R9 million per annum, the estimated total required expenditure is almost R125 million annually, and the "compromise target" budget, recently prepared by the Catchment, Stormwater and River Management Branch, is nearly R15 million.

The management of the rivers, wetlands and estuaries in and around Cape Town is a massive task that simply cannot be accomplished without realistic budgets. Of course urban areas need roads, houses, schools and hospitals; but there is little or no point in spending money on creating policies and strategies that eloquently espouse a commitment to healthy environments and the protection of biodiversity, if those who are given the responsibility for implementing these are not allocated the funds that will allow them to do so.

Give rivers and wetlands their own Erf numbers

One suggestion is that all wetlands, vleis and rivers, including that those are now canals or small stormwater conduits, within Cape Town, which do not already fall under the City's Environmental Resource Management Department ,be surveyed along with their buffer zones, and be allocated an Erf number, just the same as all other urban land be it a residential plot, a school, a sports field, or a business plot. These areas could then be zoned in a special category, and be protected through appropriate rules, regulations and budgets. An opportunity exists currently for individually mapped and identified rivers, vleis and wetlands to be included as an overlay layer in the City's Integrated Zoning Scheme, although the implications and benefits this still needs to be investigated. What is certain is that all vleis, wetlands and rivers should receive some level of formal conservation status in terms of the Protected Areas Act, and that the City's Biodiversity Management Branch should be involved with the relevant line department in the ecologically sustainable management of each and every one of them.

Dumping in the Bokmakierie Canal in Hazendal, March 2008 (Photo: Tracy Blues)

Compliance enforcement

Even if we have wonderful laws, they are worthless unless they are enforced. For instance, dumping outside of demarcated areas is illegal in our city, and yet one only needs to look at the Pelican Park stormwater outlet, the Jakkalsvlei Canal, or the Big and Little Lotus Rivers to know that simply making dumping illegal is not enough. Rubbish is brazenly dumped into the canals and rivers, often neatly packed in black refuse bags. It may be that much of this dumping could be avoided if backyard dwellers are given access to the property owners' wheelie bins. Another major problem is the purposeful dumping of unwanted household items, including sofas, wardrobes and tyres into river and canals when they are in flood. These items are carried downstream by the floodwaters but only as far as the closest litter trap, which they then block completely. This not only causes flooding of the areas adjacent to the litter traps but also endangers the lives of City officials who have to try to unblock them under treacherous conditions.

No one benefits from the littering and dumping that is so endemic to our land, least of all the residents and the environment. Ultimately, the aim should be to capture the hearts and minds of all Capetonians and have them view healthy rivers and vleis as the underpinnings of a healthy society, but this is probably going to take a while. Until then, it is unlikely

Voluntary environmental regulations by Andy Singer (Cagel Cartoons)

Some of the rubbish cleared from Zeekovlei's east shore during the 2008 drawdown (Photo: Roger Godwin)

that people will stop dumping voluntarily. In the United Kingdom, illegal dumping of anything carries a fine of £5000 (R75 000 at the current exchange rate). These stiff (even by UK standards) penalties, combined with effective policing, have led to clean highways, waterways and parks. Where are our Green Scorpions when we need them?

There is also an urgent and serious need to clean up our act with respect to water pollution, as the pressure on our waterways and water bodies is simply untenable. If, as appears to be the case, the wastewater treatment works cannot keep pace with the growth of Cape Town, then the effluent from these works should be directed elsewhere, either into the sea, or into their own giant wetlands, where the final "treatment" can occur. In this regard, it is worth considering designing new treatment works with suitably large spaces around them, so that when they too become overloaded, their polishing wetlands can be increased in size. Our rivers and vleis simply cannot be expected to cope with the current loads from point-source (and some diffuse-source) polluters. At the very least, enforcement of the "polluter-pays principle" would see additional funds being allocated towards mechanisms to improve the quality of water being discharged into them.

There is no doubt that buffer zones, and more wetlands, will assist in improving the quality of water that eventually reaches the waterways and water bodies. Indeed, constructed wetlands (such as those on Plankenbrug River below Kayamandi in Stellenbosch) or rehabilitated wetlands (such as those at Cafda Corna, which filter runoff from the surrounding area before it enters Rondevlei) are increasingly being utilised to pre-treat poor quality runoff before it enters the rivers and vleis.

From the notes of the False Bay Ecology Park Committee Meeting, Thursday 24th, July 2008:

Zeekoevlei Annual Drawdown Cleanup

- 100 casual workers employed during good weather conditions.

Removed from shallow water and reeds:

- 9 000 black bags of refuse
- 7 refrigerators
- 2 washing machines
- 18 large motor car sections
- 4 trolleys
- 4 dead dogs
- Massive volumes of alien growth, including water hyacinth

Zeekoevlei Manager, Asieff Khan

Dealing with floods

The unique position and topography of Cape Town decreed that, before urbanisation, the Cape Flats and many other areas were covered by seasonal wetlands. Indeed this is one of the reasons that these were some of the last areas to be developed. Under urban conditions, hardening of the surrounding catchments has increased the peak runoff and exacerbated flooding on parts of the Cape Flats, as have upstream flood alleviation works aimed at transporting flood water from those areas (and on to the Cape Flats) as efficiently as possible.

Climate change is likely to worsen the situation as the effects are predicted to include:

- less rainfall, coupled with increased variability and increased unpredictability of extreme events;
- larger flood peaks (and therefore flooding);
- increased temperatures; and
- elevated sea levels (and therefore elevated groundwater levels on the Cape Flats).

The Cape Flats also have a higher water table than other parts of Cape Town, and in winter the water reaches the surface. Filling in the wetland areas in the higher areas and on the Cape Flats simply displaces floodwaters. Yet the filling of wetlands continues regardless. It is time that any development that will impinge negatively on wetlands or rivers is disallowed. Even if the City has to compensate land owners for "lost" income potential on their investments, surely that is better than making the poorest people pay every winter because they live on what are essentially seasonal wetlands.

Perhaps it is also time to accept that parts of the Cape Flats are always going to flood in winter, and to plan accordingly. This situation is not unique and we can take our lead from parts of the world where this is also the case. For instance, in some places with a lot of water and seasonal flooding, people live in houses on stilts. Perhaps we should copy them?[6] The idea is not a crazy as it might seem at first glance. Not only are living areas kept high and dry, but building on stilts does not displace flood water nor does it harden the catchment in quite the same way as "conventional" buildings.

CLIMATE CHANGE

The 20th century has seen the greatest rate of global warming in the past thousand years, driven mainly by anthropogenic emissions of greenhouse gases. Climate models now predict that the atmosphere's temperature will increase by 1.4ºC to 5.8ºC by the year 2100, even if the global greenhouse gas emissions are curtailed significantly in the short- to medium-term. This will increase the likelihood of extreme weather events such as droughts, floods and heat waves.

The Northern and Western Cape provinces are projected as the two South African provinces most at risk of climate-induced warming and rainfall change.

Mukheibir and Ziervogel (2006)

Opportunities for limiting future flood damage

City of Cape Town policy requires that, for new developments, peak discharges of stormwater runoff do not exceed those that would have occurred from the same storm under conditions prior to the development. To comply with this requirement, developers should provide storage or other measures within their developments to regulate stormwater runoff during periods of high rainfall. These regulations have lead to the evolution of features such as Capricorn Lake at Capricorn Park, (see Chapter 13)

6 Witten (2007)

In places with a lot of water and seasonal flooding, people live in houses on stilts. Perhaps we should copy them? (Photo: iStock Photo)

and the expanded Blouvlei at Century City (see Chapter 9). Given that it is difficult to retrofit such a regulation when development has used up the available space, a case could be made for tightening this requirement in certain newly-developing areas to compensate for existing areas where there is no space left for detention storage. This, however, will only assist in reducing peak floodwaters if the areas are situated in the same catchment. Flood attenuation in highly developed areas, where many of the wetlands and river corridors have already been lost, requires more innovative solutions and more understanding and cooperation from the residents.

Do-it-ourselves flood attenuation

Reduce our "catchment-hardening" footprint

Each and every one of us can assist a little with making our catchments a little less hardened. Concrete and other non-porous surfaces add to the run-off factor (and thus to flood peaks), whereas grass, loose gravel and permeable paving do not. Rain tanks also assist in attenuating some of the first floods of the winter, as does directing gutter pipes into the garden rather than into the stormwater drains. Basically, any measures that lessen the rate at which rainwater leaves the place where it falls, or assists with on-site infiltration, will help.

Rain tanks

To attenuate a flood, you need sufficient space to store at least a portion of the peak flows, and a means of controlling the rate of outflow from that storage. A very rough calculation shows that a rain tank at every house in a medium-density residential area could provide about 90 cubic metres per hectare of storage, which would have

OPPORTUNITIES FOR LIMITING THE WATER QUALITY IMPACTS OF URBAN STORMWATER

The City of Cape Town is also proactively pursuing measure to ensure that potential pollutants in stormwater arising from new developments is treated on site before being discharged into the City's waterways or waterbodies. This approach is in line with international best practice, which aims to minimise the impact of urban stormwater on the receiving environment.

Candice Haskins, City of Cape Town, personal communication

Ecological Gardener by ARES (Cagel Cartoons)

a significant flood-attenuation effect. This would benefit downstream communities, provided that the rate of discharge from the storage could also be controlled.

Here's the catch, though. In Cape Town, the events that cause the worst flooding happen after a couple of days of soaking rain when the catchments are saturated. These are the events that flood control measures must be designed for. Rain tanks are "operated" for water storage and not flood control, so are likely to be full or nearly full when flood-creating events occur, reducing or eliminating their effectiveness as flood detention storage facilities. Conventional flood control detention ponds are designed to release water continuously at low pressure heads (i.e. keeping the pond

near empty), and to "choke" the outflows when the rate of inflow exceeds a certain threshold, thereby holding back the runoff when it matters and attenuating the flood peak.

In short, while rain tanks are excellent for storing water for later use, the ways they are currently used negates their potential for flood control. Is it not possible though, to achieve both water storage and flood attenuation using household water tanks? Of course it is – either by having two tanks each designed to serve a different purpose or by redesigning the water storage tanks to allow for some flood attenuation capacity.

Alternatively, if you have sufficient space, you can create your own seasonal vlei. (See Re-creating seasonal vleis.) This will not only provide some flood attenuation, but will also provide much-needed habitat for a myriad of creatures, and an educational facility for children and adults alike.

Looking after what we've got

We may have lost many of our rivers and wetlands but what a lot we've still got! Management of these waterways and water bodies is a huge task. We have already made some suggestions as to how allocation of identities (Erf No.) and realistic budgets might make this task more manageable and more ecologically-friendly, but we have one more suggestion to make. This is basically to increase the level of personal attention given to each river, wetland and estuary.

River wardens

Much of the labour required for the rehabilitation and maintenance of our rivers, wetlands and estuaries is unskilled, and these projects can provide much needed employment and a sense of "ownership" for people living in the area. For instance, trained river wardens are responsible for much of the implementation on the Keysers River Restoration Project. The project has not only provided employment and a sense of ownership, but also training and skills learning. Similarly, there are river wardens on the Liesbeek and other some parts of other rivers in the City.

Presently, much of the maintenance that is done on our rivers takes place at the end of summer, in preparation for the floods of winter. By the end of summer, this task has become enormous but could possible be reduced by ongoing low-level involvement by a few people. For example, if we consider the Black River water hyacinth infestation, at the end of winter there is very little hyacinth in the canal. This is a result of the pre-winter cleaning and some flushing by floodwaters. During the summer months, the hyacinth grows steadily, boosted by high nutrient levels, low flows and warm temperatures, so that by the end of the summer another enormous clean-up task awaits the staff at the Catchment, Stormwater and River Management Branch (to say nothing of the costs of disposing of the unwanted plant material at the dump).

But what if we kept the hyacinth at its end-of-winter levels all year?[7]

7 Which is already part of the City's plan.

Clearing water hyacinth from the Westlake Canal, January 2006 (Photo: Gavin Lawson)

WATER HYACINTH

Water hyacinth is a floating plant that has clusters of leaves with spongy stalks arising from a base of dark purple feathery roots. The leaf clusters are often linked by smooth horizontal stems (called stolons). Linked plants form dense rafts in the water and mud.

LOOK FOR:

- Large spike of lavender-blue flowers
- Spongy, bulbous leaf stalks
- Large, rounded glossy leaves

Florida Department of Environmental Protection (undated)

Accepting that the high-nutrient levels and low-flows so loved by the hyacinth will persist for the foreseeable future, one possibility for doing this would be to manually clear the hyacinth at the same rate at which it grows. This is not a small task. The growth rate of water hyacinth is among the highest of any known plant, and water hyacinth populations can double their size in as little as two weeks by sending off short runner stems that develop new plants (daughter plants).[8]

How about trying the following as a plan? At the end of winter, have a once-off, concentrated effort to reduce the hyacinth as much as possible. Then, employ two river wardens for every kilometre of the Black River Canal (the hyacinth affected portion of the Black/Salt River Canal is about six kilometres long – so that would mean six teams). Equip each team with a small, motorised (if depth allows) croc,[9] the necessary safety and work clothing, and nets and bags, and ask them to keep the river clear of all alien aquatic weeds and litter. The personnel and equipment costs could be off-set through the sale of advertising space on the crocs and clothing of the wardens (the canal is flanked by two major freeways, the N2 and M5, so visibility is high), and by savings on end-of-summer clearing costs. Material cleared from the river could be stored in piles until it is dry and then it could be removed to the dump. Since hyacinth growth is suppressed by the cold water and higher flows in winter, these river wardens could be redeployed to help another river, with a different problem, during the wetter months. Other rivers with a similar hyacinth problem include the Big Lotus River, Zeekoe Canal, the lower Liesbeek River, the Kuils River and the Diep River.

8 Florida Department of Environmental Protection (undated)
9 Croc: A small inflatable canoe.

The Noordhoek Wetlands Project drew its labour force from the Masiphumelele, Ocean View and Red Hill Informal Settlement. Here people register for work on the project. (Photo: City of Cape Town)

Continuous clearing of the hyacinth would not only assist flood control, but would also have numerous ecological benefits, given that large-scale mechanical cleaning is extremely damaging to the aquatic biota, and that water hyacinth mats:

- lower dissolved oxygen concentrations, damaging fish and aquatic insect populations;
- deposit large amounts of rotting plant material on the bottom of a waterway;
- provide ideal breeding environments for mosquitoes; and
- decrease biodiversity.

The clearing of hyacinth is just one example of many where specially assigned river, wetland or estuary wardens could assist in the day-to-day management and maintenance of our waterways and water bodies. We appreciate that the City does undertake some manual cleaning of rivers, but we suggest that this could be expanded and formalised to the benefit of the environment and, at the same time, provide additional employment for unskilled labourers.[10] After all, gardens have gardeners, parking garages have attendants, and shopping malls have cleaners. Why shouldn't all rivers have wardens?

10 Possibly as part of the Expanded Public Works Program.

Creating a multi-stage channel as part of flood alleviation works on the Hout Bay River, *circa* mid-1990s (Photo: Hout Bay Museum)

Softening the blow

It is highly unlikely that we have seen the last of river engineering, particularly that aimed at alleviating flooding risks. Here too, we now have projects that can act as tangible examples of the benefits of a multi-discipline approach to such situations. Simply put, if we are to look after our rivers, it is vital that the design of river works is accomplished through an iterative process of evaluation and adjustment of plans and ideas provided by engineers and ecologists alike.

In the Lourens River Flood Alleviation Project,[11] for instance, ecologists examined each cross-section along the length of the river in the field. They outlined ecological and geomorphological concerns and made suggestions for softening the impacts at each river reach. The eventual designs incorporated many of the suggestions proposed by the ecologists to soften the blow, including:

- multi-stage channels, set according to ecological flow zones, where appropriate;
- a policy of "non-disturbance" of the river bed and low-flow channel form (including in-stream morphology such as riffle-pool sequences);
- uneven river margins;
- establishing slopes of at least 1:2, where possible;
- re-vegetation with indigenous riparian plant species;
- major earth works focused on outside bends, thereby maintaining sinuosity;

11 Brown and Boucher (2003)

The Working for Wetlands team building gabions (rock baskets) to combat bed and bank erosion on the Princeskasteel River, April 2007 (Photo: Mandy Noffke)

- establishment of a nursery to propagate indigenous plants for the rehabilitation process; and
- establishment of a two-year maintenance period for newly planted vegetation.

Requests from the public also led to the retention of some large alien trees, such as oaks and willows, where they were not deemed to be a hindrance to the passage of flood waters.

The project illustrated that it is possible to incorporate ecological principles and social considerations into major urban river works, even where engineering considerations

Bagging sago pondweed (*Potamogeton pectinatus*) for transportation to a newly rehabilitated vlei. Pondweed uses nutrients in the water, thereby assisting in the maintenance of clear water conditions and preventing algal blooms. (Photo: Mandy Noffke)

must take preference, to the benefit of all the residents (even the non-human ones). There is even an economic upside, with the cost-benefits analyses (see Chapter 20) showing us that money spent on "softening" has a far higher return than money spent on hard engineering.

Rehabilitating rivers and wetlands

Projects such as the M5/N2 Interchange Wetland, Blouvlei, the Liesbeek Parkway Wetlands, lower Silvermine River and others, have ably demonstrated that development and rehabilitation can go hand in hand. Each of these has resulted in a win-win situation, with a little bit gained for the environment (and a lot gained for the people of Cape Town) as part of each of the associated developments, namely the new M3 off-ramp, Century City, River Office Park and the high-value cluster-housing in Fish Hoek. Importantly, these projects worked with the environment to maximise the benefits. For instance, they all include a portion of seasonal wetland or floodplain, as they would have naturally, and they are all planted with indigenous vegetation that not only enhances the quality of the habitat provided but also requires less maintenance.

Re-creating buffer zones

Rivers and wetlands are incomplete without their riparian zones. Re-creating buffer zones along all rivers and around all wetlands is a first step to truly rehabilitating them. (See Urban river and wetland buffer zones.)

Erosion repair

The additional volume and velocity of stormwater runoff entering urban rivers, combined with the degradation of the riparian zone through, for instance, vegetation removal or invasion by ill-suited alien species that do not bind the soil, means that the steeper sections of our rivers, streams and drainage lines are highly susceptible to erosion of their banks and beds. Frequently, the erosion originates where residents dug into the banks or bed of a river to "create" a water feature, which created a weak

Blomvlei, filled with sago pondweed (*Potamogeton pectinatus)* (Photo: Mandy Noffke)

point (a so-called "knick-point") from which the erosion spread. If left untended, erosion destroys the habitat in the upstream rivers and exacerbates sedimentation in the lower rivers. Fixing bed and bank erosion is not a small task, as it often requires excavation and the building of large erosion-resistant structures. For instance, the enormous Longkloof Weir on the Hout Bay River was built to halt bed erosion that was travelling upstream from a knick-point. So, the standard principles with respect to bed and bank erosion are: don't start it and, if it does start, try to catch it early.

Re-creating seasonal vleis

Of the vleis lost to Cape Town over the course of its history, proportionally more were vleis that were dry during the summer months and flooded during the winter. These are the so-called seasonal vleis.

Apart from the fact that they contribute greatly to biodiversity, recreating seasonal vleis is sensible from a management perspective for a number of reasons.

- Typically, because they are only flooded in the winter months, these vleis seldom suffer from the same level of water quality problems as permanent vleis do. Most lakes are clear for the first year or two after filling. This is because that is how long it takes for the algae to dominate. Seasonal wetlands keep ecosystems in this phase of the cycle.

No sooner does the delightful element moisten the earth, and replenish the hollows, than every pool becomes a concert-room, in which frogs of all sizes, old and young, seem contending with each other for a musical prize.

William John Burchell, The Frog's Concert (1782-1863)

Re-creation of a seasonal vlei in Tokai (Photo: Mandy Noffke)

- Most water quality problems manifest in the hot summer months, so seasonal vleis are ideal for the Western Cape, where the wet and cold seasons coincide.
- Because seasonal vleis are empty at the start of the wet season, they provide desperately-needed flood retention capacity.

Local is lekker!

The drought and subsequent water shortages of 2004-2005, did much to change people's perceptions about the value and beauty of indigenous flora in their gardens. Hopefully, the trends started then will continue, as it is indigenous vegetation that underpins the structure and functioning of our rivers, wetlands and estuaries, and provides the most suitable habitat for the animals of the area. Love of local should be extended to indigenous landscapes such as seasonal vleis and wetlands in general. Seasonal vleis may lack some of the allure of man-made lakes in the summer, but they win hands down in the winter when the burgeoning of life is simply magical.

The value of islands

For the inhabitants of the urban rivers and wetlands of Cape Town, urbanisation not only eats into their habitat but also brings with it the added dangers of traffic and domestic predators. (Yes, cuddly old kitty can be a terror.) Incorporation of islands into wetlands and artificial lakes – whether they are permanent or seasonal - greatly enhances protection from predation for birds and other creatures.

The value of small projects

Individually, the relatively small scale of many of the rehabilitation efforts described in the preceding chapters, such as Hout Bay, Langevlei Canal, Bottom Road, Westlake River, M5/N2 Interchange Wetland, Cafda Corner (Prince George Drive), cannot be expected to have an appreciable effect on the overall habitat integrity and biodiversity of the region. Yet each provides a dramatic contrast to the sterility of the concrete canals, roads and pavements that characterise so many of the rivers. The rehabilitation efforts required relatively little space and have been "squeezed in" alongside existing structures. They are also fairly easily replicated, and so, potentially, many such units could have a significant cumulative impact in upgrading the ecological status of our urban rivers. In terms of water quality, collectively, they could

The Western Cape Wetlands Forum

The Western Cape Wetlands Forum (WCWF)* is a resource and contact base for anyone interested in wetland-related issues in the Western Cape. Membership is open to all who share the WCWF vision and there are currently over 300 members.

The vision of the WCWF is a future of environmental responsibility in which wetlands are:

- adequately protected in terms of their hydrological function, biodiversity and value to human communities;
- effectively managed with currently accepted best sustainable practice; and
- optimally restored and rehabilitated where degraded.

The objectives of the WCWF are to:

- promote in all sectors of society awareness and understanding of wetlands, their roles as part of both the natural and human environments and the factors that affect them;
- facilitate the flow of information regarding wetlands in both professional and popular spheres of interest;
- link areas of expertise that will promote the best flow of relevant information for the protection, management, monitoring and restoration of wetlands;
- debate the establishment of new legislation and the revision of existing laws as appropriate; and
- identify priority areas of research.

* Contact: wetlandsforum@sanbi.org

have a measurable effect on the condition of the water in the vleis that many of these canals feed. Small projects, in many cases championed by concerned residents, and sustained by partnerships, play a particularly valuable role in the urban setting.

Safety issues

The public sometimes vetoes rehabilitation projects on the grounds that they create little-used areas that attract criminal elements. These concerns need to be taken seriously, particularly in modern-day Cape Town. There are, however, ways of dealing with such concerns without forsaking the natural environment.

In Macassar, for instance, at the request of the local residents, rehabilitation of the river margin was done without large trees and shrubs so that visibility remained good and the area provided a public amenity. In other areas, where poor visitation was perceived as a potential problem, rehabilitation activities included the creation of braai areas, skateboarding arenas, cricket grounds and sports fields.

Also, earlier we suggested increasing the personal attention given to each river, wetland and estuary through the introduction of river wardens. In this regard, it is worth noting that the presence of river, wetland and estuary wardens would also increase the general safety of an area.

Learning by doing

In gathering the information for this book, we have been astounded at just how much is being done to rehabilitate and protect the rivers and wetlands of Cape Town and its environs. There was just no way that we could capture everything that is going on but it is clear to us that in all corners of our city, there are examples of concerned residents making a plan and making difference.

These folk are living the maxim, "Just do it".[12]

Cape Action Plan for People and the Environment (C.A.P.E.)

The City of Cape Town is located within the Cape Floral Kingdom, the smallest of only six floral kingdoms in the world. The Cape Floristic Region has a high proportion of unique and endangered species, and as a result is considered a global biodiversity hotspot, placing an international responsibility on the City, Provincial Government and National Government to ensure its adequate conservation. This led to the Cape Action for People and Environment (C.A.P.E.) partnership programme that aims to conserve the Cape Floristic Region in a way that will deliver significant benefits to the people of the region. The City of Cape Town is one of the founding signatories to the C.A.P.E. Memorandum of Understanding, which secures the commitment and participation of the implementing agencies to the C.A.P.E. Strategy. C.A.P.E. has many priority programmes that are integrally linked to wetlands and rivers, such as Invasive Alien Species Programme (removal of alien fish from selected rivers has been in the press recently), the Estuaries Programme and Freshwater Programme.

In January 2002, the City of Cape Town commissioned an audit of river and wetland engineering and rehabilitation activities. This report is a synopsis of both the successes and failures in rehabilitation projects undertaken before 2001, and provides a useful guide for new projects.[13] Since then, many other projects have been undertaken or initiated, and there is lots of help out there for those who would like to join the good fight.

Paying for it

Despite their benefits, the potential for increased City funding of rehabilitation projects seems limited for the foreseeable future. This is primarily due to other more urgent priorities and a lack of clear financial returns from rehabilitation projects given current rate structures.[14] Van Zyl, Liemann and Jansen (2004) provide a useful synthesis of possible avenues for funding of rehabilitation initiatives, most of which are based on charging a large number of individuals a small amount of money to fund projects from which society as a whole will benefit. These include consideration of:

Rates: Rehabilitation might increase rateable property values in one area, as was the case in Fish Hoek with the Silvermine Flood Attenuation Project, but lower them in areas that did not benefit from rehabilitation. Rehabilitation may also generate long-run advantages for the municipality as they increase property values, and therefore rates. These are centred on the enhancement of a large viable rateable base of properties.

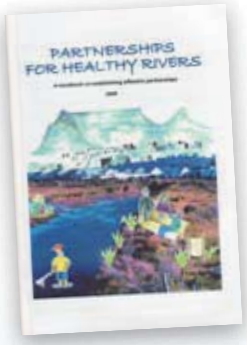
Fiscal taxes: Although uncommon in South Africa, special taxes have been used successfully elsewhere to fund rehabilitation. For instance, in Durango, Colorado in the United States, the Animas River Trail was funded from a part of the ½ cent sales tax increase, approved by city voters. The funds were used to build a new recreation centre and for rehabilitation along the river.

User fees: Entrance fees, concession fees (for the right to provide a service such as food), and licences or permits have long been used as an instrument for raising conservation funds.

Donations and grants: Donations, typically from individuals or companies, or government grants have been used extremely successfully to finance conservation and rehabilitation in South Africa and abroad. Local examples include the Mondi Wetlands Project, the Mazda Wildlife Fund and Working for Wetlands. Often these funds are managed by government or non-government organisations, such as the Wildlife Society of South Africa (WESSA), the South African National Botanical Institute (SANBI), the Department of Water Affairs and Forestry or the Department of Environmental Affairs and Tourism.

13 Freshwater Consulting Group (2001)
14 van Zyl *et al.* (2004)

PARTNERSHIPS FOR HEALTHY RIVERS



The Green Connection has completed a handbook entitled Partnerships for Healthy Rivers in partnership with the City of Cape Town, the Wildlife Society of South Africa (WESSA), the Table Mountain Fund and the World Wide Fund for Nature (WWF).

This user-friendly handbook outlines guidelines, which can be used to help society, and government sectors establish and manage riverine partnerships and ensure their long-term sustainability and effectiveness.

Local business support:	Local businesses finance many of the initiatives in an around Cape Town. The Westlake Wetlands Garden, for instance, is entirely funded by local businesses, and Zandvlei Trust recruits from unemployed people from Vryground (Capricorn Park) via the LINK (a Marina da Gama social upliftment project) and trains them to maintain and improve the garden. Similarly, a local estate agency employs a part-time caretaker on the Liesbeek River adjacent to Riverside Road. There are many, many other such examples.
Volunteer contributions:	The efforts of volunteers are often pivotal to the success of rehabilitation projects. They can provide valuable time for initial rehabilitation as well as ongoing project maintenance work. They can generate interest in projects and assist directly with sourcing funding. Local groups and individuals that are familiar with their environments can often provide information valuable to the formulation of environmental management plans. They can also fulfil an important watchdog role ensuring that local authorities are held accountable for ensuring the maintenance of rehabilitated areas. Volunteer organisations, such as the "Friends-of" groups, also raise funds through membership fees, and lobby for funding from other sources.
Public-private partnerships:	(see Partnerships)

Partnerships

Partnerships are a potentially exciting and powerful way of approaching the rehabilitation and conservation of the rivers in Cape Town and its environs. They represent the truth of the adage that "the whole is more than the sum of its parts".[15]

From the City's side, their Catchment, Stormwater and River Management Strategy highlights the need for the involvement of communities and other stakeholders in the management of river systems through catchment forums, including efforts to promote beneficial uses of stormwater and river systems through educational programmes and capacity-building initiatives. The City's commitment to this idea is underlined by its involvement in many of the rehabilitation projects across Cape Town. Indeed, the involvement of local government has been cited by many as a key factor in ensuring the success of their river or wetland rehabilitation and maintenance projects. Help with how to go about forming such a partnership is available in the form of a handbook called Partnerships for Healthy Rivers (available on www.wessa.wcape.school.za/handbooks.htm).

Integrated conservation planning is a growing form of public-private partnership. In the case of urban areas, this may take the form of an agreement to rehabilitate and conserve a large portion of an area in return for development rights in the remaining sections. Many such examples exist outside of Cape Town, where private

15 www.wessa.wcape.school.za/handbooks.htm

How a river helped Seoul reclaim its heart and soul

Historically, the Cheonggyecheon River was a shallow, wide seasonal stream that formed the divide between the rich in the north and the poor in the south of the City of Seoul. As Seoul grew, the Cheonggyecheon River became little more than a sewer. The river was eventually turned into a road (and the river was encased in a drain underlying it), and later into an elevated 6-lane highway.

With ecological restoration being the main theme around the world, the then mayor of the City of Seoul, Lee Myung, proposed a plan to restore the river, tear down the motorway and create an 8-kilometre long, 800-metre wide, 400-hectare park through the city where the river once flowed. The vision was to create a focal point of historical significance and aesthetic appeal.

This was no easy task. The road carried 160 000 cars daily and was always jammed. It had also been promoted as a symbol of the industrial prowess of South Korea. A city university interviewed thousands of the city's inhabitants about what they thought were important in the city. Most listed environment and water. To cut a long story short, the electorate approved the restoration plan, and work began in July 2003. At a cost of US$ 380 million, 620 000 tonnes of concrete and asphalt were removed and recycled. River flow was restored from groundwater sources and 22 new bridges were built. The removal of the motorway had expected and unexpected effects. Traffic jams elsewhere in the city did not increase dramatically. While some people did find alternative routes, many gave up their cars and the city improved its bus service, all of which had a positive effect on the environment. To top it all, summer temperatures near the river were 3.6 C lower than those recorded near the motorway, as the river acted as a natural air conditioner.

John Vidal - Guardian News Media (2007)

The "new" Cheonggyecheon River, Seoul. (Photo: Rinux posted at Flickr)

The world is moving so fast these days that the man who says it can't be done is generally interrupted by someone doing it.

Harry Emerson Fosdick
(1878 - 1969)

A poster prepared for the Noordhoek Wetlands Study, which shows the number and diversity of organisations involved in either funding or hands-on operations

nature reserves are managed by and for a small group of residents, for instance, Jakkalsfontein on the West Coast. False Bay Ecology Park attracted the interest of a group of investors for very much this reason. The idea being that limited upmarket housing be developed in the middle of the "park", and the areas around that be upgraded and managed as conservation areas, thereby providing the residents with "nature-reserve living" in the city. Watch this space!

Thank you and best wishes

Thank you for taking the time to read this book. (Or this sentence, whichever is the case.) We hope that you have enjoyed it and learnt something about our rivers, wetlands and estuaries. We certainly did. We set out with the idea of writing a short book but the information just kept on coming in, and contrary to our initial expectations, much of it was heartening. We have not managed to capture everything, there is simply too much. Thank you again to all of those people who contributed so willingly towards this book. Thank you too, to those who are contributing so willingly (and doggedly) towards the betterment of our waterways and water bodies. May you

have many, many new recruits.

Ring out a slowly dying cause,
And ancient forms of party strife;
Ring in the nobler modes of life,
With sweeter manners, purer laws.

Alfred, Lord Tennyson

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About the Authors

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Julia Wood graduated from the University of Cape Town with an MSc in Botany. Since the late 1980s she has worked in and around Cape Town in the field of conservation planning and management. Currently, Julia works for the City of Cape Town, as the manager of the Biodiversity Management Branch, which is responsible for 23 nature reserves in the City. It has also been assigned the task of ensuring that the Biodiversity Strategy and Network is implemented.

Martin Thompson joined the City of Cape Town in 1968. He is a civil engineering technologist. Since the early 1990s, he has been involved in pursuing an integrated approach to stormwater management with particular emphasis on the preservation of river systems. He is currently a member of the City's Catchment Management Branch.

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Mandy Noffke was born in East London. She studied Town and Regional Planning at the Cape Technikon and has lived in Cape Town for 16 years. She is a director and founder of WET-LAND Solutions. Her work focuses on environmental and wetland rehabilitation management, particularly on projects linked to poverty relief.

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Prof. Chris Hartnady is a former Associate Professor of Geological Sciences at UCT. He is a born and bred Capetonian who lives in Kalk Bay. He became interested in earth science as a caver in his teenage years. Apart from hydrogeological work, he has a great interest in geohazard science, particularly earthquakes, volcanoes and cyclones. Chris is a partner at Umvoto Africa.

Justine Ewart-Smith grew up in Cape Town and studied ecology at the University of Cape Town. She has been working on rivers and wetlands since 1998 and currently works part time as a researcher at the Freshwater Research Unit, UCT and part time as a consultant with the Freshwater Consulting Group.

Marius Burger is a South African herpetologist, currently employed with the Animal Demography Unit (ADU) at the University of Cape Town to do surveys for Southern African Reptile Conservation Assessment (SARCA). Before that he was co-ordinator of the Southern African Frog Atlas Project (SAFAP), also at the ADU. In addition to his herpetological researches, he also conducts faunal studies for ecological impact assessments.

Emily Fairbairn, until recently, was a school teacher who taught in Cape Town for 30 years. She is currently employed by Proudly Manenberg, a community based organisation, founded in 2005 in response to the endemic social problems of poverty and crime. Its vision is to "build a vibrant, proud and dignified Manenberg through creating opportunities". Its work is achieved through community participation and building private and public sector partnerships, and is guided by the principle: "Only the Best for the People of Manenberg".

Geordie Ractliffe is a born Capetonian and a graduate of the University of Cape Town. Geordie has been working on the city's river and wetland ecosystems for the past 17 years. She founded the Freshwater Consulting Group in 2001. Her work

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Dr Liz Day has a PhD in Marine Biology from the University of Cape Town, but switched her interest to freshwater systems in 1998. She specialises in the management, rehabilitation and conservation of urban rivers and wetlands. Liz and her family live on the banks of Zeekoevlei.

Mike Luger is a born and bred Capetonian. He has a Masters in Environmental Management from the University of Cape Town. Mike joined Ninham Shand Consulting Services in 1994 and currently heads up the firm's team of 40 environmental practitioners. He retains a strong interest in river and wetland management, and in the assessment and planning of water resource developments.

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Glossary

1-in-10 year flood	a flood event that occurs on average every 10 years
1-in-20 year flood	a flood event that occurs on average every 20 years
1-in-50 year flood	a flood event that occurs on average every 50 years, i.e. has a 2% chance of happening during the next year
abstraction	taking water out of a river, wetland or water body
adsorbed	collected in a condensed form on a surface
alien/exotic	introduced from elsewhere (neither endemic nor indigenous)
allochthonous	from outside the river
anoxic	devoid of oxygen
anthropogenic	caused by humans
aquifer	underground layers of permeable or fractured rock, or unconsolidated materials (gravel, sand, silt, or clay) that hold water or permit appreciable water movement through them
AsgiSA	Accelerated and Shared Growth Initiative for South Africa
autochthonous	from within the river
benthic	organisms that inhabit the shallow, bottom habitat of water
berm	sand bar
biodiversity	"The variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part; this includes diversity within species [i.e. genetic diversity], between species and of ecosystems." (Convention on Biological Diversity, 1992)
biota	the living organisms that occupy a place together such as plants, animals and bacteria
box culvert	covered canal
breaching	opening of a river mouth
buffer zone	an area that reduces the impact of one area on another
canalisation	make into an artificial waterway
catadromous	move between rivers and the sea
catchment	area of land that collects rainwater into a river or wetland, also known as a watershed or basin
channel	a narrow deep waterway connecting two larger bodies of water
culvert	a conduit under a road
cumecs	cubic metres per second - the measurement of the amount of water passing a point in the river at a particular moment
detention facility	a structure that temporarily stores excess stormwater for a period of time. The outlet of the structure is designed to release the stored water into the

	downstream watercourse at a rate less than the flow rate into the facility during storm events.
dune-slack wetlands	wetlands in the valleys between sand dunes
distributary	a splitting of a main river channel to form more than one, for example at a delta
ecology	the study of the distribution and abundance of life and the interactions between living and non-living organisms and their environment
endemic	does not occur outside the area
escarpment	transition from one series of sedimentary rocks to another series of a different age and composition
estuary	area where the river meets the sea, characterised by a zone of intermediate salinity, and often influenced by tidal action
eustatic	global changes in the sea level due to water mass added (or removed from) the oceans (e.g. melting of ice sheets)
eustatic sea level	sea level with reference to a fixed point, the centre of the Earth, another term used to describe the sea level is the 'Relative Sea Level' which is the one measured with reference to the base level, above which erosion can occur and below which deposition can occur
eutrophication	an increase in concentration of available plant nutrients in river water is an almost inevitable consequence of human presence. It comes from runoff from farms and gardens, from wastewater treatment works and septic tanks, or simply from untreated human or animal waste. The consequences of eutrophication are that plants grow better, faster and often become larger, clogging river channels and hampering the passage of floodwaters
exotic/alien	introduced from elsewhere (neither endemic nor indigenous)
flood attenuation	methods to lessen the effects of flooding
gabion	a basket-like structure filled with rocks
geological template	geological timescale used to describe the timing and relationships between events that have occurred during the history of Earth
geomorphology	the branch of geology that deals with the structure of the Earth and the changes that take place in the development of land forms
graben	an elongated depression between geological faults (the antithesis of a horst)
gracht	canal built by early Dutch settlers at the Cape
groundwater	water found underground in porous rock strata and soils, for example as a spring
habitat Integrity	an assessment of the extent to which anthropogenic influences have modified the natural habitat
horst	a section of the Earth's crust that is up-thrown relative to the adjacent rocks and is bound by faults on either side (the antithesis of a graben)
humic turf	acidic soils rich in organic material
hydraulics	the science that establishes the behaviour of fluid in a pipe, canal, or natural watercourse. In general, the amount and speed of flow depends on the size of the conduit, the slope in a river or canal or pressure in a pipe, the roughness of the material and the sinuosity of the river, canal or pipeline.
hydrography	the measurement of physical characteristics of waters and marginal land
hydrology	the science that determines how rainfall will flow across the landscape. In general, the quantity of flow depends on the intensity and duration of rainfall,

	the area, shape and slope of the catchment, and the nature of the ground and/or vegetation on which the rain falls
indigenous	living/growing naturally in an area, but not necessarily confined to the area
inundation	the rising of a body of water and its overflowing onto normally dry land
isostatic equilibrium	when a certain area of the Earth's crust has equal pressure on every side, achieved by gravity acting on the crust
Ma	million years
magma	molten rock that sometimes forms beneath the surface of the Earth
oligitrophic	nutrient-poor
orographic	rain that occurs when an airstream crosses a montain barrier
reach	a continuous stretch of a river
rehabilitation	process of restoring an area to a good condition
retention facility	a structure that retains runoff indefinitely should the capacity of the structure be sufficient to contain such runoff. Excess flow into the structure will be discharged via a spillway.
riffle	shallow flow over cobbles
riparian	the shores or banks of rivers, ponds, lakes and wetlands
riparian zone	the interface between land and a flowing surface water body
river health	a summary of a wide range of assessments of different parts of the riverine ecosystem, such as the channel or the fish, in terms of the extent to which they differ from the natural state
salinity levels	the amount of salt in water, measured in parts per thousand, where salt water is 35 parts per thousand
sinuosity	bends and curves
turbidity	refers to the clarity of water
urbanisation	the development of a town or city
wastewater	sewage, effluent

Appendix A

Frogs

Habitat preferences of frogs that occur in Cape Town and its environs.[1] (Photos: Cliff Dorse, Marius Burger and Suretha van Rooyen)

Common name	Scientific name	Habitat	Location	Distribution
Western Leopard Toad	*Amietophrynus pantherinus*	Sandy coastal lowlands and wetlands	Cape Peninsula, Cape Flats	Endemic to the Western Cape, extending eastwards to Gansbaai region
Raucous Toad	*Amietophrynus rangeri*	Mesic temperate areas with fynbos or grassland. Also Succulent and Nama Karoo, thicket, forest and savannah biomes	Northern suburbs	South Africa, Lesotho and Swaziland, from sea level to altitudes >1000m
Cape Sand Toad	*Vandijkophrynus angusticeps*	Coastal flats and rocky montane areas	Cape Flats and Peninsula, and northern suburbs	Endemic to Fynbos Biome, just entering the Eastern Cape
Cape Mountain Toad	*Capensibufo rosei*	Undisturbed Mountain Fynbos, flatter mountain tops, shallow pools of standing water	Table, Muizenberg and Kalk Bay mountains, Silvermine Valley, Cape of Good Hope, Chapman's Peak and Kommetjie area	Endemic to the winter-rainfall region of the Western Cape

Western Leopard Toad
(*Amietophrynus pantherinus*)

Raucous Toad
(Amietophrynus rangeri)

Cape Mountain Toad
(Capensibufo rosei)

1 Minter *et al.* (2004)

Arum Lily Frog
(Hyperolius horstockii)

Branded Stream Frog
(Strongylopus bonaespei)

Cape River Frog
(Amietia fuscigula)

Common name	Scientific name	Habitat	Location	Distribution
Table Mountain Ghost Frog	*Heleophryne rosei*	Clear perennial streams in moist, forested ravines, gorges and valleys in upper catchments	Table Mountain on the Cape Peninsula: Upper Disa stream, Skeleton Gorge, Wynberg Caves, Platteklip Gorge, Top of Window Gorge, Echo Valley	Endemic to Table Mountain
Arum Lily Frog	*Hyperolius horstockii*	Coastal vegetation in the Fynbos biome. Pans, dams, vleis and slow flowing streams with arum lilies, sedges, and reeds	Cape Peninsula	A near Western Cape endemic occurring along the southern seaboard from Cape Town to Humansdorp
Rattling Frog	*Semnodactylus wealii*	Grassland and Fynbos biomes. Pans, ponds, dams and marshes	Cape Peninsula and Kenilworth Race Course	A South African endemic, with the south-western distribution limit reaching Cape Town
Cape Rain Frog	*Breviceps gibbosus*	Loamy soils and clays, West Coast Renosterveld	Slopes of Table Mountain, Devil's Peak, Wynberg Hill, and northern suburbs	Endemic to the Western Cape, occurring from the central Peninsula in the south, to west of Citrusdal in the north
Cape Mountain Rain Frog	*Breviceps montanus*	Mountain Fynbos vegetation, including pine plantations and high altitude areas	Occurs with *B. gibbosus* in some localities in the Cape Peninsula	Endemic to the Western Cape, from Clanwilliam to the Outeniqua mountains

Common name	Scientific name	Habitat	Location	Distribution
Rose's Rain Frog	*Breviceps rosei*	Coastal lowlands and lower slopes in fynbos and thicket biomes, stable dunes, riparian thicket	False Bay, and on the Peninsula	Endemic to the Western Cape coast from Lambert's Bay to Gouritsmond
Cape Peninsula Moss Frog	*Arthroleptella lightfooti*	Mountaine Fynbos and Afro-montane forest, seepages in open fynbos and kloofs	Table Mountain National Park and Kirstenbosch Botanical Gardens	Endemic to the Cape Peninsula
Flat Caco	*Cacosternum platys*	Open areas in variety of vegetation types	Cape Peninsula and northern suburbs	Restricted to winter-rainfall region of the south-western Cape
Cape Caco	*Cacosternum capense*	Flat or gently undulating low-lying areas with poorly drained loamy or clay soils, temporary pools and pans	Rondebosch, Cape Flats, Kuils River, Durbanville, Kraaifontein, Faure and Stellenbosch	Endemic to the Western Cape, extending north almost to Graafwater
Micro Frog	*Microbactrachella capensis*	Seasonal wetlands in low-lying coastal areas in the Fynbos biome	Almost extinct on the Cape Flats, the last surviving population is restricted to Kenilworth Race Course	Endemic to the Western Cape including Betty's Bay/Kleinmond region and between Gansbaai and Agulhas
Banded Stream Frog	*Strongylopus bonaespei*	Mountain Fynbos, margins of forest, shallow, seasonal wetlands	Cape Peninsula	Western Cape, extending marginally into the Eastern Cape

Cape Peninsula Moss Frog
(Arthroleptella lightfooti)

Cape Caco
(Cacosternum capense)

Micro frog
(Microbactrachella capensis)

Cape Sand Frog
(Tomopterna delalandii)

Clicking Stream Frog
(Strongylopus grayii)

Western Leopard Toad
(*Amietophrynus pantherinus*)

Common name	Scientific name	Habitat	Location	Distribution
Clicking Stream Frog	*Strongylopus grayii*	Small dams, ponds, pools, ditches and shallow seeps	Cape Peninsula, Cape Flats and northern suburbs	Widely distributed: Northern Cape, Eastern Cape, Free State, Lesotho, KwaZulu-Natal, Swaziland, Mpumalanga and Limpopo
Cape River Frog	*Amietia fuscigula*	Grassland, Fynbos and Karoo biomes, at permanent springs, ponds, dams and slow streams	Throughout Cape Town and its environs	South Africa and Namibia
Cape Sand Frog	*Tomopterna delalandii*	Lowlands and valleys in Fynbos and Succulent Karoo biomes, pans, vleis, dams, and small watercourses in flat, sandy areas	Cape Peninsula, Cape Flats and northern suburbs	Endemic to South Africa, occurring from the Northern Cape through the Western Cape to the low lying areas of the Eastern Cape
Cape Platanna	*Xenopus gilli*	Low-lying Fynbos, in acidic black-water wetlands	Cape of Good Hope	Endemic to the Western Cape, including Betty's Bay/Kleinmond region and between Gansbaai and Agulhas
Common Platanna	*Xenopus laevis*	All biomes, in permanent or seasonal wetlands such as ponds, dams, marshes and rivers	Throughout Cape Town and its environs	Widely distributed in sub-Saharan Africa

1 Previously called ***Bufo pantherinus***
2 Previously called ***Bufo rangeri***
3 Previously called ***Bufo angusticeps***

Appendix B

Waterbirds

Little Egret
(*Egretta garzetta*)

Little Bittern
(*Ixobrychus minutus*)

Whitefaced Duck
(*Dendrocygna viduata*)

Habitat preferences of waterbirds that occur regularly in the south-western Cape, excluding species predominantly occurring in coastal lagoons and estuaries[1] (Photos: Sion Stanton – www.sionstanton.com)

Occurrence codes: R = roost, F = feed and B = breed

SPECIES	Aerial over water	Open water	Open shore	Marsh	Trees, bush and grass near water	Specific preferences or requirements
Little Egret		F		R, B	R, B	Breed in heronries (requiring suitably large sites such as trees and reed beds)
Yellowbilled Egret				F, R, B	R, B	
Cattle Egret			R	R, B	F, B	
Blackcrowned Night Heron			F	F, B	R, B	
Little Bittern				F, R, B		
Hamerkop		F			B	Large trees
Sacred Ibis		F	F	F, B	F, B	Breed in heronries
Glossy Ibis				F	B	
African Spoonbill		F		R	B	
Greater Flamingo		F				Large area shallow, saline/brackish water, abundant algae
Lesser Flamingo		F				
Whitefaced Duck		F	R			
Fulvous Duck		F	R			
Whitebacked Duck		F	R		B	
Egyptian Goose			R		B	

1 Maclean (1985)

Yellowbilled Duck
(*Anas undulata*)

African Black Duck
(*Anas sparsa*)

Black Crake
(*Amaurormis flavirostris*)

SPECIES	Aerial over water	Open water	Open shore	Marsh	Trees, bush and grass near water	Specific preferences or requirements
South African Shelduck		F	R			
Yellowbilled Duck		F	R	R	B	
Cape Teal		F	R	R		Saline/brackish water
Hottentot Teal		F	R	F		
Redbilled Teal		F	R	R	B	
Cape Shoveller		F	R		B	
African Black Duck		F			B	Fast flowing rivers
Southern Pochard		F	R	R	B	
Spurwinged Goose			R			
Maccoa Duck		F		F, B		
African Marsh Harrier				F, B		Large undisturbed marshy areas
African Rail				F, B		
Black Crake				F, B		
Baillon's Crake			F	F, B		
Redchested Flufftail			F	F, B		
Purple Gallinule				F, B		
Common Moorhen				F, B		
Redknobbed Coot		F, B				Fresh to brackish water
African Jacana			F	F		
Painted Snipe				F, B		
Ringed Plover			F, R			
Kittlitz's Plover			F			Flat, bare shore, open nest area

SPECIES	Aerial over water	Open water	Open shore	Marsh	Trees, bush and grass near water	Specific preferences or requirements
Threebanded Plover			F, R			Open nesting area
Blacksmith Plover			F, R		F, R	
Wood Sandpiper			F	R	F	
Marsh Sandpiper			F	R		
Greenshank			F	R		
Curlew Sandpiper			F, R			
Little Stint			F, R			
Ruff			F	R		
Ethiopian Snipe				F, B		
Pied Avocet		F	R			Saline/brackish water
Blackwinged Stilt		F	R			
Water Dikkop			F		F	
Kelp Gull			R		R	
Greyheaded Gull			R		R	
Hartlaub's Gull			R		R	
Whiskered Tern	F					
Whitewinged Tern	F					
Marsh Owl	F				R	Needs to be completed?
Burchell's Coucal				F, B		
Pied Kingfisher		F			F	Clear water, perches Near/over water, and steep mud banks for breeding
Giant Kingfisher		F			F	
Malachite Kingfisher		F			F	
Whitethroated Swallow	F					

Marsh Sandpiper
(*Tringa stagnatilis*)

Pied Avocet
(*Recurvirostra avosetta*)

Whitethroated Swallow
(*Hirundo albigularis*)

Brownthroated Martin (*Riparia paludicola*)

African Marsh Warbler (*Acrocephalus baeticatus*)

Common Waxbill (*Estrilda astrild*)

SPECIES	Aerial over water	Open water	Open shore	Marsh	Trees, bush and grass near water	Specific preferences or requirements
Brownthroated Martin	F					
African Marsh Warbler				F, B	F	
Cape Reed Warbler				F, B		
African Sedge Warbler				F, B		
Levaillant's Cisticola				F, B		
Cape Wagtail			F	F, B	F, B	Trees or dense reeds
Cape Weaver				B	F	
Southern Masked Weaver				B	F	
Red Bishop				B	F	
Common Waxbill				F	F, B	
Fish Eagle	F				R	Open water

Cape Weaver (*Ploceus capensis*)

Appendix C

List of relevant Cape Town City Council guidelines, policies and by-laws

Cape Town City Council maintains an excellent and informative website. Copies of its strategies and by-laws, are available on www.capetown.gov.za.

By-laws

By-law - Wastewater and industrial effluent

By-law – Water

By-law - Rates

By-law – Stormwater management

By-law – Environmental Health

By-law – Dumping and littering

By-law – Limit or restrict the use of water

Policies and strategies

Integrated Metropolitan Environmental Policy

Biodiversity Strategy

Coastal-zone Management Strategy

Environmental Education and Training Strategy

City Parks Development Policy

General principles for the *Integrated Metropolitan Environmental Policy*

- A commitment to adopting and implementing the principles and underlying approaches to sustainable development of the City of Cape Town, and ensuring the integration of environmental issues into local government decision-making at all levels.
- A commitment to ensuring that current generations use natural resources in such a way so as to maximise the benefit to all, while ensuring that those resources are protected for the use of future generations.
- A commitment to the protection of the constitutional right to a healthy environment and the recognition of the responsibilities and obligations of sustainable service delivery and ecologically sustainable development for the benefit of all.
- A commitment by the City of Cape Town to developing and implementing detailed sectoral strategies, in order to implement and enforce the general policy principles, for all environmental issues so as to meet the commitments described in the sectoral approaches.
- A commitment to a holistic approach to the environment and to protecting the City of Cape Town's unique biodiversity.

Further, a commitment to a special responsibility on behalf of the global community to ensure the conservation and protection of the Cape Floristic Kingdom.

- A commitment to, as a minimum, meeting or where practical exceeding the requirements of relevant international, national and provincial environmental legislation.
- The recognition by the City of Cape Town of the inherent rights of all living creatures and a commitment to the humane treatment of all animals, both domestic and wild.
- A commitment to the responsible stewardship of the resources within the local government's charge, through open, consultative, integrated and transparent governance of the City of Cape Town. This will be achieved by ensuring that best practice environmental solutions and activities are implemented at all times and that sustained partnerships with communities are achieved.
- A commitment to applying the precautionary principle, which states that if environmental consequences of a proposed activity are of significant impact and/or concern, and are uncertain, that activity should not be undertaken.
- The commitment by the City of Cape Town to the integration of environmental considerations in all its functions and activities, including strategic planning initiatives such as the Integrated Development Plan (IDP), and international initiatives such as Local Agenda 21.
- A commitment to the involvement of, and partnerships with, civil society in

decision-making processes regarding environmental management of the City of Cape Town.

- A commitment by the City of Cape Town to recognising and minimising the impact of its activities on the global environment, through understanding and monitoring its ecological footprint.
- A commitment to promoting an ethic of collective environmental responsibility in the City of Cape Town by means of environmental education and awareness programmes.
- A commitment by the City of Cape Town to recognising the role of disadvantaged communities (particularly the youth, women and persons with disabilities) in the development and enhancement of the City.
- A commitment by the City of Cape Town to open, transparent and effective environmental governance.

And for water …

A commitment to ensuring that the quality of coastal, marine and inland waters of the City of Cape Town is suitable for the maintenance of biodiversity, the protection of human health and a commitment to the principle that all City of Cape Town inhabitants have the right to clean, potable and adequate water sources. This commitment includes:

- Recognising that water is a scarce and valuable resource, which sustains communities, ecosystems and economic development.
- Recognising the importance of groundwater as a water resource.
- Management of water demand to ensure the long-term sustainability and affordability of water resources and the environment.
- Ensuring water quality, at a minimum, meets national standards as established by the Department of Water Affairs and Forestry.
- The effective management of all wastewater systems.

The Metropolitan Spatial Development Framework

Historic (five years or older) existing approved 4(6) Structure Plans for Cape Town and its environs are currently undergoing a process of updating and incorporation into the existing Metropolitan Spatial Development Framework, which will be used to direct and inform development decisions in the city over the next decade.