Rivers and Wetlands of Cape Town

Caring for our rich aquatic heritage

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Water Research Commission

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Eventually, all things merge into one, and a river runs through it. The river was cut by the world's great floods and runs over rocks from the basement of time. On some of the rocks are timeless raindrops. Under the rocks are the words, and some of the words are theirs. I am haunted by waters.

Norman Fitzroy Maclean – ***A River Runs Through It***

Foreword

Cape Town is blessed with remarkable environmental resources, not the least of which include a rich freshwater heritage. But this city has grown from 800 000 people to 3.4 million in the past 50 years. This has placed tremendous demands on natural resources and urban infrastructure.

The local government of Cape Town is committed to balancing the interests of development with the need to conserve our natural heritage. This is the only way to ensure that the quality of life of every citizen steadily improves. Catchment, Stormwater and River Management forms an important component of the package of municipal services provided by the City that are necessary to achieve this goal. Sound management of both the natural and man-made components of the drainage system adds value to our urban environment, protects us from floods and health risks related to poor water quality, while ensuring that receiving waters are protected from the impacts associated with runoff from urban areas. In order to rise to the challenges implicit within this field, the City adopted the Catchment, Stormwater and River Management Strategy in 2002, and continues to embrace new approaches, which ensure the promotion of principles of sustainable urban catchment management.

Another important step taken by the City to ensure healthy environments and protect our valuable ecological resources has been the approval of the Integrated Metropolitan Environmental Policy (IMEP), which is supported by a number of key environmental strategies, including the Biodiversity Strategy, which provides a framework for linking important ecological systems across the city and identifying key areas for interventions. The City is also a one of the founding signatories of the Cape Action for People and Environment (CAPE) programme that aims to ensure conservation and restoration of our valuable natural resources in a way that benefits all citizens of the Cape Floristic Region.

The information in this book is a valuable synthesis of unpublished documents and personal communications. Were it not for this book, much of this information would be in danger of being lost. We hope that preserving the past lessons documented in this text will assist us in future with the conservation and sustainable management of our precious aquatic resources.

Helen Zille
Mayor of Cape Town

Acknowledgements

The project behind this book arose from a successful proposal to the Water Research Commission's unsolicited proposal call in June 2005, and was funded and guided by the Water Research Commission and its nominated Reference Group, who gave of their time and support in directing and reviewing the product. The members of the Reference Group were:

Dr Renais Dube	Water Research Commission (Chairperson)
Prof. Albert Rooseboom	University of Stellenbosch
Dr Mike Shand	Ninham Shand
Mr Martin Thompson	City of Cape Town
Ms Julia Wood	City of Cape Town
Ms Toni Belcher	Department of Water Affairs and Forestry
Ms Tovho Nyamande	Department of Water Affairs and Forestry
Prof. Bruce Kelbe	University of Zululand
Dr Mandy Uys	Laughing Waters
Prof. Abraham Thomas	University of Western Cape
Mr Colin Whittemore	Ninham Shand.

Ms Toni Belcher and Ms Tohvo Nyamande made available two of the Department of Water Affairs and Forestry interns, Mr Graeme Williams and Mr Mulalo (Freedom) Mbedzi, to assist with the initial data-gathering.

Ninham Shand (Colin Whittemore) made available the newspaper cuttings on river-related issues collected over the years by Mr Ninham Shand.

Consultants and scientists, too numerous to mention individually, from across the Western Cape, provided us free access to their reports, scientific papers and photographs and made themselves available for meetings and workshops to discuss key aspects of the book.

Numerous City and Government officials assisted with the gathering of the maintenance costs and other data, and we extend our thanks to: Alfred Moll, David Kriel, Doug Austin, Mogamet Kenny and Talcot Persent, Julia Wood and Dalton Gibbs, Faiez Voterson, Johan Herholdt and Jacobus Verwey (all City of Cape Town); Dean Impson (CapeNature); Willie Enright (Department of Water Affairs and Forestry); John Dini, George Davis and Mandy Noffke (Working for Wetlands); and Liz Day (Freshwater Consulting Group), Denis Davey (Friends of Die Oog), Mike Shand (Ninham Shand), James Forsyth (Friends of Constantia Greenbelt) and Liz Wheeler (Friends of the Liesbeek River).

Candice Haskins reviewed an early draft of the text – a horrid, horrid job done well.

Staff at the various state and other museums and archives provided invaluable assistance in the search for relevant information and photographs.

Ros Townsend assisted with the sourcing and collection of historic photographs and paintings.

Many people very kindly gave us access to their libraries of river-related photographs – all are acknowledged in the text.

Many community groups assisted with the review of, or contributed text for, the chapters for "their" rivers or vleis. These included: Friends of the Liesbeek River, the Zandvlei Trust, Friends of Zeekoevlei and Rondevlei, Rondevlei Nature Reserve, Friends of Rietvlei, Friends of Die Oog and the Hout Bay Museum. Special thanks to Liz Wheeler, Gavin Lawson, Roger Godwin and Dennis Davey for going above and beyond.

It would not have been possible to complete this project in the time provided had it not been for the work of Tim Berners-Lee, who invented the worldwide web and his successors, who developed it further. The contribution of Ray Tomlinson, who invented e-mail, was equally valuable. We are indebted – whew – we think!

An unpublished text by Tony Murray, entitled "Much water under many bridges", provided much of the engineering information contained in this book.

Acknowledgements for "Much water under many bridges"

Tony Murray's original text arose from a project that was initiated by Rod Arnold at a time when he was Head of the Drainage Department of the City of Cape Town. That project was guided by a Steering Committee, who gave of their time, support and other contributions to the project. The members were:

Mr Rod Arnold	City of Cape Town (Chairperson and Secretary)
Mr Mark Obree	(At the time) Head of the Catchment Management Department of the City of Cape Town, who obtained financial support
Dr Mike Shand	Ninham Shand
Mr Henk Beekman	City of Cape Town
Mr Herby Oberhofer	City of Cape Town
Mr Martin Thompson	South Peninsula Municipality
Mr Alan Walker	City of Cape Town

Outside the Committee, Neil Grant provided important information on his former responsibility for Simon's Town as well as undertaking some valuable editing. Rory

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Oliver Trevor of Muizenberg Historical Society edited much of the manuscript and provided information.

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Judge Ian Farlam placed his extensive knowledge, enormous library and boundless enthusiasm at Tony Murray's disposal and was a constant source of inspiration.

Additional sponsorship

As with many projects, this book ended up being a much bigger job than originally envisaged. We are grateful for the contributions from the additional sponsors that stepped into the breach when funding was required for the design and layout.

Ninham Shand Consulting Services

Southern Waters Ecological Research and Consulting

Photo: iStock Photo

Chapter 1

Introduction

"The future belongs to those who understand that doing more with less is compassionate, prosperous and enduring, and thus more intelligent, even competitive."

Paul Hawken - environmentalist, entrepreneur, journalist, and author*

* www.paulhawken.com

The waterways and water bodies of Cape Town have played a pivotal role in the history of the area. In common with many major cities in the world, the streams, rivers, wetlands and vleis of Cape Town have been shaped as much by the region's political and social history as by nature and technology.[1] Inevitably these aspects have had an effect on the ecological integrity and functioning of the City's water systems. The provision of water supply, drainage and waste removal for a city is no mean feat, and past decisions and actions should be seen in the social, economic and technological context of their time.

1 After Petts *et al*. (2005)

"All things are connected, like the blood that runs in your family. The water's murmur is the voice of my father's father."

Suquamish Chief Sealth

Much water under many bridges: The history of the catchments, rivers, and drainage systems of greater Cape Town

Over the years, many engineers engaged in drainage in the City of Cape Town, and elsewhere, kept a record of their activities, which were carefully filed away. Some presumably thought they might have need to refer to these notes at a future date, while others left them for their successors to consult if necessary. It is unlikely that these intriguing records were ever extensively used for engineering purposes - but the core of the history of an important element of the development of Cape Town was gathering dust in the filing cabinets of the Council.

Tony Murray painstakingly sifted through these records and created an entertaining and informative text, which he kindly supplied as the "seed" for this book.

The development of Cape Town and Stellenbosch in the last three centuries is associated with astounding engineering progress, and littered with unsung engineering heroes. These men (yes, for the most part they were men) designed, dug and built in, around and on our rivers and vleis with the purpose of promoting the safety and convenience of the residents.

The future may be unknowable[2] but, with the benefit of hindsight, parts of it are also fairly predictable. Effect follows cause, follows effect, and in a pattern as old as time itself, mimicked the world over, rivers adjust and are adjusted in the face of urban sprawl.

It is not for us, removed from the context of their times, to pass judgement on what has gone before. Our duty is to learn from our predecessors, build on the good they have left behind, try to rectify the mistakes made and use their legacy of knowledge to do better in the future. And to remember that, all too soon, we will be the predecessors.

Our aim with this book is to provide a fresh perspective on rivers and river management in Cape Town, using the lenses of time and space. We "step-back" in time and track the changes that have occurred and the reasons for those changes. We "step-back" spatially and consider the major urban catchments feeding False Bay and Table Bay as a unit, in the context of their unique geological and climatic history.

We do this in the hope that lessons from the past, combined with insights from a society that has learnt much about its dependence on nature, will assist us not only in understanding where we are but, more importantly, in plotting a better path into the future.

2 Two Little Blessings: Monkey Videos

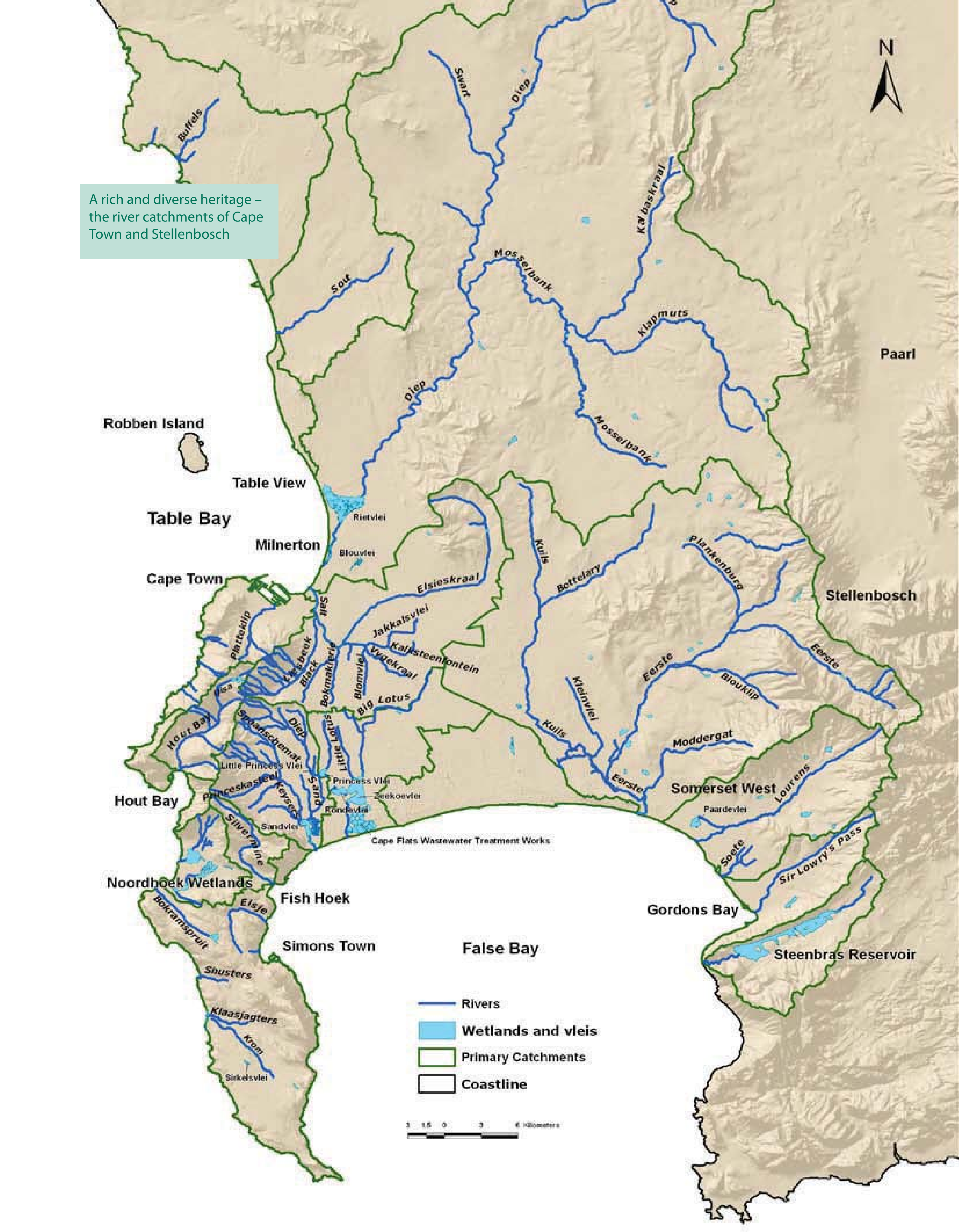
Cruising at Zandvlei
(Photo: Gavin Lawson)

The waterways and water bodies

Cape Town and Stellenbosch are richly blessed with rivers such as the Diep River, Liesbeek River, Hout Bay River, Eerste River and Lourens River. Add to this the wealth of small, shallow lakes and wetlands, known collectively as vleis, situated mainly on the Cape Flats including Rondevlei, Zeekoevlei, Blouvlei, Paardevlei, Wildevoelvlei and their cousins, and the responsibility on all of us to make good on nature's investment becomes clear.

At one time, many of the vleis would have been inter-connected - a string of pearls strung across the Cape Flats. It is thought that with the last emergence of the Cape Flats from the sea, changes in topography brought about changes in drainage and that wind-blown sand filled up many of the depressions, isolating the remaining water bodies. One school of thought has it that bare sands once covered the whole of the Cape Flats and that there were continual changes in the size and location of the vleis, as a result of rapidly shifting sand dunes.[3] A second contention is that the Cape Flats were historically stablilised, mainly by "waboom" (a species of protea) and other proteas, but were destabilised in the eighteenth century when settlers plundered the

3 Harrison (1958)



A rich and diverse heritage – the river catchments of Cape Town and Stellenbosch reeds, trees and bushes in the area for firewood and building material.[4] This seems unlikely, however, given the immensity of the area relative to the human population at the time. It is also not borne out by paintings from the days of early settlement. Whatever the case, the Cape Flats were artificially stablised in the early 1900s by the planting of the now-ubiquitous Australian wattles (*Acacia longifolia*, *Acacia mearnsii* and *Acacia cyclops*) and, in the last century, urban expansion resulted in the elimination of many of the wetlands that once characterised the Cape Flats. Only the largest systems and some of the smaller, isolated water bodies remain. Without exception, these have been extensively regulated and modified.[5]

The western shore of Table Bay was also once dominated by a vast system of estuarine lakes, formed by the Diep River from the north, and the Black, Liesbeek and Salt rivers from the south. Of this, only the Milnerton Lagoon and the salt marshes on the Diep River remain. The Hout Bay River also has a small estuary on the Atlantic Coast but this too is much reduced from its natural form. On the other side of the Peninsula, False Bay is far richer in estuaries, with eight in total. Of these, the Eerste and Lourens river estuaries, and Zandvlei fall within the boundaries of Cape Town and Stellenbosch.

While it is true that the greater part of the Eerste River catchment is outside the boundaries of the City of Cape Town area, nature is scornful of boundaries determined by politicians, and the influence of the stream that rises in the Jonkershoek Mountains is such that we felt it must be included in this history.

Groundwater and seeps

Much of the fresh water in the area takes the form of underground seepage and groundwater, which although not easily apparent to the eye, nevertheless occupies a pivotal position in structuring plant communities and determining the distribution and abundance of certain animal species.[6]

Layout of the book

The chapters in this book are arranged on the basis of the major river and vlei catchments in the area. While it was not possible to include every stream, the sections that follow outline the known history from 250 million years ago to the present day for:

- the rivers of the City Bowl
- the Liesbeek River
- the Elsieskraal River and Black River
- the Diep River (Milnerton)
- the Salt River
- Zeekoevlei and Rondevlei

4 Mossop (1927), Bickerton (1982)
5 Brown (1996)
6 Fraser and McMahon (1994)

- Zandvlei, the Sand/Diep River (Constantia), the Keysers River and the Westlake River
- the Hout Bay River
- the rivers and vleis of the Southern Peninsula
- the Noordhoek wetlands and streams
- the Kuils River
- the Eerste River and
- the Lourens River and the Sir Lowry's River.

We hope you enjoy it.

Photo: Gavin Lawson

Chapter 2

The physical template

"The laws of Congress and the laws of physics have grown increasingly divergent, and the laws of physics are not likely to yield."

Bill McKibben - environmentalist, entrepreneur, journalist, and author Vermont, USA*

* Quoted in Hawken *et al*. (1999); www.billmckibben.com

Rivers and wetlands are complex systems whose characteristics are the product of the influences of geology, hydrology and ecology. These influences tend to be hierarchical, as it is largely the geology and geomorphology that determine the form and structure of catchments and, hence, provide the template onto which first hydrology and then ecology exert their influence.[1] The present-day arrangement of the rivers and wetlands of the Cape Peninsula and adjacent areas reflects the past

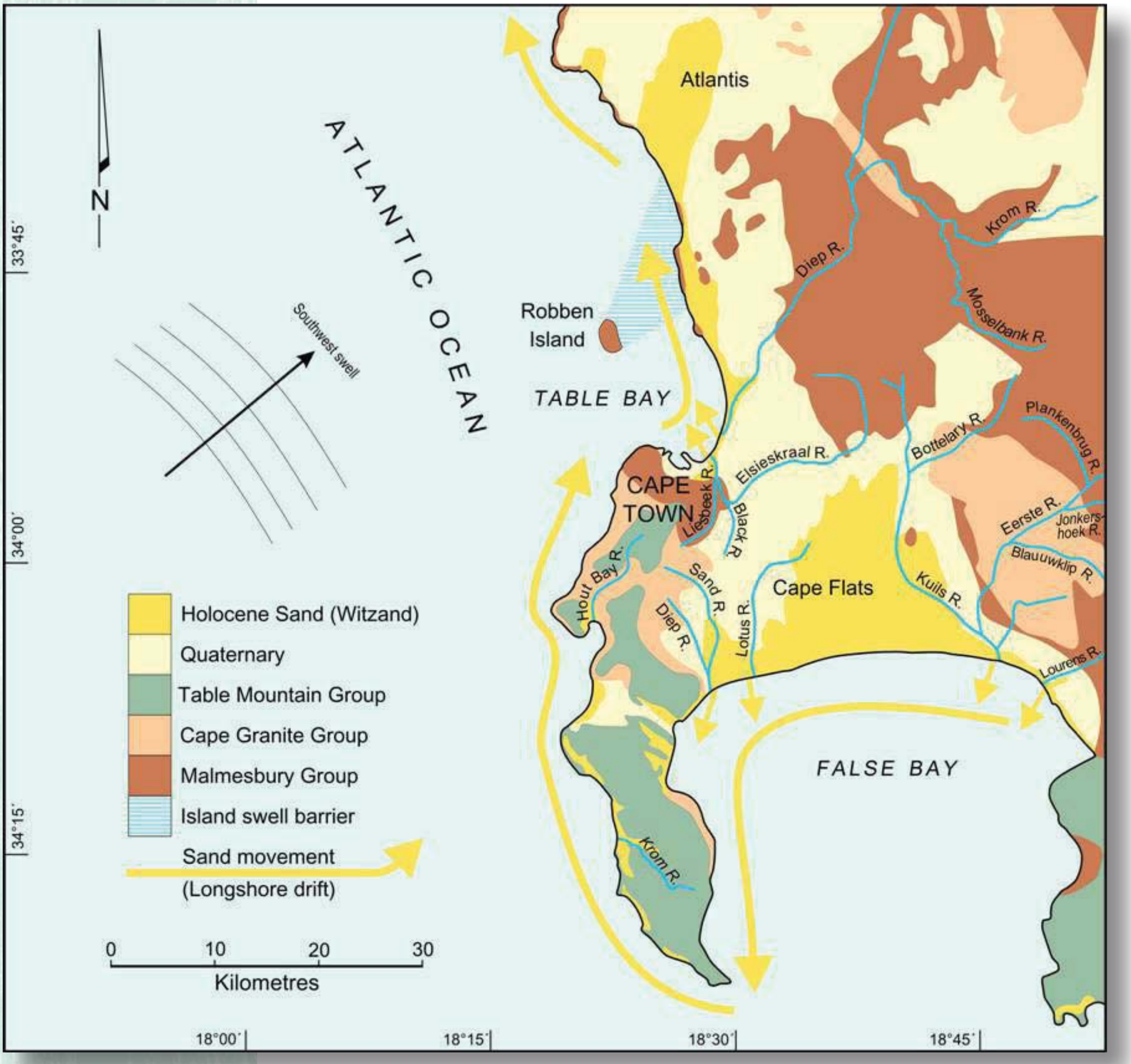
1 Dollar *et al*. 2007

and present influence of:

- the area's geology and geomorphology;
- sea level oscillations and climate change;
- present-day geomorphological processes such as hydraulic, vegetation and sediment interactions; and
- human impact such as channel engineering, abstraction of water and sediment, and catchment land use changes.

Understanding how best to manage these systems should therefore start with an understanding of their geological history, and the physical constraints imposed by their present-day topography.

The geology of the Cape Peninsula and adjacent areas (modified after Compton, 2004)



Geology

The oldest geological formations in the area belong to the Malmesbury Group of rocks that make up the basement of the area. Around 540 million years (Ma) ago, the Cape Granite Suite, formed by solidification of cooled magma (molten rock) from below the surface of the earth, pushed through the Malmesbury Group rocks along a roughly north-northwest orientation.[2] These intrusions are called plutons and are responsible for the higher areas of the Cape Peninsula, Kuilsriver-Helderberg, Stellenbosch and Paardeberg.[3]

The rock strata of the Cape Peninsula and adjacent areas, with the oldest formations at the bottom and the youngest at the top (after Hartnady and Rogers 1990)
Ka = thousand years ago

Group	Formation	Time
SANDVELD GROUP	Witzand Formation	<6 Ka ago
	Langebaan Formation	110–75 Ka ago
	Velddrift Formation	130–110 Ka ago
	Springfontyn Formation	500 Ka ago
	Varswater Formation	3 Ma ago
	Elandsfontyn Formation	13 Ma ago
u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u-u		
FALSE BAY DOLORITES		130 Ma ago
i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i		
TABLE MOUNTAIN GROUP	Pakhuis Formation	
	Peninsula Formation	510–480 Ma ago
	Graafwater Formation	
n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n-n		
	Cape Point Intrusive	520 Ma ago
i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i		
CAPE GRANITE SUITE	Cape Peninsula, Kuils River-Helderberg and Stellenbosch batholiths	540 Ma ago
i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i-i		
MALMESBURY GROUP	Sea Point Formation	560 Ma ago
	Bloubergstrand Formation	

u=major unconformity n=nonconformity i=intrusive contact

Younger Table Mountain Group rocks overlie the Cape Granite Suite. These are quartzitic sandstones deposited on the sea floor from around 500 Ma. Over time, the

"GEOLOGY, n. The science of the earth's crust - to which, doubtless, will be added that of its interior whenever a man shall come up garrulous out of a well. The geological formations of the globe already noted are catalogued thus: The Primary, or lower one, consists of rocks, bones or mired mules, gas-pipes, miners' tools, antique statues minus the nose, Spanish doubloons and ancestors. The Secondary is largely made up of red worms and moles. The Tertiary comprises railway tracks, patent pavements, grass, snakes, mouldy boots, beer bottles, tomato cans, intoxicated citizens, garbage, anarchists, snap-dogs and fools."

Ambrose Bierce (1842-??)

2 Hartnady and Rogers (1990)
3 Theron *et al.* (1992)

deposited sands compacted and solidified, and currently form a geological formation that is approximately two kilometres thick. Many of the area's mountain ranges are Table Mountain Sandstone, including, as the name suggests, Table Mountain. These sandstones once covered the whole area; the rocks on Table Mountain were originally linked to the same formations capping the mountains on the eastern flanks of False Bay from Gordon's Bay to Cape Hangklip. However, over the last 400 million years, the middle portion was removed through aggressive erosion and the Cape Flats was created. Around 130 Ma, another group of molten rocks, named the False Bay Dolerites, pushed through the Table Mountain Group rocks, further affecting the topography of the area. These dolerite dykes are clearly evident around the coastline, with an excellent example at Froggy Pond just south of Simon's Town.

The mainly unconsolidated sands of the Sandveld Group are the youngest of the geological strata in the Peninsula, and overlie the bedrock (Malmesbury Group and Cape Granite[4]) of much of the Cape Flats, the area around Noordhoek and the area north of Table Bay. These are deposits of river-, sea-, wind- and estuarine-derived sediments. The most recent of these, the Witzand Formation, is only six thousand years old, and is comprised of vegetated and unvegetated calcareous dunes that characterise, for example, the False Bay coastline, Mitchell's Plain and Khayelitsha.

This geological template set the scene for the geomorphological development of the main rivers of the Peninsula and adjacent areas.

Geomorphological development

The present-day position and characteristics of the area's rivers stem partly from the merging of the supercontinent Pangaea, some 250 Ma, partly from the subsequent break-up Pangaea and its off-shoot, Gondwana (some 125 Ma later), and finally from erosion of the Table Mountain Group rocks from the Cape Flats.

During the formation of Pangaea, the layers of rock that make up the Table Mountain Group were crumpled into a series of arches (anticlines) and troughs (synclines). The overall effect was to create a general elevated area with a steep eastern flank from Paarl to Piketberg.

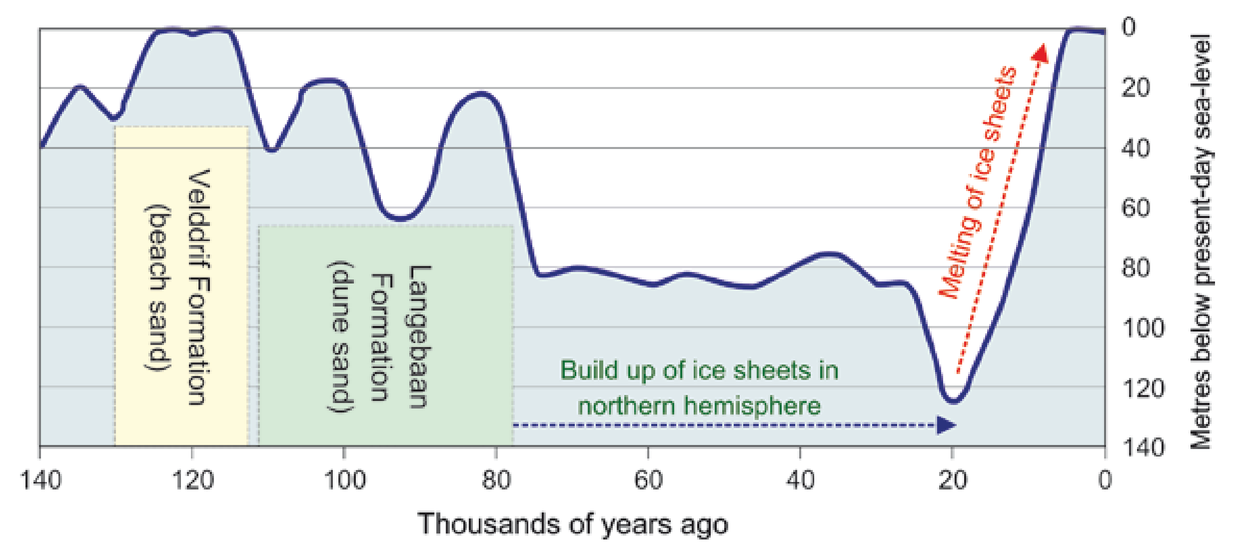
The break-up of Gondwana was associated with cataclysmic faulting that created a complex landscape of raised (horsts) and sunken (grabens) sections. For a time, this meant that the rivers flowed into inland depressions forming inland lakes.[5] However, as the continents drifted apart and the Atlantic Ocean opened, the whole area "tipped" as isostatic equilibrium was restored, and large-scale vertical faulting resulted in the formation of the high escarpments that characterise the area today. Evidence of this tipping can also be seen in the present-day positions of the geological strata, for instance, the base of the Table Mountain Group sediments lies below sea level in the southern peninsula (i.e. south of the Noordhoek/Fish Hoek Valley), and above sea level in the northern peninsula.

4 The Table Mountain Sandstone having been eroded away.
5 Dingle *et al.* (1983)

The effects of changes in sea level

A sequence of major rises (transgressions) and falls (regressions) in sea level have had a significant impact on the Peninsula shoreline, and consequently on its rivers and wetlands.

Today, sea level is high relative to most past levels because of the thermal expansion of the ocean as it picks up heat from natural greenhouse warming in the atmosphere, and because melting glacier and land ice add water to the ocean.[6] This process with occasional reversals has been the dominant factor influencing the area's rivers and wetlands over the last two million years.



Sea level changes over the last 140 thousand years relative to present day (present day sea level = 0 on the y-axis) (after Compton 2004)

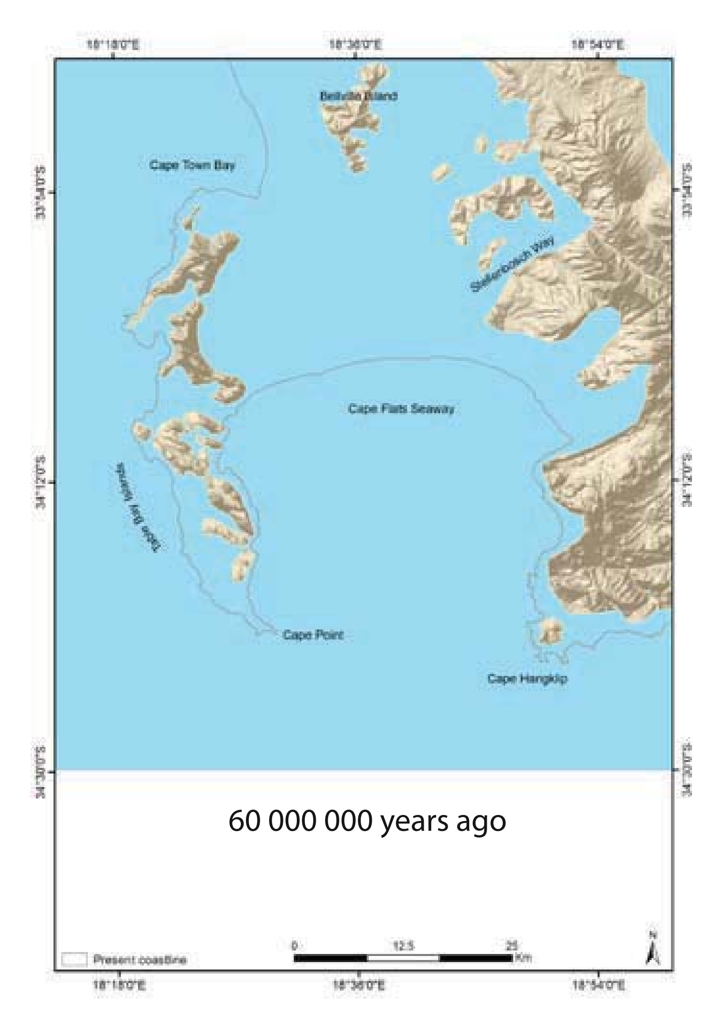
The last significant fall in sea level occurred during the Last Glacial Maximum, some 20 000 years ago, when the shoreline shifted to the mouth of False Bay and to the west of Robben Island. The rivers that extended across False Bay and Table Bay at that time incised their valleys to the lowered base level. Conversely, during marine transgressions (and rising base levels), the sea advanced landward covering much of the Cape Flats, and the river channels were infilled with sand. The current shoreline is approximately 6000 years old, having risen since the low sea-stand of -130 metres during the Last Glacial Maximum approximately 20 000 years ago.

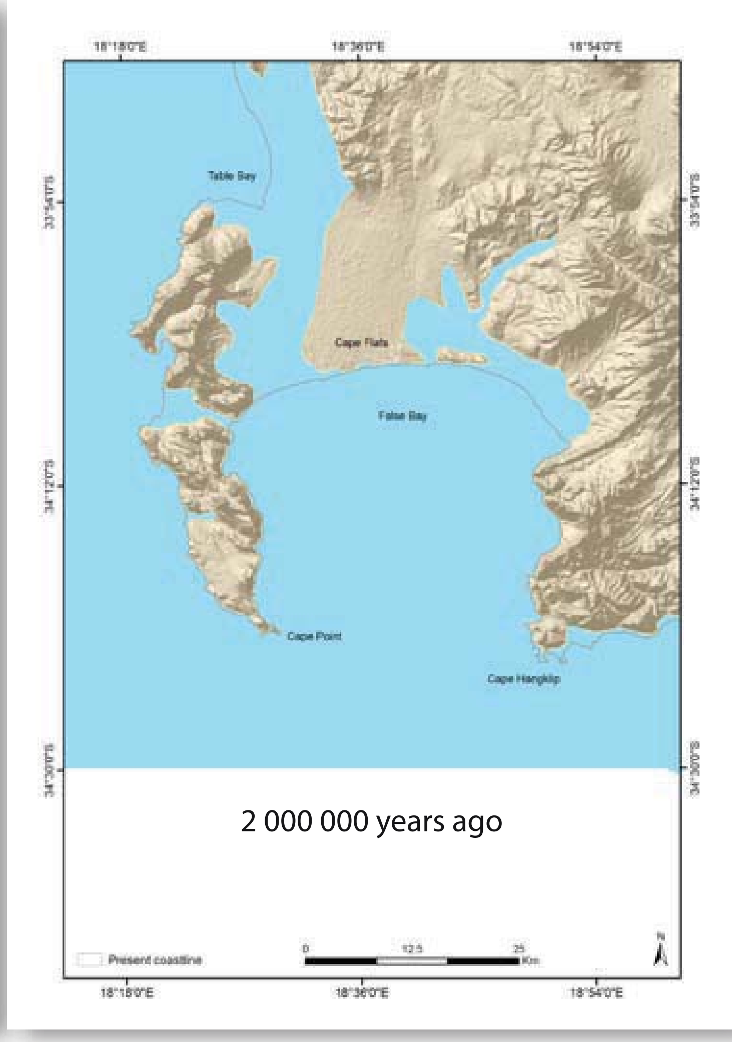
The proto-rivers of Stellenbosch and Paarl

Until comparatively recently (geologically speaking), the rivers around Stellenbosch and Paarl looked different from those of today. Until around 34 Ma, an early version of the Jonkershoek River, called the proto-Jonkershoek River, flowed northwest via the early Mosselbank/Groen River system before reaching the ocean near present-day Vredenburg.[7] Interestingly, the proto-Berg River also had a course different from

6 Although there is debate among earth scientists whether we are currently experiencing a "high stand", it is generally accepted that the eustatic sea level is rising.

7 Söhnge (1991)

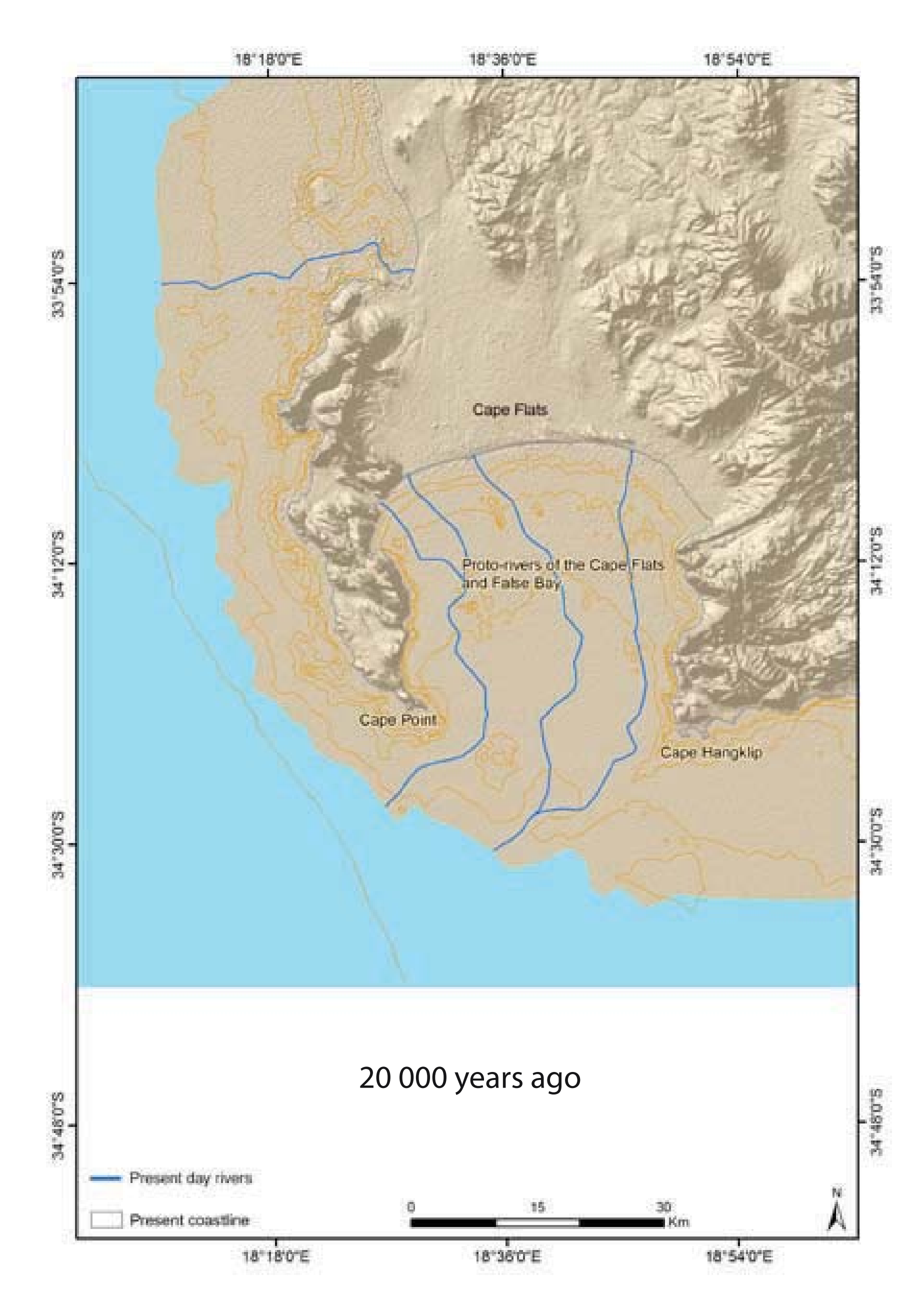




present. It flowed via Verlorenvlei into the proto-Olifants/Orange River, which at that time entered the sea through the Olifants River mouth at 31° S.[8]

A significant change occurred during the Oligocene (*circa* 31 Ma) when a fall in sea level relative to the land of 400 to 500 metres, combined with some uplift, exposed the western continental shelf to a width more than 200 kilometres beyond that of the present day.[9] This spurred the capturing of the proto-Jonkershoek River by the Eerste River, which then flowed to the southeast and entered False Bay near Wolfdrift. This was part of a whole series of river "captures". For instance, the proto-Olifants/Orange River system lost the contribution of the Orange River, which moved to its present-day exit at Alexander Bay, and the Berg River was diverted via a tributary of the early Groen/Sout River to flow into the sea at Veldrift.[10]

8 Dingle and Hendey (1984)
9 *ibid.*
10 Rogers (1982)



(*opposite page left*) Inundation of the Cape Peninsula and adjacent areas under elevated sea levels *circa* 60 Ma when the Southern Peninsula would have been an archipelago.

(*opposite page right*) Inundation of the Cape Peninsula and adjacent areas under elevated sea levels *circa* 2 Ma, when the Southern Peninsula would have been two main islands divided along the Noordhoek/ Fish Hoek valley

(*left*) Under the low sea levels experienced *circa* 20 000 years ago, the coastline would have stretched to the continental shelf.

The proto-rivers of the Cape Flats and False Bay

The two main south-draining rivers of the Cape Flats, the Diep River (Constantia) and the Kuils River, were significantly affected by pre-Quaternary and Quaternary (2 Ma) sea level changes. They created great valleys, which today are buried by the sands on the ocean floor of False Bay and on the Cape Flats. Below these sands, cut into the underlying Malmesbury bedrock, are two significant palaeo-valleys that reflect the

"Water, water everywhere nor any drop to drink."

Samuel Taylor Coleridge, Rime of the Ancient Mariner*

* Wordsworth and Coleridge (1798)

ancient routes that the proto-Diep River and proto-Kuils River took to the sea.[11]

It is unclear exactly when these palaeo-valleys were formed; perhaps it was during very low sea-stands around 31 Ma. It is significant that both are incised parallel to the contact between the Cape Granite and the Malmesbury Group sediments, with the less-resistant granite being preferentially eroded.

The inverted Diep River

The Diep River (Milnerton), which today enters the sea via the Milnerton Lagoon, flows in the "wrong" direction relative to the majority of the rivers in the rest of the area. It flows southwest, effectively transverse to the grain of the rocks.[12] This unusual hydrography can be ascribed to two major factors: firstly, river capture associated with periodic uplift and, secondly, the sequence of sea level changes.

The Diep River was already in existence 60 Ma ago, and geophysical techniques have demonstrated that as with the Kuils and Diep (Constantia) rivers, two palaeo-valleys underlie it and extend to the continental shelf; these have since been infilled with sands washed into the area during sea level rises. The shifting shorelines associated with the sea level changes saw Rietvlei either as a small bay (at high sea levels) or as a delta front (at low sea levels).

The rivers of the peninsulas

Unlike the Cape Flats and False Bay rivers, the courses of many of the rivers of the Peninsula (both on the False Bay and the Atlantic seaboards), are controlled by the major lineaments in the Table Mountain Group rocks. These are predominantly northwest to southeast in the Southern Peninsula (i.e. Krom River southwards), and to the northeast in the Northern Peninsula.[13] Platteklip Gorge above the City Bowl is an excellent example of a river flowing along a lineament, while the course of the Liesbeek River is controlled by a north-northeast striking fault zone that runs through the Kirstenbosch Gardens towards Constantia Nek. This phenomenon can also easily be seen in the small streams running off the Twelve Apostles.

Modern-day division of river basins

In summary, it is possible to divide the river basins of the Peninsula and adjacent areas into four sub-regions. These are the:

- Peninsula river basins;
- Cape Flats river basins;
- Eastern Pluton river basins; and
- Diep River (Milnerton) basin.

11 Rogers (1980)
12 Mabbutt (1950) and (1952)
13 *ibid.*

North-northeast striking fault zone seen in the small streams running off the Twelve Apostles (Photo: Pieter Kriel)

The Peninsula rivers are mainly steep and narrow as they are underlain by Table Mountain Group rocks in the south and by granite and Malmesburg Group rocks in the north.

The gentle-gradient Cape Flats rivers flow over recent Sandveld Group sediments, but roughly follow the courses of the underlying palaeo-valleys of the Diep (Constantia) and Kuils rivers. The build-up of sediments washed into the area during sea level rises, and the movement of sand and other fine particles along the coast play a significant role in retarding river flow, creating the Cape Flats wetlands.

The rivers of the Eastern Plutons all originate from one point (i.e. are radial in their pattern) with the hydrography of the present-day Eerste River reflecting the capture of the Jonkershoek River and the consequent demise of a former north-westerly flowing river that reached the sea near Vredendal.

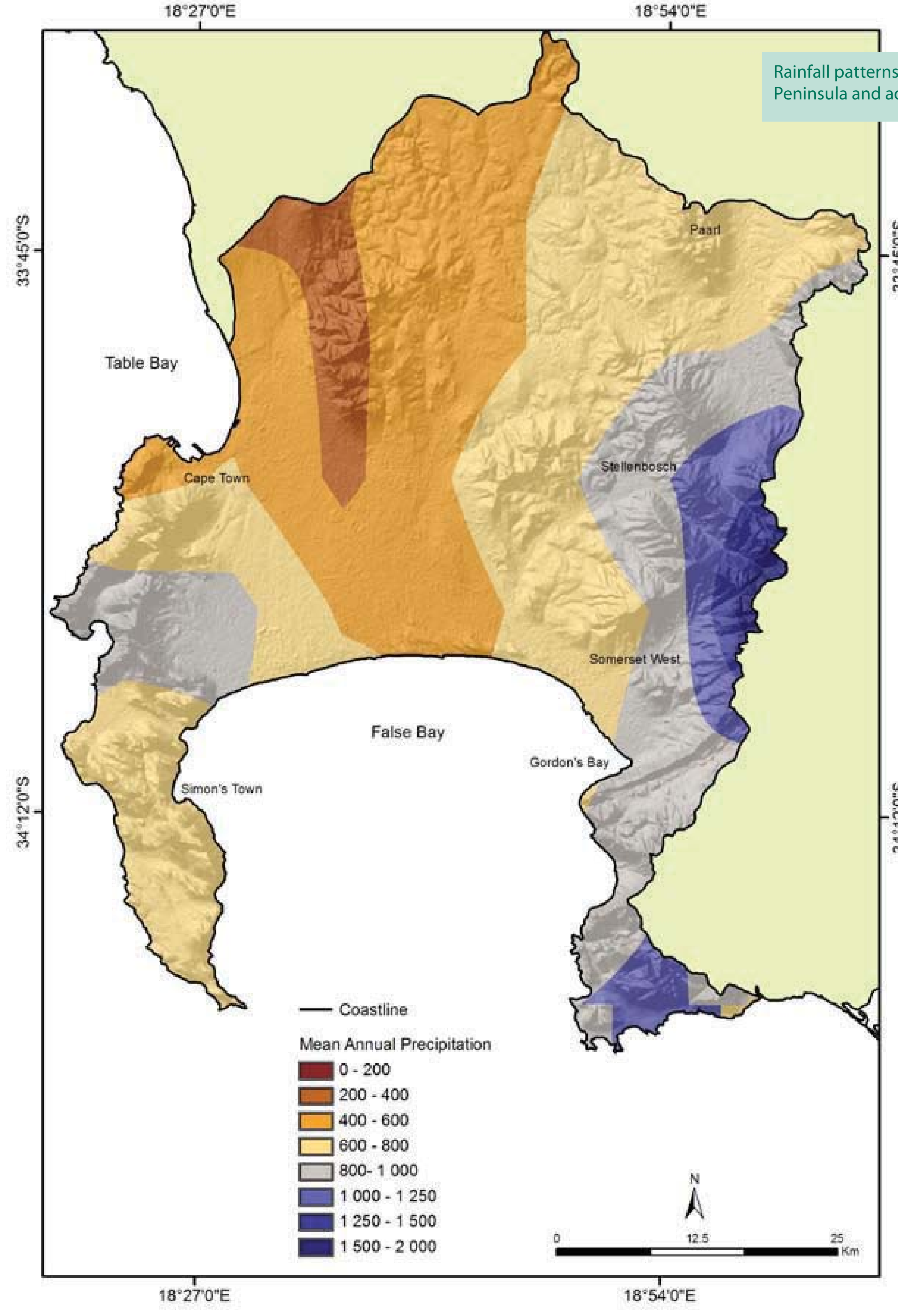
The unusual hydrography of the south-flowing Diep River also reflects the influence of river capture and differential uplift, with the sediments of the Rietvlei area reflecting the influence of sea level changes over the last two million years.

Hydrology and rainfall

Modern river systems are constantly changing. While the positions of rivers and wetlands are a function of the geological template (without direct engineering intervention), the volume and pattern of water flowing down a river or through a wetland strongly influences its character. It is the energy imparted by water moving across the bed of a river of wetland that moves sediment, creates or destroys physical features, and transports seeds and eggs downstream. It is water that allows the upstream passage of aquatic animals, and it is water that sustains the rich life in rivers and wetlands and on their banks. Of course, the animals and plants themselves exert an influence on the sediment and physical features, completing the intricate and complex web of interactions that characterise living systems.

The influence of water on rivers and wetlands is complicated by the temporal dimensions of duration, timing and frequency. For instance, to understand the formation of valleys and floodplains, one would need to understand wet and dry cycle characteristics over millennia, while for tidally-driven processes in estuaries a daily description would be appropriate. A good starting point, however, is a description of the rainfall and river flow patterns of the Cape Peninsula and adjacent areas.

At home with the famous Cape Town rain (Photo: Cate Brown)



Rainfall patterns in the Peninsula and adjacent areas

Rainfall and river flow patterns

The Peninsula and its adjacent areas lie just far enough south to be affected by frontal systems that move eastwards over the Southern Ocean. These bring rains in the winter. In summer, the frontal systems are weaker and tend to move further south; accordingly the area experiences only increased cloud and occasional light rain. This means that, on average, the area experiences a Mediterranean-type climate with warm, dry summers and mild, wet winters with strong winds. At a regional level relief plays a significant role in the way in which these frontal systems deposit their moisture. This, in turn, affects the characteristics of the runoff in the river systems at a basin level, and consequently the geomorphology and hydraulics of rivers and wetlands.

The consequence of the interaction between the higher-level global circulation patterns and the area's topography is that the highest rainfall is experienced in the east where the frontal systems are funnelled through False Bay and are forced to rise up the Hottentots Holland, Jonkershoek and Groot Drakenstein mountains before releasing their moisture. Rainfall decreases dramatically from the east (approximately 1 700 millimetres per annum), across the Cape Flats to the west coast, where the mean annual precipitation is around 400 millimetres.

River flows mirror the rainfall pattern; flow is strongly seasonal, with most of the flow occurring in the winter months (June to September). It is also highest in the east and lowest in the west.

Groundwater

Groundwater is water that occurs underground and 'daylights' as springs, wetlands, seeps or as flow into rivers or the sea. An aquifer is the underground layer of rock or earth material from which groundwater is abstracted. Groundwater flows from areas of recharge to areas of discharge. Recharge occurs where water from rainfall, surface water, neighbouring aquifers or even from water supply systems is added to the aquifer. In the unsaturated zone, water infiltrates through pores and macro pores, such as cracks and fractures, downwards until it reaches the piezometric surface or water table. Once in the saturated aquifer, the flow is controlled by hydraulic permeability and the gradient of the water level. Flow paths may be fairly short in time and length (several hundred metres/weeks/months) or long (hundreds of kilometres and thousands of years).

Two types of aquifer occur in the Peninsula and adjacent areas: primary and secondary aquifers.

Primary aquifers

In primary aquifers water moves through spaces formed at the same time as the geological formation was formed. Rainfall will infiltrate a primary aquifer until

Mountain slopes near Rawsonville in the Breede River valley showing sloping Table Mountain Group strata in sequence from right to left:
(1) Peninsula Formation – quartzitic sandstone;
(2) Cedarberg Formation – shale;
(3) Nardouw Subgroup, consisting of 3a) Goudini Formation – siltstone and reddish-weathering sandstone; and 3b) Skurweberg Formation – quartzitic sandstone.
(Photo: Umvoto Africa)

it reaches a rock or clay layer of low-permeability, a so-called aquitard. This may either trap or redirect the flow of the water. The Cape Flats aquifer is probably the best-known primary aquifer in the area, others include the Atlantis and Newlands aquifers.

Secondary aquifers

In secondary aquifers water moves through spaces formed after the geological formation was formed, such as fractures in hard rock. The secondary aquifers of the Peninsula and adjacent areas are associated with the previously discussed Table Mountain Group rocks that make up the Cape Fold mountains. The ridges and cliffs of the “folds” comprise the Peninsula and Skurweberg Formation sandstones; both formations are highly resistant to weathering. The troughs and gentler slopes tend to be siltstone and shale-bearing units.

The intense fracturing and faulting of the two quartzitic sandstone formations has endowed them with “secondary porosity”, which allows water to seep into the rocks through cracks in them. The water contained in these interconnected fracture networks is referred to as a “secondary aquifer”. The mechanical strength of these rocks means that the interconnected fracture networks are able to remain open to water percolation to depths of several kilometres. At these sorts of depths, water passing through the cracks is heated by the Earth, which is why the area around Cape Town boasts some of the world’s hottest and strongest thermal springs of non-volcanic origin. These include the Brandvlei Hot Springs near Worcester and the Citrusdal Baths near Citrusdal.

And so ...

The modern rivers and wetlands of the Peninsula and adjacent areas owe much of their beauty and diversity to the inherited physical template that has developed and evolved over the last 500 million years. While these modern rivers and wetlands modify the template through the actions of present day physical processes such as the movement of sediment and the creation of new floodplains, left untouched they are essentially a function of the action of water acting on the physical template. However, the spatial and temporal distribution of the water acting on them is also constrained by higher-level atmospheric processes. Similarly, the characteristics of the aquifers of the area are a function of their inherited physical template and the action of water on them. Direct and indirect human intervention has changed this situation. Rivers have been canalised, moved, filled in, concretised, and even created. Wetlands have been destroyed, modified and, in some instances, artificial ones created. These interventions and their effects are discussed in the remaining chapters.

Photo: Helen Dallas

"The river is a book. The rocks in the river are the pages in the book and the animals that live on the rocks, the words on the pages. We have to learn to read."

Dr Jackie King, Principle Researcher, Freshwater Research Unit, University of Cape Town, and Southern Waters' Associate Consultant

Chapter 3

Rivers as ecological systems

In much the same way as present-day hydrography is influenced by geological and geomorphological processes, climate and sea level changes, and human impact, the natural river fauna and flora are also determined by these influences.

The ecological character of a river is a product of a myriad of interrelated factors, such as size and topography, geology and derived soils, and the seasonal and long-term climate to which it is subjected. These factors work together, through mechanisms that are complex and for the most part poorly understood, to determine the flow pattern (hydrology), channel shape and arrangement (geomorphology) and biology of different parts of the river.

The rivers in Cape Town and much of the rest of the south-western Cape can be divided into six zones. Each of these zones is linked to those upstream by the unidirectional flow of water, materials and seeds, and, at times, by the bi-directional movement of animals.

The river continuum

Streams and rivers change naturally along their lengths with respect to temperature, depth, current speed, substratum, turbidity (clarity) and chemical composition. These factors are important determinants of the distribution of the animals and plants along the river course, and thus the longitudinal physical and chemical changes are reflected in changes in the composition of the animal and plant communities.[1] The result is a longitudinal biotic zonation that can be used to classify reaches of rivers. These zones are not discrete and attempts to define them in terms of a single variable have been unsatisfactory.

Generally speaking, however, the rivers in Cape Town and much of the rest of the south-western Cape can be divided into six zones. Each of these zones is linked to those upstream by the unidirectional flow of water, materials and seeds, and, at times, by the bi-directional movement of animals.

In general, biological communities form in a predictable fashion from a river's source to its mouth, based on the size and availability of organic matter in the system.[2] Thus, successive downstream communities process the so-called coarse particulate organic material (CPOM), the chief energy source of headwater streams, into ever-finer particles (FPOM). For instance, in the mountain-stream zone, leaf-fall is the primary source of food for river-dwelling animals. The large number of whole leaves falling from riparian trees results in these zones being dominated by species known as "shredders", which break-up or shred leaves. Further downstream, as the river widens and sunlight can reach the bed, the emphasis switches from "allochthonous" (from outside the river) to "autochthonous" (from within the river) food sources, such as algae. Because there are fewer leaves falling into the river, shredders are less important here and the community is dominated by species that scrape bacteria off the surface of rocks ("scrapers") or graze algae ("grazers"). In the lowland reaches of rivers, fine particulate matter suspended in the water column and deposited on the riverbed results in a community dominated by detritivores or filter-feeders. Interestingly, this is partly why alien trees such as oaks are damaging to local river systems. The timing and extent of their leaf-fall, and the nature of their leaves, are such that they cannot be properly "processed" by the indigenous stream communities.

Although longitudinal linkages dominate, lateral and vertical linkages are also at play, as surface water and groundwater interact.

Mountain source and cliff waterfall

The sources of the rivers in Cape Town and its environs often consist of boggy areas with sponge vegetation and humic turf (acidic soils rich in organic material). Outside the sponges, the flow is fast and occasionally torrential, often with waterfalls. The water is clear, although sometimes peat-stained, and levels of oxygen saturation are high. Mean summer water temperatures are below 20ºC.

1 Vannote *et al.* (1980), Davies and Day (1998)
2 Vannote *et al.* (1980)

Cascades over boulders in a Cape Town mountain stream – Hout Bay River, Hell's Gate (Photo: Tirmanmak Hiking Club)

Top: Cliff waterfall on Table Mountain (Photo: Gordon Richardson)

Opposite page top: Mountain stream in the Jonkershoek Valley, upstream of Stellenbosch. (Photo: Helen Dallas)

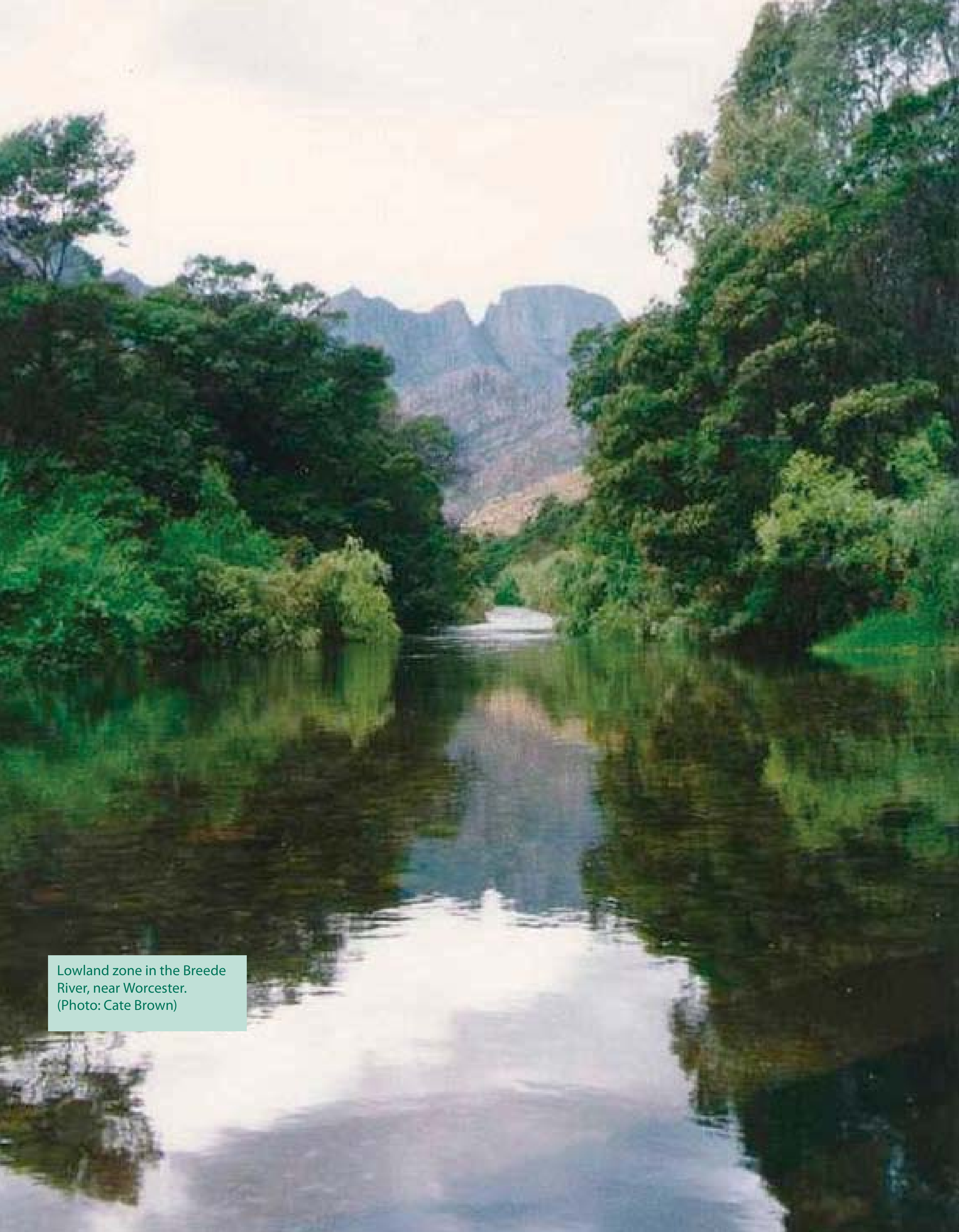
Opposite page bottom: The foothill zone of the Lourens River in Somerset West. (Photo: Cate Brown)

Mountain-stream zone

Mountain streams are characterised by narrow, defined channels with steep gradients, often with small waterfalls and rapids. There may be occasional rock pools. The substratum consists of boulders, bedrock and cobbles, and flow is generally fast through riffle sections (shallow flow over cobbles) and slow in pools. The riparian trees may or may not form a closed canopy over the stream. Deposition of inorganic sediments is negligible and the surfaces of rocks and vegetation are virtually free of algal growth. The water is clear except during spates, when the rivers may become muddy torrents. Mean summer water temperatures are around 20ºC.

Foothill zone

River foothills are zones of widening channels, decreasing bed gradient and lower flow velocities. The substratum consists of boulders and cobbles. Stony riffles and runs alternate with rock pools. Although there are still riparian trees, the river is wider and, because of this, the canopy is usually open. Turbidity is variable but usually low. Summer mean temperatures are above 20ºC.



Lowland zone in the Breede River, near Worcester. (Photo: Cate Brown)

Transitional zone

Transitional zones are usually zones of single, but occasionally multiple channels with a mixture of cobbles, sand and bedrock. Stony riffles, deep runs and deep backwaters dominate and there is usually a dense band of marginal vegetation on the riverbanks. The belt of riparian trees is often narrow and the canopy is open. Turbidity is variable and mean summer water temperatures are above 20°C.

In Cape Town, this standard definition of the transitional zone has been expanded to include the wetland transitional zone. This is a low-gradient mixed-bed alluvial zone with trickle flow through wetland vegetation. Many of the rivers of the Cape Flats are in the wetland transitional zone and, in the past, probably comprised a complex array of terminal channels and wetland systems.

Lowland zone

The lowland parts of rivers have a shallow gradient, with areas of deposition alternating with stony reaches. The riparian vegetation consists of reed beds and a few trees. The water is often turbid and mean summer water temperatures are usually well above 20°C.

Estuary

River flow into estuaries is generally slow (especially in summer), but tidal flows through the mouth of the larger systems such as Zandvlei and Milnerton Lagoon can be significant when their mouths are open. Tidal fluctuations can vary from a few centimetres in a constricted system, to more than a metre after a flood. Salt marshes, reeds and sedges dominate the riparian vegetation. Salt marshes, especially, are tolerant of changes in salinity resulting from changes in river inflow and mouth conditions. Temperatures in the estuaries are governed by atmospheric temperatures and the ambient temperature of the nearshore marine environment. During upwelling events in the summer, the sea temperatures in the nearshore can be as low as 10°C. For example, the summer mean temperatures in an estuary in False Bay can vary from above 25°C in the upper reaches to below 15°C in the lower reaches when the estuary is open to the sea during an upwelling event.

Wetlands and vleis

In contrast to rivers, wetlands do not drain the landscape and are areas where water flows slowly or not at all. They therefore accumulate materials like soil particles and organic matter. Because wetlands reduce the rate at which water moves across the landscape, they provide a number of very important services to humans.[3]

- They tend to reduce the force of floodwaters because they absorb some of the water in their loose, organic, peaty soils. Those wetlands that are areas of reduced

3 Davies and Day (1998)

Diep River Estuary, Milnerton. (Photo: Gordon Richardson)

gradient also cause the water to spread out across the landscape rather than being channelled through river courses. The wetland plants such as reeds and sedges, and sometimes trees, further retard the rate at which water flows. The flood-prevention value of some wetlands in the United States of America (USA) has been estimated at about US$13 500 (approximately R100 000) per hectare per flood!

- They tend to cleanse the water passing through them because the reduced flow rates mean that particles (including bacteria) drop out of suspension, and the wetland soils and plants take up nutrients. Thus water leaving a wetland is often of much higher quality from a human perspective than it was when it entered. This is why wetlands are often constructed as a means of treating poor-quality water.
- Slowing the movement of water and spreading it laterally allows time for vertical infiltration into the substratum and ultimately into the groundwater. Many wetlands are thus said to aid in groundwater recharge.
- Peatlands, which are wetlands in which organic matter is stored in the soils, cover no more than 3% of the world's land area and yet they store almost 20% of the carbon stored in the Earth's soils. The vast majority of peatlands occur in the tundra of the far northern hemisphere.[4]

Cape Town used to be rich in wetlands of various kinds: coastal lakes such as Zeekoevlei[5] and Rondevlei[6]; a huge estuarine delta at the mouths of the Salt, Black

4 Maltby (1991)
5 Harrison (1962), Hutchinson *et al.* (1932)
6 Hutchinson *et al.* (1932)

Wetlands at Dolphin Beach, Milnerton (Photo: Jenny Day)

and Diep rivers[7]; extensive seasonally inundated marshes in the rather indefinite lower courses of Cape Flats rivers such as the Black, Kuils, Eerste and Lourens; mountainside seeps on the steep eastern slopes of Table Mountain; and hundreds and hundreds of depressions that fill with water in winter to form a mosaic of land and water. Should anyone doubt this to have been the case, a glance at the names of the erven on the Cape Flats will show that almost all of them had the word "vlei" in the name: Swartvlei, Blouvlei, Diepvlei, Moddervlei, Rietvlei and – as if pointing out that they were not wet year-round – Tumbleweed Vlei.

Many of these seasonal vleis become (or became) inundated in winter as a result of the rise of the water table above the surface of the soil. They form a fairly unusual wetland type that has become extremely rare over the last few decades as a result of developments for housing and commercial enterprises. A number of species of small wetland crustaceans were first described from these systems. One crustacean expert was G.O. Sars, a remarkable Norwegian biologist, whose correspondents in the Cape sent him packets of dried mud from the bottoms of dry seasonal ponds. When he received the mud, he would wet it in an aquarium and study the specimens that hatched. Several of the species that he described were from localities such as "brickworks at Durbanville", "vlei at Bergvliet" and "Greenpoint Common". These species probably became extinct before anyone other than Sars ever saw them.

Some seasonal vleis still exist, in the centre of Kenilworth Racecourse, for instance,

7 Barbier (1786)

Retreat Vlei – there in 1960 – gone by 2000. (Cape Argus, 1 October 1960)

and at Cape Point. As an aside, the racecourse is one of the most important areas for biodiversity conservation in general in Cape Town. Many vleis on the Cape Flats are now under Khayelitsha and, if built, the proposed film studios near Faure will eliminate or irreversibly alter many of the best remaining vleis. A more positive note can be sounded though with regard to a small vlei with the unattractive name of Moddervlei (also called Middelvlei on some maps). Moddervlei, in the grounds of the Rondevlei Bird Sanctuary, was covered over by several metres of sand when the Rondevlei Canal was built in 1959. In an attempt to restore it as a wetland, uncovering of the vlei began in 1994 and carried on throughout the late 1990s. By 2000, the seeds of several species of wetland plants had germinated and Moddervlei became a pretty, and functional, seasonal wetland. Subsequent surveys have shown it to be of rarity value and botanically quite different from the adjacent Rondevlei.

Flow regimes and flooding

Rivers

The flow regime of a river consists of several different kinds of flow, each of which contributes to the river's overall maintenance. Naturally a river exists in a state of dynamic equilibrium, able to respond to seasonal and annual fluctuations in climate because its species have different tolerance ranges and so differ in their abundances as

Boys tubing down the Liesbeek River in flood (Photo: Gordon Richardson)

conditions change. Thus, at any time there is a mix of species that can cope efficiently with prevailing conditions, while other species may be present in lower numbers or surviving as, for instance, eggs, seeds or spores, until more suitable conditions occur. In the natural situation, the mix of species and numbers of individuals present usually result in assemblages where no single species proliferates to pest proportions.[8]

Manipulations of flow regimes represent unnatural disturbances to rivers. These disturbances increase in severity the further the flow regime is altered from the realm of what is natural for that system. Responses of rivers to flow manipulation can take many forms. For instance, hydrological cues that trigger fish spawning or seed germination may occur at the wrong time of the year or not at all, resulting in individuals of affected species perhaps failing to reproduce. Seasonal reversal of wet- and dry-season low-flows could mean that hydraulic and thermal conditions become mismatched with life-cycle requirements, again causing populations of some species to decrease in abundance. Other species, many seen as pests, are often able to take advantage of such environmental conditions, or the weakening of competition from the affected species, and increase in abundance.

In temporary or seasonal rivers, and in wetlands, the dominant role of subsurface flow or groundwater, and its relationship with surface flow, complicates the response of these systems to flow manipulations. Perennial systems flow year-round because of groundwater inflows. Groundwater systems contribute to rivers and wetlands as baseflow long after rains have passed and surface waters have dried up. In the drier parts of the Western Cape, the surface flows in many rivers are seasonal or episodic, and groundwater is the major source of water for humans and nature. These flows also sustain seemingly isolated pools between rainfall events and support the vegetation along river corridors.

"In real terms, floods are good. Cyclones are good. They play a good role ecologically. What makes them disasters are vulnerable people."

Ms Paula Zucula, Head: National Disaster Management Institute, Mozambique

8 Brown and King (2002)

Estuaries

A typical gauging plate attached to a Department of Water Affairs gauging weir, where continuous records of the flow in the river are kept for use in water resource management and planning. (Photo: Cate Brown)

Ecological processes in estuaries occur along gradients of salinity and other water quality features, and are influenced by river and seawater inflows. Because seawater is denser than fresh water, water entering from the rivers usually forms a layer of fresh water over the heavier seawater. Therefore the deeper water of an estuary may be saline, while the upper layers are fresh, or nearly so. The degree of stratification may be influenced by the wind, to the extent that the estuary could be completely mixed, such as occurs at Zandvlei. The duration and frequency with which the estuary is open to the sea depends on river flows, the state of the tide, the degree of mouth protection and the size and shape of the system. These factors influence the numbers and types of estuarine plants and animals that occur in an estuary, and hence its overall condition.

Increased freshwater inflow, due to sewage discharges and runoff from hardened catchments, has altered the mouth status (prolonged the periods of open mouth conditions) and the salinity gradients in estuaries. Reduced flooding leads to less scouring, so an estuary may silt up and the mouth remain closed for longer periods than is natural, thus changing the connectivity with the marine environment, the salinity gradients, and ultimately the animal and plant species that live there. Extended periods of mouth closure, coupled with sustained low river inflow, lead to estuaries becoming progressively fresher. Conversely, where the mouth remains open, reduced flow can result in an estuary becoming more saline.

Chemistry

Under natural conditions the waters of most rivers and vleis in the south-western Cape are pure and acidic, and they are often also darkly peat-stained. They are pure (very low in dissolved solids) because of the rocks over which they flow and from which the groundwater flows. The sandstones of the Table Mountain Series are ancient - about 500 million years old - and the sediments that formed them all that time ago were also ancient. During the millennia, water leached the soluble minerals from them so that nowadays the rocks are little more than inert quartzite. The only major ions present in any significant concentrations are sodium and chloride, which are provided by rain water. The water is acidic and darkly stained because of the surrounding fynbos vegetation. Many fynbos plants produce large quantities of tannin-like organic compounds that leach from dead plant litter. These compounds are highly acidic (periodic measurements by the Freshwater Research Unit at the University of Cape Town indicate a range in pH values from 3.6 to 4.7 in Window Stream in Kirstenbosch), and impart a dark colour when dissolved in water. Interestingly, everyday tea is dark brown and acid for the same reason: the presence of tannin-like organic acids. It is not surprising, then, that the fynbos produces rooibos and honeybush teas of its own. These peat-stained waters are soft and taste good. Until the 1950s or so, the water coming out of Cape Town's taps was a beautiful clear brown colour, rather like Coca Cola. Sadly, though, the acidity is corrosive of pipes and so the organic material is now removed before the water is piped to our houses. The water supplied to Cape

Kirstenbosch Botanical Gardens (Photo: South African Tourism)

Town residents was clarified from about 1950 when the Steenbras Filtration Plant started operating. (Brown water was a feature in Hermanus until 1975.)

Lack of leachable minerals is also reflected in the minor constituents found in the water. Nutrients such as nitrogen and phosphorus are usually limiting, in the sense that they are present in such low concentrations that their lack limits plant growth. And, as any gardener in the south-western Cape will know, many untended plants show signs of deficiency of trace elements such as copper and manganese.

Not all natural waters are low in salts. Waters in contact with Malmesbury Shales tend to have higher concentrations of dissolved solids, while seasonal vleis such as the Noordhoek Salt Pan (now Lake Michelle) are, or were, highly saline.

The effects of humans on water chemistry can be profound. Stormwater runoff contains all manner of chemicals, from nutrients to heavy metals and other toxins, as well as bacteria. Stormwater entering aquatic ecosystems can thus alter the very nature of the water and can ultimately result in the replacement of the natural assemblage of plants and animals with another, more tolerant, assemblage. This is one of the reasons (flood abatement being the other) for creating detention ponds, which hold stormwater for long enough for some of the pollutants and sediment particles to settle out. Runoff from agricultural and suburban lands contains nutrients, herbicides and insecticides and may contain other agrichemicals such as hormones and antibiotics. Purified sewage return flows contain high concentrations of nutrients, as well as some pathogenic bacteria and viruses. Furthermore, many rivers and vleis now receive water that has been contaminated by human waste from informal settlements and from dysfunctional sewage systems.

Phosphorus as a limiting nutrient

Phosphorus is a key component of the molecule commonly known as ATP (adenosine triphosphate) – the molecule that provides the requisite energy for cellular activity. Accordingly, phosphorus is a major limiting factor to life, both in water and on land. Phosphorus does not exist in nature in its elemental (P) form, but rather as one or other form of phosphate. Phosphorus cycles and recycles through organic (living) and inorganic (non-living) matter.

Phosphorus is not a toxicant, but a naturally scarce and life-supporting element that, when present in oversupply (eutrophication), results in biological overgrowth. Its effective management and control, especially in shallow lakes and vleis, can reverse or prevent this process.[9]

The deleterious impact of the disposal of phosphate-rich effluents on vleis and rivers first became evident during the 1950s and is now recognised as a global threat to water quality, ecosystem health and the recreational use of rivers and vleis.

Riparian vegetation

The adjective "riparian" generally refers to the shores or banks of rivers, ponds, vleis and wetlands. Though the riparian zone occupies a small area in relation to the greater catchment area, its influence on the surrounding landscape, mostly through its vegetation, is great.[10]

Riparian vegetation stabilises banks, affects the flow of the river, drops leaves and other organic material into the river, acts as a buffer that protects the river from sediments, fertilisers, pesticides and other matter draining downhill through the catchment, and provides food and shelter for people and wildlife. Riparian zones are naturally disturbed by floods, which open up spaces on the banks, and are thus vulnerable to invasion by alien plants.

The rivers of Cape Town mainly arise in the sandstone mountains of the Cape Peninsula and the Hottentots Holland. The influence of geology on the vegetation is emphasised in the modern names given to the types of vegetation, namely Peninsula Sandstone Fynbos (found along the Elsjes, Hout Bay, Klaasjagers, Klawersvlei, Liesbeek, Platteklip and Silvermine rivers) and Kogelberg Sandstone Fynbos (found along the Eerste, Lourens and Steenbras rivers). The Diep River rises in the Boland Granite Fynbos of the Perdeberg, while the Mosselbank, Kuils and Elsieskraal rivers arise in the Swartland Shale Renosterveld of the Tygerberg. A few rivers, such as the Black and Lotus rivers, start as marshes on the Cape Flats in azonal Cape Lowland Freshwater Wetland vegetation.

Marshes are frequently found in the mountains at the source of rivers where runoff from the surrounding slopes collects before forming streams. These are Restionaceae-dominated marshes, typically with low, matted hummocks of *Anthochortus crinalis*,

9 Harding (2000)
10 Rienecke *et al.* (2007)

A high altitude wetland in the headwaters of a river sourced in the Hottentots Holland Mountains. (Photo: Charlie Boucher)

or tall, dense, erect-stemmed stands of *Chondropetalum mucronatum*. Rare species, particularly geophytes such as ground orchids, Ericaceae and Proteaceae, are often found in association with these marshes, which are sometimes relics of geologically wetter periods. The white swamp daisy (*Osmitopsis asteriscoides*) is a characteristic, aromatic-leaved emergent shrub of these sandstone marshes found from high to low altitudes.

Waterfalls at the edges of the high-altitude sandstone plateaus support a fascinating flora, which benefits not only from moisture in winter and summer cloud, but also from spray from the waterfalls. Reversal of flow by updraughts is an extreme form of water recycling that is quite common in the windy Cape. Annual pilgrimages are made in January to March each year to view the magnificent red ground orchid, the so-called Pride of Table Mountain (*Disa uniflora*), in flower in this specialised habitat. The extremely localised (its rarity status is vulnerable) mauve-flowered Cape Gloxinia (*Charadrophila capensis*) occupies this same habitat in the headwaters of the Eerste River at Jonkershoek.

The Pride of Table Mountain (*Disa uniflora*) occupies a specialised habitat near waterfalls, where it benefits from water laiden updraughts. (Photo: South African Tourism)

Zonation of the riparian vegetation

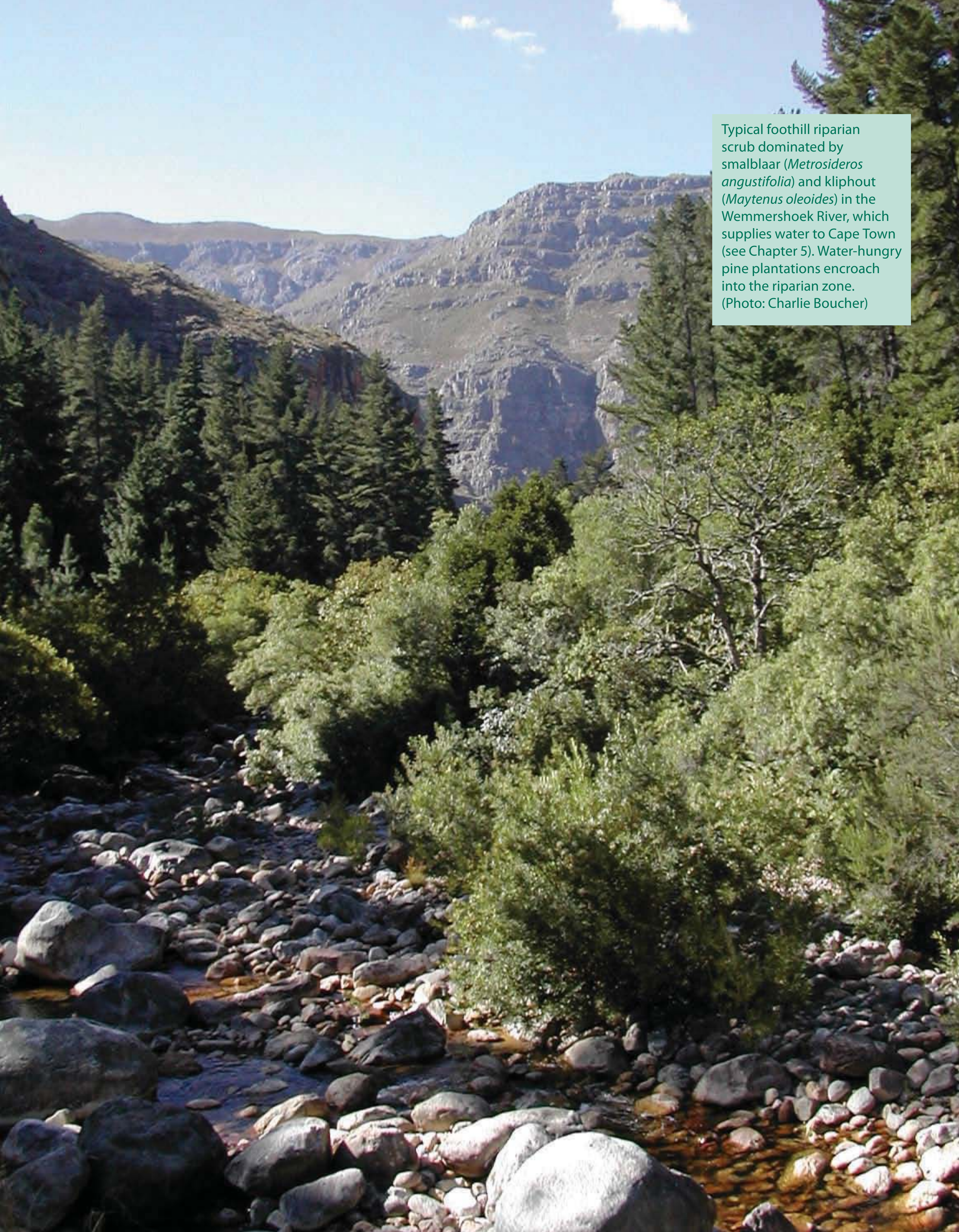
Headwater and mountain streams

The rocky headwater streams are characteristically lined by gnarled smalblaar (*Metrosideros angustifolia*), willowy yellow-flowered *Gnidia oppositifolia* and wiry Restionaceae such as *Ischyrolepis subverticellata*. The wild almond (*Brachylaena neriifolia*) is commonly found along the Hottentots Holland mountain streams. Surprisingly, on the Cape Peninsula, it is restricted to the Silvermine River.

At the foot of the waterfalls and in the narrow kloofs, for instance, above Kirstenbosch and Hout Bay, remnant forests can be found with the red alder (*Cunonia capensis*), witels (*Platylophus trifoliatus*) and yellowwood (*Podocarpus elongatus*). This is where the early Dutch settlers came to collect wood for buildings.

Foothills

The foothill zones of the rivers are typically boulder-strewn and the vegetation lining them must be strongly rooted to withstand the rapidly flowing water. Here wild almonds (*Brabejum stellatifolium*), palmiet (*Prionium serratum*) and the water heath (*Erica caffra*) lend variety amongst dense stands of smalblaar.



Typical foothill riparian scrub dominated by smalblaar (*Metrosideros angustifolia*) and kliphout (*Maytenus oleoides*) in the Wemmershoek River, which supplies water to Cape Town (see Chapter 5). Water-hungry pine plantations encroach into the riparian zone. (Photo: Charlie Boucher)

The Kuils River passing through Khayelitsha (Photo: Rembu Magoba)

Transitional and lower rivers

The transitional zone sees the start of patches of the attractive pale-yellow-flowering *Freylinia lanceolata* lining the rivers such as the Eerste and the Lourens, which drain the eastern mountains forming the limits of Cape Town and its environs. Along the transition from foothills to flats are typical riparian forest trees, such as those Simon van der Stel would have encountered during his first overnight stay in Stellenbosch. These are wild almonds (*Brabejum stellatifolium*), Cape holly (*Ilex mitis*), wild peach (*Kiggelaria africana*), sybas (*Maytenus acuminata*), river yellowwood and mountain cedar (*Widdringtonia nodiflora*).

Estuaries

The estuaries of Cape Town have generally been modified and do not function as they did before European settlement occurred (see Chapter 6). The vegetation in these estuaries, and the estuary remnants, has also changed. Back-flooding, previously associated with extended mouth closure (sand bars build up and close off direct connection with the sea), no longer takes place in most estuaries because the bar is either opened as soon as a head of water develops or increased flow from wastewater treatment works and stormwater discharges keeps the mouth open through the dry season. This happens at the Diep, Eerste and Zeekoevlei estuaries, where the ponding into large water bodies during the summer months does not occur anymore. In most of the estuaries of Cape Town, the available water column habitat (surface area and depth) for estuarine biota, such as fish, has been severely reduced and, in general, overall estuarine productivity has declined dramatically. Lower salinity levels have decimated the saltmarsh vegetation, and the absence of back dune lakes has resulted in terrestrial vegetation taking over where saline wetlands were previously found.

The influence of geology

Rivers with their origins in Malmesbury Group shales or that flow through shales or calcareous sands on the Cape Flats collect nutrients from the surrounding substrates. Fringing reed beds then become the norm. Rietvlei, at the mouth of the Diep River, is named after the copious stands of reeds (probably *Phragmites* sp.) that lined the vlei's banks in van Riebeeck's time.[11] The Eerste River differs from the rest of the rivers in Cape Town and its environs in that it is densely lined with a subspecies of Cape willow, namely the silver willow (*Salix mucronata* subsp. *hirsuta*). This species, which has been recorded from streams and swamps in the Hout Bay valley, is now thought to be extinct on the Cape Peninsula. It is, however, still commonly found along the Olifants River in the Cedarberg. Bulrushes (*Typha capensis*) regularly form dense stands in the marshes fringing the slow-flowing rivers of the Cape Flats where finer sediments accumulate. Here they tend to block the waterways such as the Diep and Kuils rivers, and are often cleared to prevent flooding. Highly saline environments are effectively arid to plants even when they are wet. Thus van der Stel records that the banks of the Diep River at Malmesbury, with its saline lowflows, supported a dense cover of thorn trees[12], which are virtually absent today because they were a good source of firewood. We associate thorn trees with rivers in arid areas such as in the adjacent Succulent Karoo Biome.

Invasion by alien species

One of the prime areas where woody aliens have spread is along riverbanks. This habitat used to be well-wooded but, as we read from van Riebeeck and van der Stel's journals, wood for home cooking and for burning in the brick-making industry rapidly became in short supply as colonisation progressed. Van Riebeeck records that the twisted wild almond trees lining the Varsche and Liesbeek rivers was one of the first species to be used for firewood by the settlers.[13] Thus one of the first introduced trees was the pine imported by van Riebeeck shortly after his arrival here to provide firewood and building material.

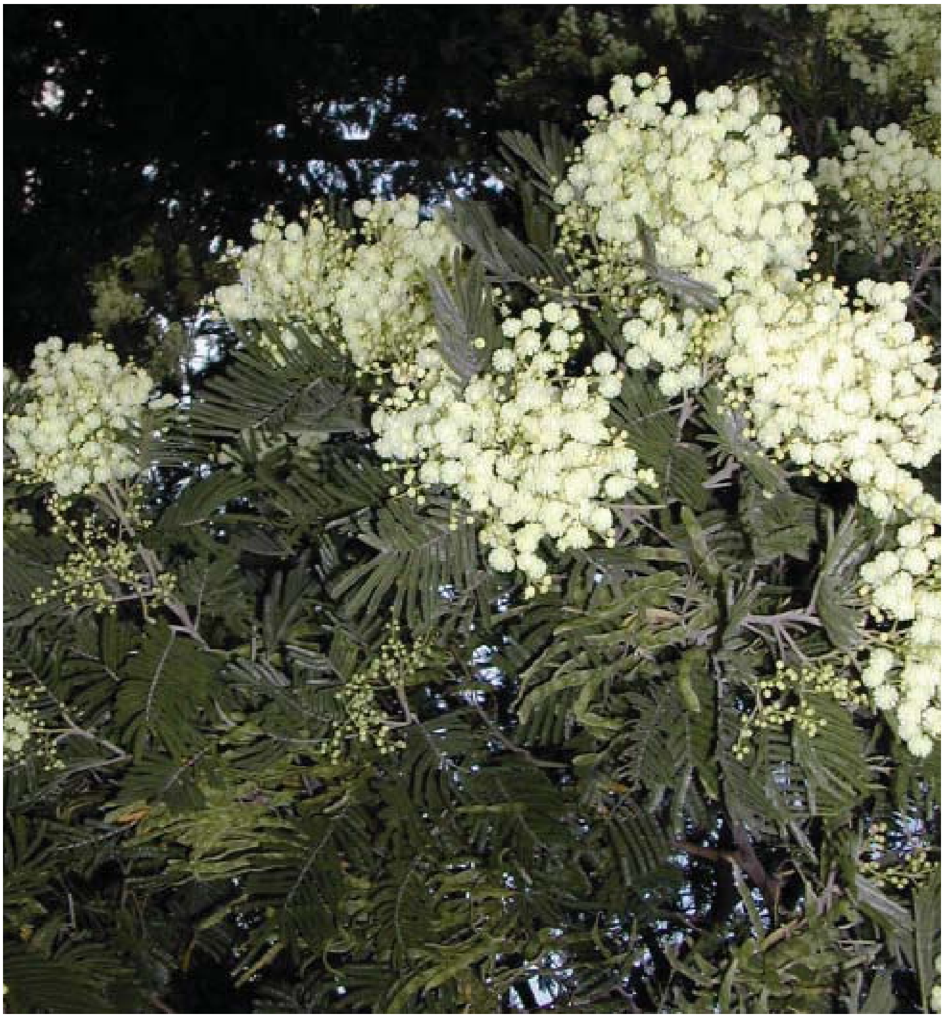
Early records suggest that the long-leaved wattle (*Acacia longifolia*), together with some other invasives from Australia, were first introduced into South Africa in 1827.[14] Currently the most common invader of Western Cape rivers is the black wattle (*Acacia mearnsii*), closely followed by the long-leaved wattle (*Acacia longifolia*) and the river gum (*Eucalyptus camaldulensis*). It has been suggested that the black wattle, as the most abundant and widespread invader of virtually all of the rivers of Cape Town and its environs, has probably caused the greatest direct loss of riparian biodiversity[15], while the river red gum (*Eucalyptus camaldulensis*) and the grey poplar (*Populus x canescens*) are known to be particularly wasteful of water.

A study of exotic weeds along these rivers shows a direct relationship between

11 Thom (1954)
12 Waterhouse (1932)
13 Thom (1954)
14 Shaughnessy (1980), Stirton (1978)
15 Versfeld (1995)

The long-leaved wattle (*Acacia longifolia*) was first introduced into South Africa from Australia *circa* 1827. (Photo: Charlie Boucher)

The black wattle (*Acacia mearnsii*) is the most widespread invader plant along the banks of the rivers of Cape Town and its environs. (Photo: Charlie Boucher)



a source of introduced garden plants along a river and the number of exotic species found. The Eerste River, for example, supports at least 174 species of riparian plants of which 32% are exotic.[16]

Runoff from catchments with dense stands of aliens is about 30% and 80% lower than for uninvaded fynbos[17], with the variation due to differences in annual precipitation and the age and density of the alien vegetation stands. During the dry summer months, when water needs are greatest, runoff in invaded catchments may be reduced to zero, converting perennial streams to seasonal ones. Cost-benefit analysis showed that the major costs of clearing alien trees and shrubs are warranted.[18] This was a prime motivation behind the introduction of the highly successful national Working for Water programme.

The water hyacinth (*Eichhornia crassipes)* forms dense mats that completely block waterways. (Photo: Charlie Boucher)

Invasives of water bodies

Aquatic invasives are regularly associated with escapes (or releases!) from fish ponds and aquariums where they have been used for aesthetic purposes or to provide habitat for the fish to shelter, breed or eat. It is therefore not so surprising to find that an aquatic invasive moss (*Fontinalis antipyretica*) was introduced along with trout into the Eerste River and has spread to the Breede and Palmiet rivers.

Stephens[19] provides us with an early report about the problem of invasive waterweeds, noting that water hyacinth (*Eichhornia crassipes*) formed a dense covering over Langvlei in the years 1926–1929. Today we know that invasions by this problem plant in the Western Cape are associated with the nutrient enrichment of our waters. This continuing problem could best be tackled by reducing the nutrient-loading before the water is added to our rivers and vleis.

A list of aquatic weeds found in South Africa would be very similar to a list of those found in the rivers of Cape Town as birds carry seeds and pieces of plants from place to place. No precise quantification of these aquatic invaders through the rivers of Cape Town has been done to date, probably because of their seasonal and annual variability. Certainly, mechanical clearing of the water hyacinth from canals and rivers such as the Berg, Black, Breede, Diep and Kuils rivers has proven to be extremely costly and biological control has so far not been especially successful. The Agricultural Research Council, DWAF and various tertiary institutions continue to study this species in an effort to understand the patterns of invasion, and what makes it so successful

16 Hence we should take far more care of which plants we use in our gardens. A clear call to "go indigenous" to save our river flora!

17 Burgers *et al*. (1995)

18 van Wilgen *et al*. (1996)

19 Stephens (1929)

Crocothemis Erythraea on *Micranthus Junceus* (vleiblommetjie or comb flower). (Photo: Geordie Ractliffe)

in our waters. Today, an integrated approach, which combines mechanical, manual, chemical and biocontrol methods, is advocated to control water hyacinth.

Aquatic invertebrates

Aquatic invertebrates are the small backboneless creatures that inhabit rivers, vleis and wetlands. They, together with the microbes and the fishes and frogs and so on, make the river a living entity. For this reason alone, their presence is necessary in every river. They are useful to humans in other ways too, however. Firstly, and most importantly, many of them feed on material such as dead leaves, live or decaying animal material, and fine particles such as sediments and bacteria. In this way they assist the decomposer bacteria in maintaining water quality. Secondly, they are particularly useful indicators of the biological integrity and water quality of rivers because they reflect antecedent as well as current physical and chemical conditions. Thirdly, they contribute to biodiversity.

We know that the plants of the fynbos biome, in which Cape Town is located, are so rich in species, and so many are endemic, that they form "the world's littlest floral kingdom". What is less well-known is that, area for area, the aquatic fauna, particularly the invertebrates, is even richer in species than the flora. For this reason alone, and given the requirements of the Convention on Biodiversity (to which South Africa is

RAPID BIO-ASSESSMENT

Aquatic invertebrates require specific habitat and water quality conditions. If the conditions change, the mix of invertebrate species will also change. This makes them good indicators of recent localised conditions in a river and they are used routinely to monitor rivers in South Africa (see National River Health Programme in Chapter 6).

a signatory), it behoves us to protect the rivers and wetlands that are home to the aquatic "goggas".

The dynamics of the invertebrate populations inhabiting different river reaches are determined by the available habitats and prevailing flow conditions. In mountain streams, for instance, natural disturbance is high and unpredictable and the landscape is erosional, producing assemblages with completely different life-history strategies from those inhabiting the lower reaches, which have relatively low disturbance regimes and depositional landscapes.

Common Blue tail (*I, Senegalensis*), Cape Point. (Photo: Cliff Dorse)

The upper reaches of Western Cape rivers have diverse arrays of hydraulic habitats, highly unpredictable hydrological regimes and diverse invertebrate faunas, relative to the lower reaches of the region's rivers. Furthermore, in the south-western Cape, the aquatic biotas most likely to be endemic and to be sensitive to changes in water quality and quantity are generally those that inhabit the upper reaches of rivers, that is, the source, mountain-stream and foothill zones.

Many animals have life cycles that involve exploiting a variety of river habitats during their life stages. For instance, fish commonly spawn in one part of their habitat, such as riffles, use a different part as a nursery area, such as backwaters, and then disperse into a third area such as deep pools for adult growth. Similarly, during its life cycle a particular species of mayfly may use the marginal vegetation and different areas of coarse sediment in fast-flowing sections of the river before emerging from the water in its flying stage.

Catchment signatures

The work of Drs Jackie King and Denise Shael in the early 2000s[20] provided insight into just how unique the make-up of riverine invertebrate assemblages can be. They showed that communities displayed strong catchment signatures and, within catchments, strong river signatures, with regard to diversity and density of invertebrates, which over-rode expected similarities between mountain-stream reaches and foothill reaches. They suggested that "all rivers may be different from one another in ways as yet not understood".

Investigation of the characteristics of the invertebrate data that produced catchment signatures revealed that there was no one over-riding cause. It was concluded that the signatures were not caused by unique species within each catchment or by a unique mix of taxa in each catchment or by unique proportions of the same set of taxa within each catchment. Instead, the signatures were caused by subtle changes of species representing each major taxon group. It does not appear that any one single environmental driver is responsible for the catchment signatures. Rather, these appear to be the result of complex interactions of many variables over geological time.

20 King and Shael (2001)

Fish

Indigenous fish

Somewhat surprisingly, Cape Town and its surrounding areas are characterised by a low diversity of indigenous freshwater fish. Only three indigenous primary freshwater fish species have been recorded within its boundaries. These are the Berg River redfin (*Pseudobarbus burgi*), Cape galaxias (*Galaxias zebratus*) and Cape kurper (*Sandelia capensis*).

The Berg River redfin became extinct several decades ago in the Eerste River, its only home within Cape Town and Stellenbosch, as a result of the predatory impacts of the alien rainbow trout (*Oncorhynchus mykiss*).

The tiny Cape galaxias (maximum size six centimetres) is widespread in the rivers and permanent wetlands of the area, especially in habitats with good water quality that have few or no alien fish. The genetic study by Dr Wishart[21] suggests that the one species currently recognised, may well in fact be five species. Genetically unique populations are found in the Silverstroom (near Melkbosstrand), Lourens, Hout Bay, Klaasjagers and Diep rivers (see Biodiversity and endemism).

The larger Cape kurper (maximum size 12 centimetres) is less widespread and is found primarily in the lower reaches of rivers. It is also less genetically diverse than the Cape galaxias. Sizeable populations of Cape kurper are found in the Hout Bay, Diep and Eerste rivers.

Several indigenous fish species that are dependent on fresh water for part of their life cycles, such as freshwater mullet (*Myxus capensis*), longfin eel (*Anguilla mossambica*) and estuarine round herring (*Gilchristella aestuaria*) are also found occasionally in the lower reaches of the rivers of the area.

Alien fish

In 1898, a circular from the Canadian Department of Agriculture received by that of the Cape of Good Hope warned against the introduction of carp (*Cyprinus carpio*) saying that they changed clear running waters into "disgusting puddles".[22] Despite this warning, carp were bred and distributed by the Jonkershoek hatchery from 1900 to 1921 whereupon legislation was passed to control the spread of what had become a noxious species.

Other popular angling species such as rainbow trout, brown trout (*Salmo trutta*), largemouth bass (*Micropterus salmoides*), Mozambique tilapia (*Oreochromis mossambicus*) and banded tilapia (*Tilapia sparrmanii*) were also bred at provincial government hatcheries for stocking local waters. Even the sharptooth catfish (*Clarias*

21 Wishart *et al.* (2006)
22 Harrison (1959)

CATCHMENT SIGNATURES IN THE VEGETATION

Recent studies by Karl Rienecke* showed that the riparian plant communities also display catchment, river and zone signatures. In other words, the mix of plant species at any point along a river is more similar to other points on the same river than similar positions on another river.

* Rienecke *et al.* (2007)

Cape galaxias (*Galaxias zebratus*) (Photo: Sean Marr)

gariepinus) were legally stocked into several waters in the Cape Flats by the Cape Department of Nature Conservation (now CapeNature).

Government stocking programmes reached their peak between 1940 to 1980 when thousands of alien fish were released into local waters to cater for angling needs. These programmes were halted in the mid-1980s in recognition of their devastating effects on freshwater ecosystems. However, illegal stocking of alien fish by anglers and riparian landowners continues to be a major problem.

Today species like carp (*Cyprinus carpio*), mosquito fish (*Gambusia affinis*), Mozambique tilapia and banded tilapia are found in most rivers and dams, but anyone angling in one of the rivers or numerous dams within Cape Town and Stellenbosch is likely to catch any one of seven alien fish species that are common in its waters.

The ecological impact of this alien fish invasion is massive, both in extent and severity. They compete with indigenous fish for food resource, impact on water quality and clarity, and prey on the small indigenous fish. Carp, for instance, frequently cause clear dams and rivers to go muddy (as was warned so long ago by the Canadians) and where the major predators such as largemouth bass or sharptooth catfish are common, indigenous fish are invariably rare or absent.

Alien fish species recorded in inland waters of Cape Town and Stellenbosch (CapeNature)

Common name	Species	Origin and impact on local fishes
Banded tilapia	*Tilapia sparrmanii*	Indigenous to other provinces, aggressive, competitor for food
Carp	*Cyprinus carpio*	Eastern Europe and Asia, competitor, degrades habitat
Largemouth bass	*Micropterus salmoides*	USA, predator
Mosquito fish	*Gambusia affinis*	USA, competitor
Mozambique tilapia	*Oreochromis mossambicus*	Indigenous to other provinces, aggressive, competitor for food
Rainbow trout	*Oncorhynchus mykiss*	USA, predator
Sharptooth catfish	*Clarias gariepinus*	Indigenous to other provinces, predator

Anglers, however, value the alien fish as indigenous fish are too small for angling. So it is the alien fish that support substantial recreational fisheries in waters like Zeekoevlei and Zandvlei. These and other waters also support subsistence fisheries, which have grown significantly in value over the last decade.

Other threats to indigenous freshwater fish

Urbanisation has placed severe pressure on rivers and wetlands. The resultant loss and fragmentation of habitat, abstraction, pollution and infestations of alien plants have added to the demise of the indigenous fish populations in parts of Cape Town and Stellenbosch. The fish are a vitally important component of the biodiversity and ecological functioning of the rivers of Cape Town and Stellenbosch. Each species plays a fundamental role in the structure and functioning of a river's food web. Studies by Dr Steven Lowe of the South African Institute of Aquatic Biodiversity on the Witte River in Bainskloof have shown that once indigenous fish species disappear from parts of a river, there are substantial shifts in the structure and functioning of aquatic invertebrates, with knock-on effects through the entire ecosystem[23].

Fishy success stories

There are some success stories. Three recent such stories involved the use of the piscicide, Rotenone, to eradicate carp, bass and banded tilapia from dams at Die Oog, Tokai and in the Tygerberg and Helderberg Nature Reserves. The dam on the Helderberg Nature Reserve was subsequently stocked with Cape kurper from the Lourens River, where the species is now rare because of pollution pressures, and will hopefully play a positive role in the recovery of this population in the Lourens

23 Dr Steven Louw, South African Institute of Aquatic Biodiversity, personal communication

A typical healthy fish catch from a local estuary, with the fish assemblage comprising Cape moony, estuarine roundherring and mullet juveniles (Photo: Steve Lamberth)

River valley. Similar procedures have been employed at Paardevlei (Somerset West) and Blouvlei (Century City). In recent years, however, the effect of wider use of this poison in our rivers and vleis has raised considerable alarm among residents in Cape Town and further afield, and other methods of achieving similar aims are being investigated.

Estuarine fish

The range of benefits and habitats provided to fish by estuaries is considerable, exceeding those of coral reefs, tropical forests and most other ecosystems.[24] Benefits provided by estuaries include high productivity, low predation, low salinities, and refuge from adverse conditions in the marine environment such as low temperatures or oxygen levels – thus improving body condition, growth and/or survival.[25] The southern African coast, from the estuaries to the edge of the continental shelf, is

24 Whitfield (1994), Costanza *et al*. (1997)
25 de Decker and Bennett (1985), Potter *et al*. (1990), Robins *et al*. (2006)

Zandvlei (Photo: Gordon Richardson)

home to about 2000 species of fish.[26] Estuaries are host to 150 of these, of which about 80 are commercially exploited.[27]

Estuarine-associated fish vary in their degree of estuarine dependency ranging from fish that are resident in estuaries, to those that are obliged to spend at least their first year in estuaries, to marine and freshwater species whose occurrence in estuaries is incidental and largely governed by salinity tolerance.[28] There are many factors influencing the abundance and diversity of fish in an estuary, including latitude, seasonality, size, salinity, habitat diversity, mouth condition, oxygen levels, turbidity, food resources, flooding and anthropogenic impacts.[29] The impacts can be direct, such as pollution, dredging, bait collection, marina development and fishing; or indirect, such as upstream impoundments, water abstraction and marine fishing. Impoundments trap sediment, reduce freshwater flow and obstruct the upstream migration of catadromous (move between rivers and the sea) species such as eels in the south-western Cape. Overexploitation in the marine environment will reduce recruitment of estuarine-associated species into estuaries. The response of estuarine fish assemblages to environmental and ecological change makes them good indicators of anthropogenic stress.[30]

In South Africa, estuarine fish diversity increases and productivity decreases as one moves eastwards from the upwelling-fed, nutrient-rich waters of the cool temperate West coast to the mostly oligitrophic (nutrient-poor) waters of subtropical KwaZulu-Natal.[31] The estuaries of Cape Town fall within the transition zone between the

26 Heemstra and Heemstra (2004)
27 Whitfield (1998), Lamberth and Turpie (2003)
28 Whitfield (1994)
29 Whitfield (1996)
30 Whitfield and Elliott (2002)
31 Emmanuel *et al*. (1992), Turpie *et al.* (2000), Lamberth and Turpie (2003)

cool, temperate West coast and the warm, temperate South coast bio-geographical regions.

Approximately 20 tons of fish are landed annually in the estuaries of Cape Town. This catch is mainly from the Rietvlei-Diep system (8-10 tons) and Zandvlei (10-12 tons) and mostly attributable to recreational angling, but sometimes with significant contributions from illegal gillnetting, especially in the Rietvlei-Diep system. There is also approximately 100 kilograms of mullet taken with castnets from the smaller estuaries each year.[32]

Historically, estuaries such as the Rietvlei-Diep, Zandvlei and Zeekoei were an integral part of vast wetland systems that even in the freshwater reaches supported a fish fauna that was predominantly estuarine in nature, comprising species such as estuarine round-herring (*Gilchristella aestuaria*) and flathead mullet (*Mugil cephalus*). Urban development has essentially severed many of the links between these estuaries and their upstream wetlands resulting in a substantial loss of fish nursery area. With regard to exploited fish species, this would have resulted in a corresponding reduction in recruitment of fish such as white steenbras (*Lithognathus lithognathus*) to the marine fisheries. Translated into economic value, 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.[33] If old connections could be re-established, the present-day value of these estuaries would likely double. Consequently, rehabilitation of these systems, especially the Eerste River and Zandvlei systems, could see a dramatic increase in available estuarine habitat, estuarine health and therefore nursery function and contribution to the near-shore fisheries.

Frogs

South Africa boasts 117 known species of frogs (by contrast England has just six), more than half of which are endemic. The bad news is that the survival of 20 of the region's 117 species (17%) is threatened.

Four of these species are classified as "critically endangered", while eight are "endangered" and another eight are "vulnerable". Two of the four critically endangered species are found on the Cape Peninsula. These are the Table Mountain ghost frog (*Helesphryne rosei*), which is found in only eight streams on the mountain, and the micro frog (*Microbastrachella capensis*), whose only known remaining population on the Cape Flats is in the indigenous vegetation inside the track at the Kenilworth Race Course.

Of the endangered frogs, the Cape platanna (*Xenopus gilli*) is now only found in the Cape Point section of the Table Mountain National Park, in the Betty's Bay/Kleinmond area and in the Agulhas National Park.

Urbanisation in Cape Town and Stellenbosch also threatens the endangered western

32 Emmanuel *et al*. (1992), Turpie *et al*. (2000), Lamberth and Turpie (2003)

33 Lamberth and Turpie (2003)

WESTERN LEOPARD TOAD – A FLAGSHIP FOR URBAN CONSERVATION

The western leopard toad (*Amietophrynus pantherinus*) is a charismatic species that is in danger of extinction. This large toad only occurs in the coastal region extending from the Cape Peninsula/ Cape Flats area to the Agulhas Plain. The majority of the known breeding sites are generally water bodies in public open space or on private land, and the few protected sites are surrounded by urban sprawl that threatens and restricts the foraging areas of the toads. Therefore, the co-operation of residents whose gardens form foraging and sanctuary areas for the toads when they are not breeding is vital for the continued survival of this endangered frog. Another major threat is road traffic and many toads die while moving to and from their breeding grounds in late winter to early summer. Incidentally, it is important to note that these toads are a protected species and it is illegal to collect and translocate them. To learn more about leopard toads and to become more toad friendly visit www.leopardtoad.co.za.

Cliff Dorse, City of Cape Town

Cape Teal (Photo: South African Tourism)

Opposite page top: Western Leopard Toad (*Amietophrynus pantherinus*) (Photo: Marius Burger)

Opposite page bottom: Cape River Frog (*Amietia fuscigula*) (Photo: Marius Burger)

leopard toad (*Amietophrynus pantherinus*), which breeds in the seasonal wetlands of the Cape Peninsula and which is consequently under constant threat from the "reclamation" of wetland areas for urban development, particularly roads, such as the Blue Route (M3) freeway and the proposed R300 toll road that crosses one of its breeding strongholds, the Westlake wetlands.[34]

The frogs that occur in Cape Town and its environs are listed in Appendix A.

Birds

The Cape Flats currently supports only a fraction of the abundance of waterbirds that it supported historically. Nonetheless, one hundred and four waterbird species occur regularly in coastal and inland wetlands in the south-western Cape. Of these, four are endemic to southern Africa, ten are considered to have a high conservation priority and seven are an immediate priority in the south-western Cape. One species (mallard duck) is a feral, exotic species that threatens indigenous species by hybridisation.

Many of these birds are now dependent or semi-dependent on altered or artificial wetlands, such as the maturation ponds at the Cape Flats Wastewater Treatment Works, farm dams and stormwater retention ponds. Indeed, artificial wetlands are

34 Yeld (2004) - with kind permission of John Yeld

Cape Grysbok (*Raphicerus melanotis*) at Strandfontein wetland area (Photo: Natio van Rooyen)

playing an increasingly important role in the conservation of waterbirds[35] and their widened distribution ranges.

Five Red Data species either inhabit or frequent the Cape Flats.[36] These are:

- Eastern white pelican (status: rare),
- Little bittern (status: rare),
- Greater flamingo (status: indeterminate),
- Lesser flamingo (status: indeterminate), and
- Baillon's crake (status: indeterminate).

The waterbirds that occur regularly in the freshwater bodies of the south-western Cape are listed in Appendix B.

35 Dennis and Tarboton (1993)
36 Brooke (1984)

Biodiversity and endemism

The fossil record both supports and further explains geological processes, providing a glimpse of life in Cape Town long before humans set foot on the soil. Many of the modern dunes and deposits in the Peninsula are rich in fossils of marine creatures, barnacles and mussels – evidence of the sea's rise and fall during the ages.

Some of the deeper peat layers associated with the wetlands of the Noordhoek Valley are rich in tree pollen of both palm and yellowwood suggesting a sub-tropical to tropical climate prevailed in the valley in the Tertiary era (65 million to 1.8 million years ago). This possibly harks back to when the Peninsula, still attached to the great continent of Gondwanaland, was situated closer to the equator, in tropical latitudes.[37]

Today, Table Mountain and the Peninsula are effective islands for the faunas of their rivers. Previous lower sea levels allowed passage between the rivers of the Hottentots Holland range and the Peninsula through connections in False Bay and along the western coastal shelf. Subsequent higher sea levels cut off these connections and isolated the populations. The higher sea levels also shortened the lengths of the Peninsula rivers, reducing population sizes and driving an increased rate of genetic differentiation.[38] The result was the development, among the fauna of the Peninsula Rivers, of characteristics distinctly different from those of their parent populations. The isolation of these populations has been further entrenched by the urbanisation of Cape Town, which has added an extremely effective barrier to the movement of aquatic animals.

Indeed this phenomenon is not restricted to the freshwater biota, and at least 112 animal species (one vertebrate and the rest invertebrates) representing 47 families are known to be endemic to Table Mountain and the Peninsula. This estimate is prefaced by "at least" because a great number of the small animals that inhabit Table Mountain have never been described and named, particularly those comprising the aquatic invertebrate fauna.

Potamonautes perlatus, photographed on the Liesbeek River under the bridge on the M3 highway in Newlands near Paradise Motors (Photo: Dick Lorant)

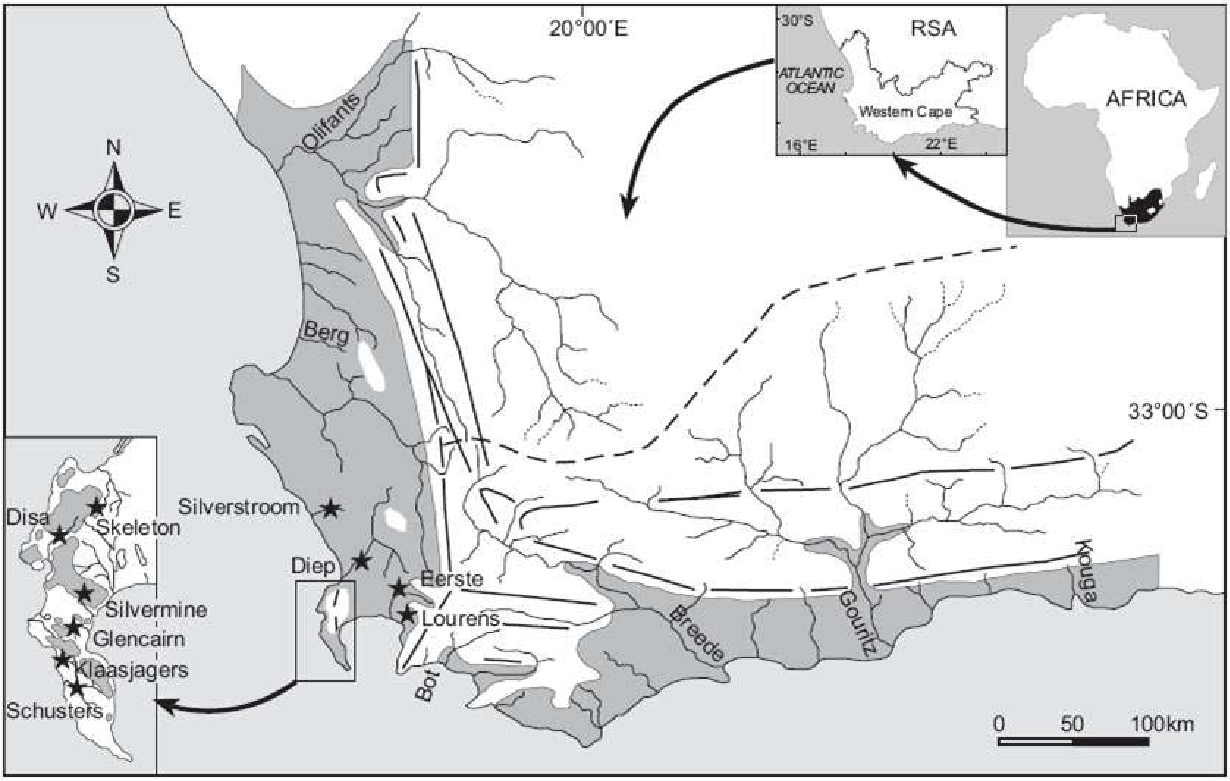
There are significant similarities between the distribution of plant and animal endemics on the Peninsula, and especially on Table Mountain. This is possibly indicative of parallel responses to the historical isolation described in Chapter 2.

The river crab

Until about the mid-1960s, it was thought that only one species of river crab (*Potamonautes perlatus*) occurred in the Western Cape region. This number was

37 Stellenbosch Town Council (1979)

38 Dr Marcus Wishhart, World Bank, Washington, personal communication



Distribution of the Cape galaxias in South Africa and the location of sampling sites (stars). Shaded area on the inset map represents areas above 275 metres above sea level, and below 275 metres above sea level on the main map areas. Solid lines indicate approximate mountain ridges. (Source: Wishart *et al*. 2006)

increased to two following an expedition in 1950/51, the second species to be named being *Gecarcinautes brincki*, but the name was later changed to *Potamonautes brincki*. Both of these species were found over the full spectrum of Western Cape rivers. The studies of Dr Barbara Cook, in the 1990s, however, showed that the populations on the Pensinsula were morphologically different and genetically isolated from those found elsewhere in the province, and represented at least two new species.[39]

The Cape galaxias – a paleao-endemic

The Cape galaxias (*Galaxias zebratus*) is a small freshwater fish, part of the paleao-endemic fauna characteristic of the south-western Cape, South Africa, and is the only galaxiid found in continental Africa.

The doctoral studies of Dr Marcus Wishart confirmed the existence of a number of genetically distinct forms of *Galaxias zebratus*, suggesting the presence of up to five species, and revealed a new genetic lineage from the southern part of the Cape Peninsula. The genetic divergence between Peninsula galaxias and their cousins in nearby systems, such as the Eerste River, suggests a period of isolation and independent evolution of around 5 Ma. Drainage evolution in the Cape Fold Mountains is thought to have played a major role in the distribution of fish[40], with eustatic sea level changes being thought to have been important in aiding the dispersion of *Galaxias zebratus.*[41] Wishart showed that the genetic patterns in these fish reflect east/west-flowing streams historically connected during periods of low sea levels.[42]

39 Stewart (1997)
40 Barnard (1943)
41 Skelton (1994)
42 Wishart *et al*. (2006)

Western Cape Archives

Chapter 4

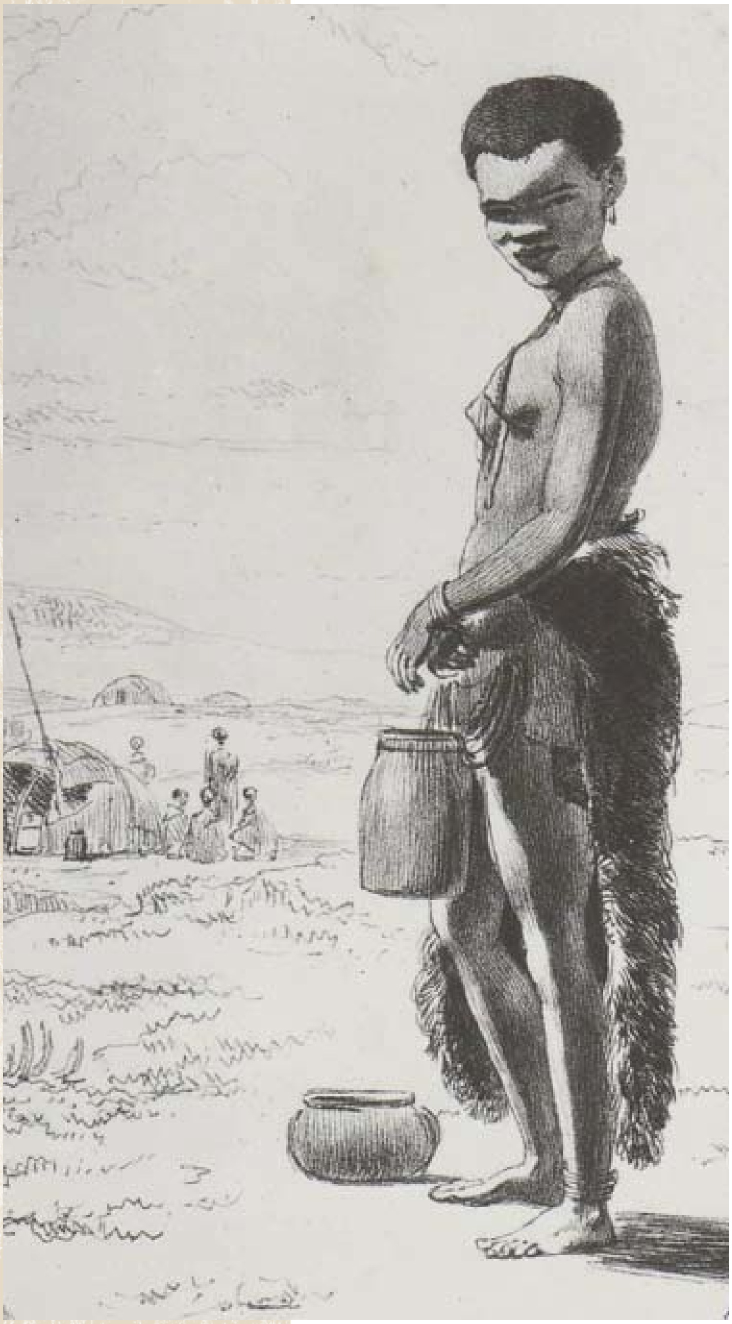
Water supply, drainage and the settlement of Cape Town

"They came for the water. Otherwise they would have gone to Saldanha."

After John Jourdain - Chief Merchant of the British East India Company's ship Ascension, which put into Table Bay on July 1608*

* Jourdain (1912)

People have made the slopes of Table Mountain and Table Bay their home since the Stone Age. Drawn to the abundant natural water supplies, the San, Strandlopers and Khoikhoi arrived from the Swartland region annually between November and January to graze their animals, hunt wild game and harvest edible plants and water



Young Khoikhoi woman, with a family group in the background, drawn by Samuel Daniell *circa* 1820 (Western Cape Archives)

in Table Valley. The valley's plentiful supply of water was also the reason that the Dutch East India Company (VOC) located their provision station en route to the East in Table Bay, rejecting the better (but considerably drier) harbour at Saldanha Bay.

The San

The San people were hunter-gatherers who lived in relative isolation in the southern part of the sub-continent for thousands of years. They had extensive knowledge of their immediate environment, on which they depended for their survival. They lived in small family units, in keeping with their nomadic behaviour. They were reportedly also accomplished fishermen, as indicated by the large number of fish bones found in coastal caves.

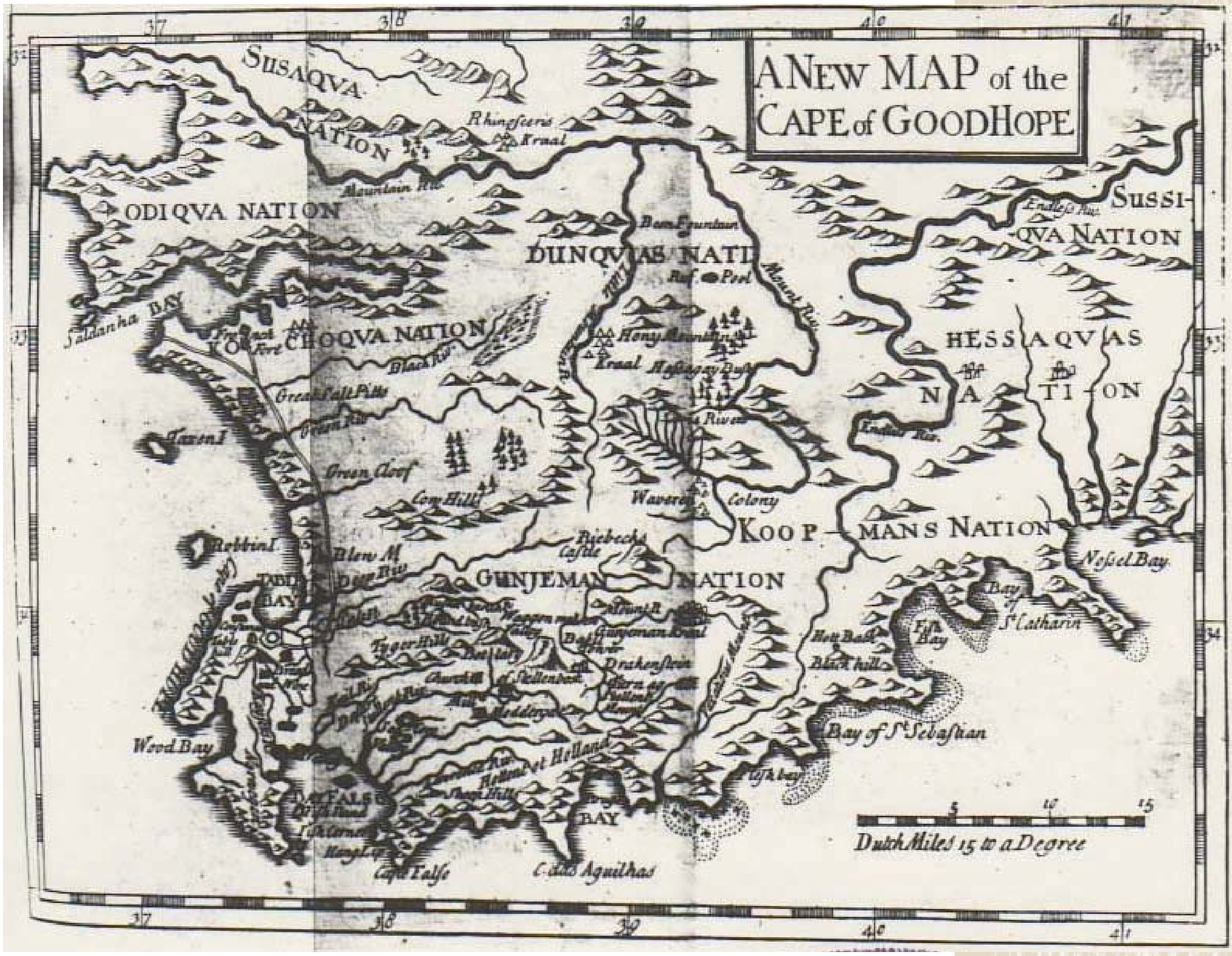
For tens of thousands of years, the lifestyle of the San in southern Africa remained undisturbed. Then, about 2000 years ago, nomadic groups started moving in from the north, in search of grazing for their domesticated animals.[1]

The Khoikhoi

By AD 500, Khoikhoi groups were settled along the western, southern and eastern Cape coasts. They were pastoralists and most probably acquired livestock, mostly sheep, through contact with early Iron Age peoples moving south.[2]

The Khoikhoi named the land around Cape Town "Hoerikwaggo" (Mountain in the Sea). The Khoi lived in harmony with nature and left little lasting impact on the natural environment, but the basic geometry of the Table Valley, such as routes into the Liesbeek Valley past Devil's Peak and over Kloof Nek, must have been established long before the European settlers arrived.[3]

1 www.oldwynberg.co.za/history.htm
2 *ibid.*
3 Malan (2002)



A "new" map of Cape of Good Hope showing the distribution of the Khoikhoi, *circa* 1600s (Western Cape Archives)

A small group of outcast and cattle-less Khoikhoi known as the Goringhaicona or Strandlopers were the permanent occupants of the valley at the foot of Table Mountain. Their leader, Harry, reportedly became the chief intermediary between the indigenous peoples and the European settlers.[4]

The Khoikhoi named the land around Cape Town "Hoerikwaggo", Mountain in the Sea.

Vistors from afar

Legend has it that more than 2000 years ago Phoenician and Arab seafarers were the first to reach the Cape by sea.[5]

4 Bredekamp (1986)
5 www.capetown.dj/history

European settlement

Jan van Riebeeck, first Governor of the Cape and a source of much of our knowledge about the early rivers and vleis of Cape Town (Western Cape Archives)

Van Riebeeck arrived at the Cape in 1652 with orders to set up a victualling station. He named the main stream flowing from the mountain, and the main source of water in the valley, the Varsche River. He also built a garden to provide fresh vegetables. To irrigate the gardens and to provide water from the settlement, he organized the Varsche River and the other streams in valley into a network of furrows.

Wherever Dutch colonists settled, they were inclined to build canals in the manner of their homeland. Van Riebeeck's furrows were soon converted into canals with names such as Heerengracht, Keisersgracht and Buitengracht, which would remind the settlers of Amsterdam.

After the arrival of the Europeans, the Khoikhoi were excluded from the land west of the Liesbeek. The European settlement grew quickly, and demand for fresh fruit and vegetables soon outstripped supply. In 1657, slaves from the East Indies were imported to assist with agriculture and other labouring activities. Some VOC employees were allocated land in small allotments and were allowed to grow produce for sale to passing ships, but they remained on the company payroll. VOC employees soon occupied the available arable land between the town and the mountain slopes, tracking the granite and sandstone soils, the wider contours and the perennial streams. The drier slopes of Devil's Peak and Signal Hill were mainly used for livestock grazing and dairy farming because of the paucity of perennial streams and relatively poor soils, and burghers settling there were given larger allotments.

Slowly the landscape began to change as vegetation was cleared for fields, trees and bushes were harvested for firewood and thatching, and the veld was burned for grazing. In 1654, brick kilns were started in the valley and in 1660 the first roof tiles became available, although thatch, obtained from the indigenous reed vegetation, was still widely used.

THE VOC

Dutch East India Company, Vereenigde Oostindische Compagnie (VOC) in Dutch, was an international Dutch trading organisation in existence from 1602 to 1800.

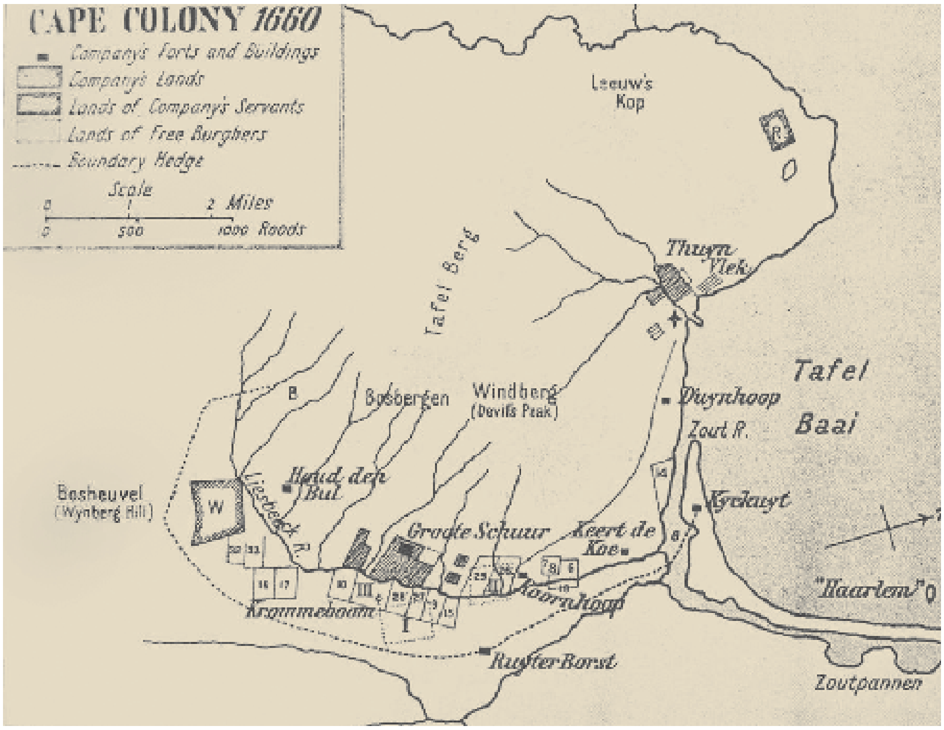
www.wikipedia.com

All of these early activities depended on the water running off the mountain. It was used to supply the ships, the town, its gardens and its livestock and, after 1660, it also powered a water mill constructed near the fort.

When urbanisation arrives, pollution follows. In 1655, van Riebeeck received a complaint from the VOC that the crew of a ship had been made ill by water taken in at the Cape. This was a serious indictment, not only of van Riebeeck's competency, but also of the suitability of the Cape as a victualling station, as there was competition from St Helena. He immediately issued a "plakkaat" – the first South African environmental legislation – to try to prevent pollution of the water source:

"Nobody shall turn sheep into the water, nor wash, nor stir up the water above the flow of the beck and fountain where the ships draw water, neither shall anyone dam or divert the water. People may wash only at the proper place on the east side of the moat of the Fort. They may not keep geese nor allow them to swim there. Nobody may cross the water furrow between the Fort and the Mountain with wagon, cattle, or merely in person other than by the usual places and bridges."[6]

6 Thom (1954)



The Cape Colony, 1660, showing Platteklip Stream and the stream rising on Devil's Peak flowing into Table Bay, and the tributaries flowing off the back of the mountain into the Liesbeek. Note the "Zoutpannen" dominating the western shores of Table Bay. (Walker 1922)

And significantly:

"Every one of the inhabitants shall clear away the mess dirt and dung heaps in front of their houses."

It was a brave and enlightened attempt to nip the rot in the bud, but the problem would still not be properly solved 350 years later.

Development of a drainage system

Cape Town under the VOC

In 1660, van Riebeeck's men widened and deepened the Varsche River furrow, which assumed the status of "canal", and built a small dam near the jetty for filling water casks for passing ships. Previously, the water collection point may have been a back lagoon of the Platteklip Estuary.

Van Riebeeck's successor, Wagenaar, replaced the dam in 1663 with a cistern that measured "sixteen roods by four and half a rood deep" (approximately 55 metres by 5 metres and 1.5 metres deep).[7] Wagenaar's reservoir was built in a great hurry because for the first time the "Caabse Vlek" had started to run out of water. All able-

FREE BURGHERS

In 1657, the VOC made a major concession and released several employees from their contracts. These "Free Burgers" were granted substantial farms along the Liesbeek River, but were required to adhere to restrictive conditions that served the VOC's interest. Familiar Southern Suburb names started to appear on local maps as the farms in the Liesbeek Valley became established, including Koornhoop, Groote Schuur, Krommeboom and Bosheuvel (Wynberg Hill).

7 Picard (1972)

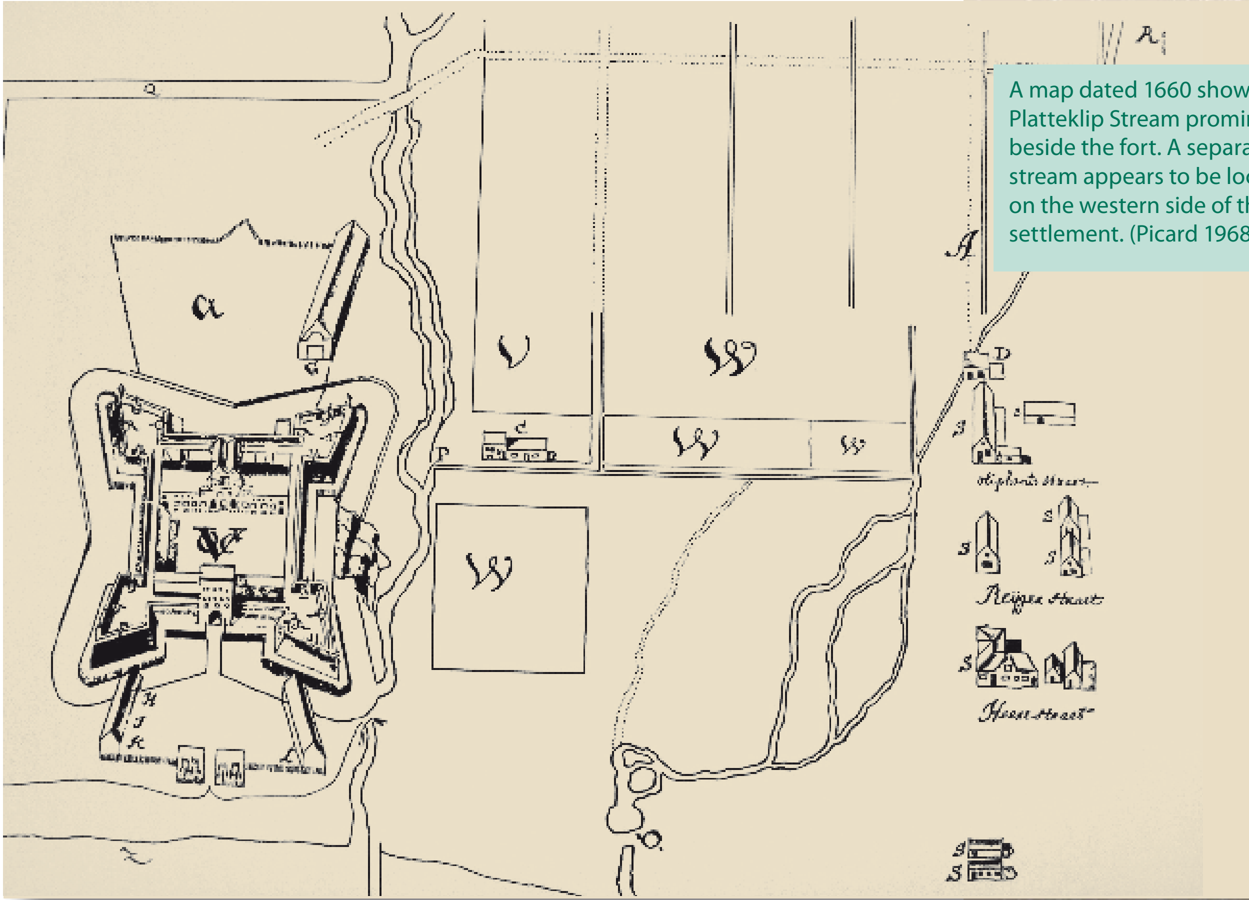
Timeline: Political	
circa	
500 AD	Khoi pastoralists use Table Valley for grazing
1503	De Saldahna and crew land in Table Bay
1620	Shilling and Fitzherbert claim Table Bay for England
1652	Van Riebeeck establishes a victualling station for the Dutch East India Company
1806	Second British occupation of the Cape
1813	Cape becomes a colony of Britain
1832	Emancipation of slaves
1872	Cape granted responsible self-government
1899 – 1902	South African War
1910	Cape and Natal colonies, Transvaal and Free State unite to become the Union of South Africa, an independent country within the British Empire
1948	Nationalist government comes to power and begins to implement apartheid laws
1961	South Africa becomes a republic
1994	South Africa becomes a democracy

bodied men were required to assist in its construction. The remains of Wagenaar's reservoir can be viewed today in the Golden Acre Shopping Centre in Cape Town.

When war broke out between Holland and England in 1665, Wagenaar was ordered to construct a substantial fortress that included a moat, and work began on the castle as we know it today. The building work dragged on for some fourteen years (and the administration of five succeeding commanders) until Governor Bax finally completed the moat around the Castle by instructing everyone passing the works to remove at least one basket of rubble from the excavation. A stream that drained the western slopes of Devil's Peak and the saddle area was diverted to fill this moat. The name of the stream is not known and it no longer exists. The diversion channel, however, which ran along the line of the present-day Buitenkant Street, became known as the Capelsluit. Unlike the canals flowing along the Heerengracht[8] and other major thoroughfares, this was a mere ditch, probably not perennial, and was never elevated to the name "gracht".

In 1693, Simon van der Stel promoted the Superintendent of the Company's garden, Hendrik Oldenland, to a post that effectively made him the first Town

8 Known today as Adderley Street



A map dated 1660 shows the Platteklip Stream prominent beside the fort. A separate stream appears to be located on the western side of the settlement. (Picard 1968)

Van Riebeeck's "plakkaat" (1655)

"Nobody shall turn sheep into the water, nor wash, nor stir up the water above the flow of the beck and fountain where the ships draw water, neither shall anyone dam or divert the water. People may wash only at the proper place on the east side of the moat of the Fort. They may not keep geese nor allow them to swim there. Nobody may cross the water furrow between the Fort and the Mountain with wagon, cattle, or merely in person other than by the usual places and bridges."

Wagnaar's Reservoir, "sixteen roods by four and half a rood deep", can be seen today on the lower level of the Golden Acre Shopping Centre, Cape Town (Photo: Tony Murray)

Engineer of Cape Town. The Governor and his Town Engineer then embarked on a series of engineering works, including improvements to the Heerengracht and the Kaisersgracht, which ran along the line of the present Darling Street, bringing additional water to the Castle and linking the Heerengracht system to the Capelsluit. The canals, however, soon became the recipients of runoff from the streets and of wastewater from the buildings, which were beginning to rise in the fledgling town. The Varsche River changed from a sparkling stream to a polluted drainage path.

The first water pipes used in the colony were made from bored tree trunks. When, in 1707, Willem Adriaan van der Stel procured 200 lead pipes from the VOC to bring fresh water from the foot of Table Mountain to the jetty, and installed fountains to supply the local needs, Cape Town considered herself well provided for. Water for household use was taken from the canals that ran alongside the streets and, when the channels were dry, a public well with a pump in Greenmarket Square was the main source of water.

Despite their gradual degradation, the grachts remained attractive features of the town and, even today, are evoked by the names of city streets such as Kaisersgracht, Heerengracht and Buitengracht. Visitors such as the French explorer Le Vaillant (1790) wrote that "the waters, which descend from the mountain in a kloof, meet the requirements of the inhabitants in abundance as well as those of the ships that called for revictualling".[9]

The street that became known as the Heerengracht was lined with oaks, and the buildings, apart from the Groote Kerk (which was on the east side of the Parade)

9 Le Vaillant (1790)

The public water pump on Greenmarket Square, *circa* 1707 (Western Cape Archives)

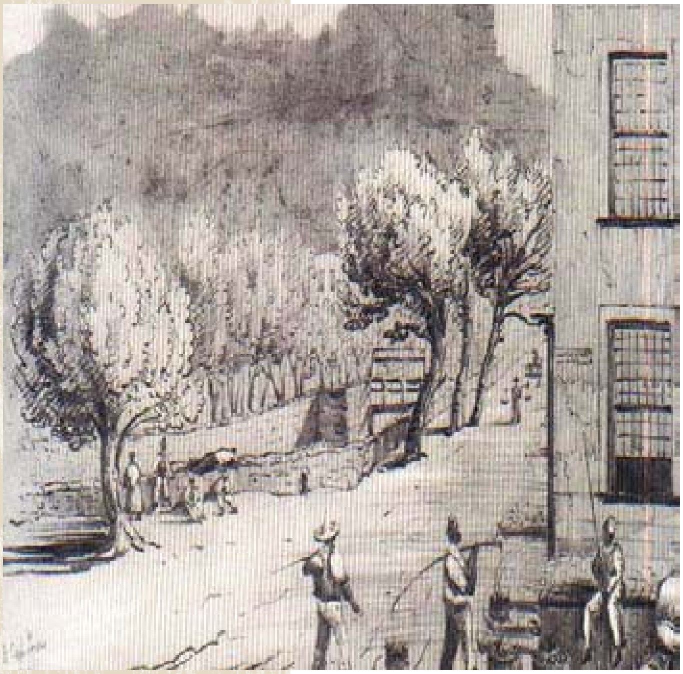
were confined to the western side. As late as 1842, Bowler sketched the Heerengracht wending its way under attractive little bridges on the undeveloped western side of the street, which suggests this beauty extended into the early years of British rule.

The grip of the VOC on the settlement weakened as its fortunes declined and the private citizenry increased. By 1731 the population was 3 157, of whom only a third were Company employees. The town was growing, and the grid pattern established by van Riebeeck was extended. Typically, the streets were flanked by channels, which were both a source of water supply and a means of drainage.

A "burgher council", with limited powers and duties, was eventually established, and, in 1714, a Town Watch was instituted on which each burgher served in rotation. While the duties were mainly of a policing nature, it did have the power to inspect the canals and water channels and to ensure "they were not fouled by slave", which really meant slaves tossing their owners' nightsoil into the grachts![10]

Cape Town, however, remained a "company town" and growth was slow. The Free

10 Picard (1968)



A watercolour by Thomas Bowler of the Heerengracht (1842) at the intersection with Castle Street at the time shows a tree-lined canal, with small bridges leading across to the Grand Parade (William Fehr Collection)

Burghers who farmed on their own behalf on the outskirts of the city were subjected to restrictive conditions, and the Directors of the Company, the "Here Sewentien" were very reluctant to spend any money on "unnecessary" infrastructure. At first, this attitude was motivated by profit, but in the latter stages of the VOC's administration, the company was approaching bankruptcy and simply had no funds to spend.

In 1793, amid growing concerns about the state of the canals and general drainage in Cape Town, the Governor requested the engineer/architect Louis Thibault to suggest what could be done to improve the bridges and sluices "in the cheapest possible manner". Presumably whatever bright ideas the competent Thibault had could not be implemented because, by this stage, the VOC was facing bankruptcy and had no funds for even "cheap" improvements.[11]

British rule

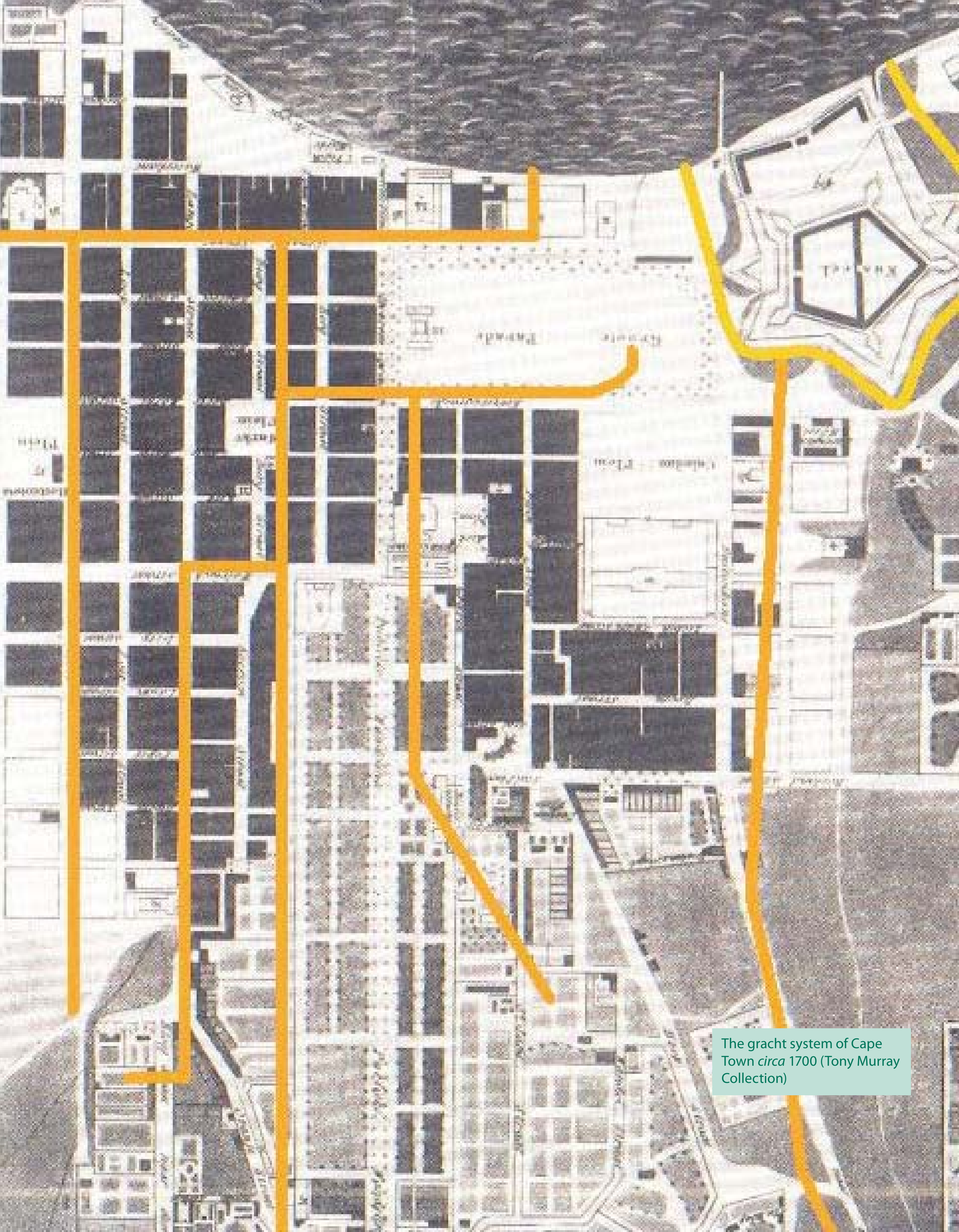
Water supply

In 1795, the British occupied the Cape in order to prevent the strategic port from falling into the hands of the French revolutionaries who had taken over Holland. Dutch rule was restored in 1803, but a second British invasion took place in 1806, which resulted in permanent occupation.

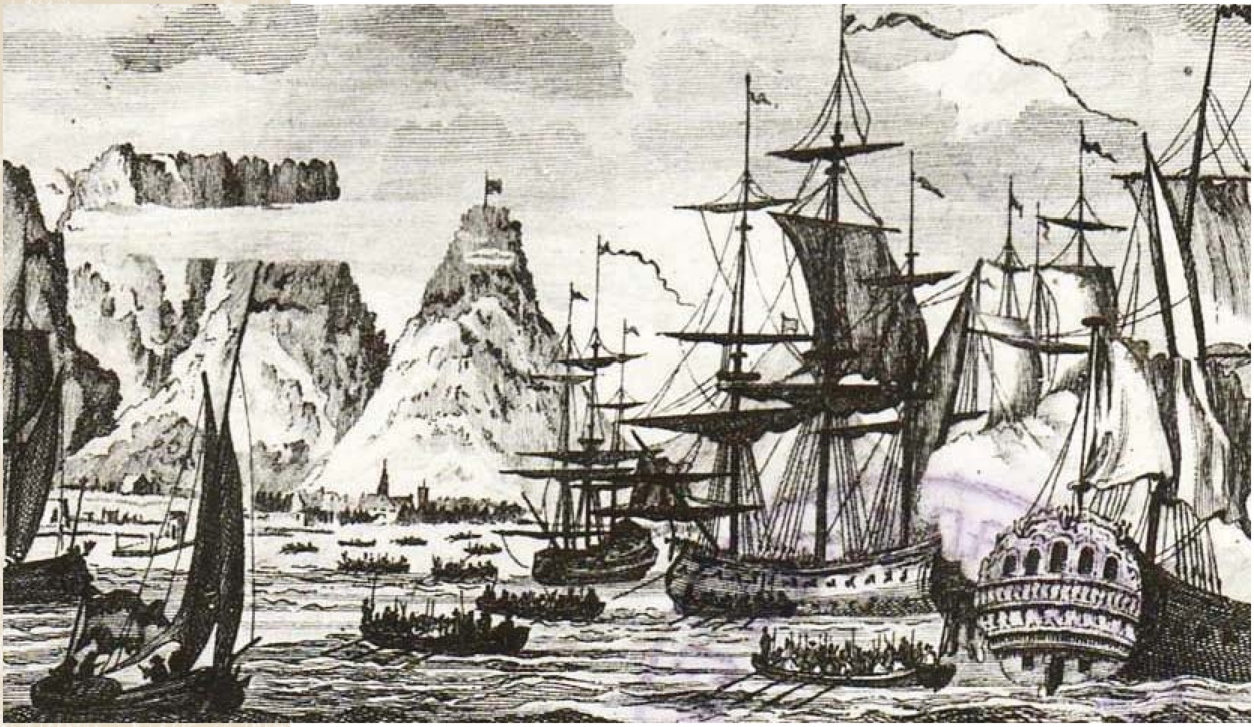
By 1806, the population of the town was about 17 000, but municipal services had hardly progressed since van Riebeeck's time. Full control of the Cape only passed to Britain in 1813 when the Cape became a colony of the British Empire and a colonial administration was gradually installed. As the Dutch had been, the British were reluctant to spend money on a colony that at the time had a very weak economy, and only minimal and essential improvements were made to the town's infrastructure and services. This situation prevailed until 1843 when the colony gradually began to pay its way and Britain began to reinvest some of the profits in infrastructure.

The shortage of water in the town was a pressing priority, and the Home Government appointed a leading engineer of the day, John Rennie, to investigate ways in which to augment the supply. In 1814, his proposed solution was to build a 250 000-gallon reservoir in what is now Hof Street. A water superintendent, Mr John Chisholm, was appointed to implement the Rennie scheme, and under his guidance the first cast-iron pipeline was laid down Long Street, with branches of smaller bore extending to the cross streets. On Rennie's instructions, Chisholm exploited springs on the

11 *ibid.*



The gracht system of Cape Town *circa* 1700 (Tony Murray Collection)



Ships in Table Bay in 1781 (Western Cape Archives)

property of the original Oranjezicht farm and had several pumps built to lift water from underground tanks for the use of the public. The extraction chambers are still in existence in the park behind St Cyprians School, and the springs still produce a megalitre of water per day, but, in recent years, this has been deemed unsuitable for human consumption. The only remaining "Chrisholm" pump, "the Hurling Swaai Pomp", is now a national monument and can be seen in Princes Street, Gardens.

Then in 1849, Chisholm built a substantial 2.5-megalitre reservoir in the Gardens. An even bigger one of 12 megalitres was completed in 1856. These reservoirs, known as Service Reservoirs No's 1 and 2, are still in use and can be seen in De Waal Park below Camp Street.

John Chisholm: Cape Town Water Superintendent 1821-1856 (City of Cape Town Archives)

The lower portions of the Platteklip Stream do not appear to have been considered for water supply at this stage, and had possibly already been diverted into the Capelsluit. There are reports of a substantial landslide at the foot of the gorge in about 1806,[12] which could have hastened the process. In any event, the upper reaches of the stream still had a role to play as these became the site of the Cape Town laundry industry. Each day a veritable army of some 500 washerwomen would collect washing from the citizens and trudge to the base of the gorge. Clothes were stamped clean in the stream and then hung on bushes to dry.

Eventually, in the 1880s, municipal washhouses were built to handle the daily laundry of the city and these were used until about 1940 when electric washing machines replaced the labour-intensive system. The historic washhouses are now used as overnight accommodation for hikers on the Hoerikwaggo Trail.[13]

12 Storrar (1974)
13 Hoerikwaggo is the Khoikhoi name for Table Mountain.

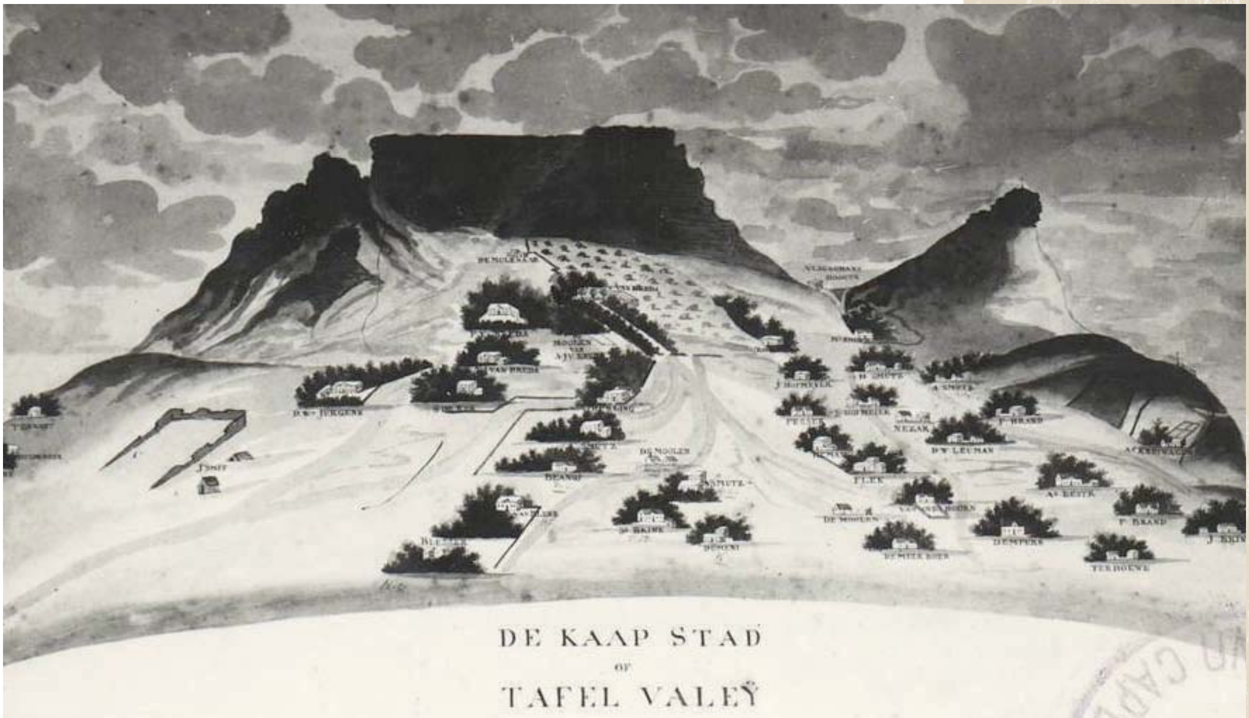


Table Mountain in 1804 showing the upper part of the valley with the properties of various individuals (Western Cape Archives)

By about 1827 the town canals had long passed their usefulness for supplying household water, and Chisholm made a start on covering them over with stone or brick barrel arches. The tempo of the job was inevitably determined by the short supply of funds, particularly during the economic slump of the 1830s, and the project took over thirty years. Freed slaves carried out the work under Chisholm's supervision. By all accounts the converted canals were not constructed to the engineering standards of the day. The freed slaves, although skilled stone masons, knew little about hydraulics and as a consequence the flow of water was often compromised. Given the resources at the disposal of the fledgling municipality, it is also unlikely that any proper maintenance was carried out. Pools of stagnant and putrid water developed at low spots, and the stenches that emerged from the drains were cause for concern and annoyance, but not action.

The Hurling Swaai Pomp, which can be seen in Princes Street, Gardens (Photo: Kevin Wall)

In 1880, a reservoir was built below the Main Spring and named the Molteno Reservoir. This burst soon after completion but was restored by 1886 and continues to serve the city to the present day. The water sources on the northern face of the mountain proved insufficient to fill this facility in normal seasons, and the Colonial Hydraulic Engineer, Mr John Gamble, identified the Disa River (a tributary of the Hout Bay River) on the back table of the mountain as a more substantial source of supply.[14]

Mr Thomas Cairncross took over as City Engineer in 1888, and built a tunnel through the mountain to access this source. Within a short time the natural flow in the river proved insufficient, however, and in 1894 the Woodhead Reservoir was built across the head of the Disa River Gorge to store water during the rainy season. When this, in turn, was unable to meet the growing demand for water, the Hely–Hutchinson

14 Report of the Select Committee (1887)

Platteklip washerwomen by Charles Davidson Bell in 1833 (Western Cape Archives)

Reservoir situated further upstream on the Disa River was commissioned in 1907 (see Chapters 5 and 14).

Wastewater removal

Removal of wastewater received little or no attention in early Cape Town and by 1857 the situation was becoming intolerable. The newly established House of Assembly decided to flex its muscles and appointed a Select Committee to report on the sanitary state of Cape Town. While the inquiry seems to have been sparked by the poor drainage in some slum areas in the vicinity of the present Barrack Street, it was apparent that the general state of drainage and cleanliness in the town left much to be desired. The situation was particularly bad in many narrow lanes in the Barrack Street area and between Long and Keerom streets.

The City Engineer estimated that the cost of installing foul sewers in Cape Town would total £20 000, which worked out at £5 per household. As the charge for nightsoil removal was £1 per year, he presumed that the householders could afford to pay off the loans at 20% per annum, and it appeared as if the more affluent sector and the merchant class would gladly accept this cost in the light of the benefits it would bring. However, one dissenting owner could frustrate the good intentions of an entire street, and there was no means of expropriating servitudes or forcing connections.

Apart from funding, the main barrier to the implementation of the sewerage proposals was the problem that the supply of fresh water was insufficient to allow for water-borne sanitation and proper flushing of sewers. Nonetheless, the Committee made strong recommendations to the legislature for a system of underground drainage and for the Commissioners of the Municipality to be given sufficient legal

The Platteklip washhouses *circa* 2003, before their renovation for use as accommodation for hikers on the Hoerikwaggo Trail (Photo: Jenny Day)

powers to bring it to fruition. The Commissioners, however, were apparently less enlightened than the members of the Committee, and little progress was made. The filthy conditions, stenches and unacceptable practices continued unabated.

By the mid 1800s, the city watercourses were, to all intents and purposes, foul sewers. Most houses had no sanitary facilities and were infested with vermin. Overcrowding was common, with 16 or 17 people to a room in some localities. Although some nightsoil contractors were in operation, the majority of the poorer classes emptied their "tubs" though first floor windows into the streets below, from where the "nuisance" found its way to such stormwater drainage as existed. Even the so-called proper disposal of nightsoil was haphazard. The official place for disposal was on the beach at Fort Knokke on the eastern side of the castle, but it is highly likely that any convenient drain, ditch or indeed canal was used, and householders who so desired were allowed to connect their water closets directly to the stormwater drains. The town was in a shocking state. Unrestrained winter torrents gouged out roads and flooded homes. During south-easterly winds, sand enveloped the town in clouds of red dust, blinding and knocking down unfortunate pedestrians. Waste accumulated in covered grachts and released stinking gases. Small wonder that the death rate in the Cape was amongst the highest in the civilised world. The Cape Town medical fraternity were at the forefront of agitation for improved sanitation. A bitter controversy developed, which led to the formation of two rival political groups, the "Clean Party" and the "Dirty Party" – neither of whom was particularly "unsoiled" – with opposing stances on public health. And nothing was done.

At about this time, the merchant Saul Solomon, convinced his neighbours to contribute £120 each to the construction of a sewer in Longmarket Street with side drains connecting to the water closets in their commercial premises. By this means, boasted Solomon, some 200 employees of the businesses were provided with

Heerengracht *circa* 1832 (Sketch by Sir Charles D'Oyley) (Picard 1968)

"A state of misery if not sin."

Saul Solomon commenting on life in Cape Town , *circa* 1880

modern sanitary facilities and were thus "delivered of their state of misery, if not of sin".

In the late 1880s, however, the authorities were sufficiently confident about the adequacy of the water supply (see Water Supply) to consider installing water-borne sewerage throughout the city. Soon after taking office, Cairncross began departmental work to improve sewerage, and commenced with a main intercepting sewer, parallel to the shore. The work was suspended though, and in 1888 a British expert, Mr Edward Pritchard, was appointed to design an integrated sewerage scheme. In the event, his plan was rejected, partly because the outfall was located more or less in the centre of the Table Bay shoreline, near the present-day yacht basin, and there were fears that this would lead to pollution of the bay. Cape Town, of course, had been effectively discharging sewage into the sea through the Heerengracht drain and other outfalls for many years. The condition of the beach from the Amsterdam battery (approximately the site of the Holiday Inn on Buitengracht Street) to Fort Knokke (near the Woodstock interchange on the N1) was disgusting, although some of the pollution was due to discharges from ships anchored in the bay. (Even in the late 1940's the apparently attractive remainder of Woodstock beach in front of Paarden Eiland was treated as a no-go area by all sectors of the population.)

Then in 1990, through the intervention of the Prime Minister, Cecil Rhodes, another British expert, Mr Clement Dunscombe, was appointed to design a sewerage system. Dunscombe proposed two options: a land-based option and a sea outfall option similar to that of Pritchard. The land-based option was for a system of broad irrigation in the vicinity of the present Ysterplaat, where he suggested an "Irrigation Colony" of smallholdings could be established as had successfully been done at Mildura

Adderley Street in 1880. The Grand Parade (left foreground) extended to Adderley Street. This area was subsequently occupied by the first General Post Office building, demolished in 1947 to make way for the building that housed the OK Bazaars for another 50 years. The Heerengracht stream flowed in the covered drain beneath the road to the right of the fountain. (Picard 1968)

in Australia. In July 1891, the Council enthusiastically voted to adopt Dunscombe's scheme, with the land irrigation option. The Mayor, Sir D.P. de Villiers Graaff, considered the decision to be one of the most important steps taken in the history of the city, and was suitably delighted that "*our beautiful Bay will be kept free from contamination*", while employment would be provided for a number of labourers in the irrigation of the land. Cape Town will become "a place of noted purity, as its situation is one of exquisite beauty, and as the health resort of South Africa, the city will become unsurpassable".

In 1893 tenders were called for the Dunscombe scheme but, to the dismay of the council, the bids were far higher than the initial estimates. The amount was some £50 000, or 25% more than expected, and the City could not see itself raising the extra capital. The additional cost seemed to be linked to the land-disposal option. When Dunscombe obligingly revisited the scheme to see if he could reduce the costs it became apparent that, apart from the cost aspect, the proposed site was underlain with the now well-known Cape Flats "koffieklip", which would prevent any seepage through the soil. The option was thus not viable. Dunscombe also appeared to have had second thoughts about the currents in the bay and their ability to keep the shores clean. On his advice the council engaged an experienced "Nautical Surveyor", Mr G.L. Good to determine the best place to locate the sea outfall. (His terms of employment were £50 per month plus £100 travelling expenses for coming out from London.) Good's survey concluded that any outfall on the Woodstock side of the city was unacceptable, and an outfall at Green Point was a more viable option.

And so it was left to a newly appointed City Engineer, Mr W.T. Olive, to produce a scheme with a required Green Point outfall that connected feeder reticulations,

A sketch by Thomas Bowler in *circa* 1844 showing the view of Cape Town from Tamboerskloof, Lions Hill, with a Malay group in the foreground (Western Cape Archives)

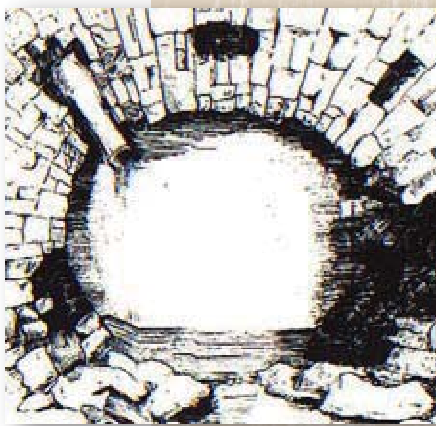
designed variously by Cairncross, Pritchard, Dunscombe and a newly appointed drainage engineer, Rigby. The scheme was implemented between 1897 and 1903. The main outfall sewer was located at a depth approaching 17 metres below Green Point Common. There were considerable difficulties in tunnelling under the Common, where rock and water were encountered – the line of the tunnel ran directly under a vlei, which then existed on the site where the Green Point Stadium now stands. Despite this, the quality of brickwork was first class, a fact that is borne out by the fact that the sewer is still in service, although the outlet into the sea off Green Point lighthouse has been modified over the years. To this day a great many manhole covers throughout Cape Town bear testimony to civic pride in this undertaking with their inscription "CITY OF CAPE TOWN SEWERS 1895".

Rigby's stormwater scheme[15]

H.P.B. Rigby was appointed as Drainage Engineer in late 1897 with the specific task of designing a stormwater drainage scheme, which would reduce the annual flooding in the city. He immediately set to work gathering rainfall data, drawing up broad specifications and surveying the existing system. His report was laid before the Council some three months later, which, considering the amount of work required and the primitive facilities at his disposal, was a considerable feat.

15 Rigby (1898)

It came as little surprise that the old drainage system was in a shocking state. Photographs and meticulous sketches showed that the brick and stone masonry had in many places decayed or fallen in. Design was also often poor, with sudden changes in grade and diameter and with semi-circular cross-sections instead of the more hydraulically-correct ovoid shape.



One of Rigby's meticulous sketches of drain condition (Rigby 1898)

The design of the new scheme was fairly straightforward, with main drainage for each catchment being laid as near to the valley bottom as possible. The old drains that could be repaired were incorporated in the scheme and all new stormwater mains were to be laid in straight lines with manholes at each change of line or gradient, or otherwise at intervals of not more than 250 feet.

Rigby found little difficulty with the potentially problematic outfall positions. He considered that it would be "quite unobjectionable" to discharge all stormwater into the nearest available points in Table Bay and his design reflects this decision. He was, however, well aware of the noxious nature of first flushes and street washings, and he designed a special manhole that diverted dry weather flow into the sewerage system. He was also practical about the reverse effect and made provision for sewage overflows to find their way into the stormwater drainage. He was unimpressed with the sewerage designers' contentions that foul sewers needed to be flushed. By now it had been established that foul sewers laid at proper gradients seldom if ever required flushing. On the other hand, he appreciated that the intermittent flows in the stormwater, particularly in the Cape climate, would allow deposits to build up, and he made provision for regular cleaning and maintenance access.

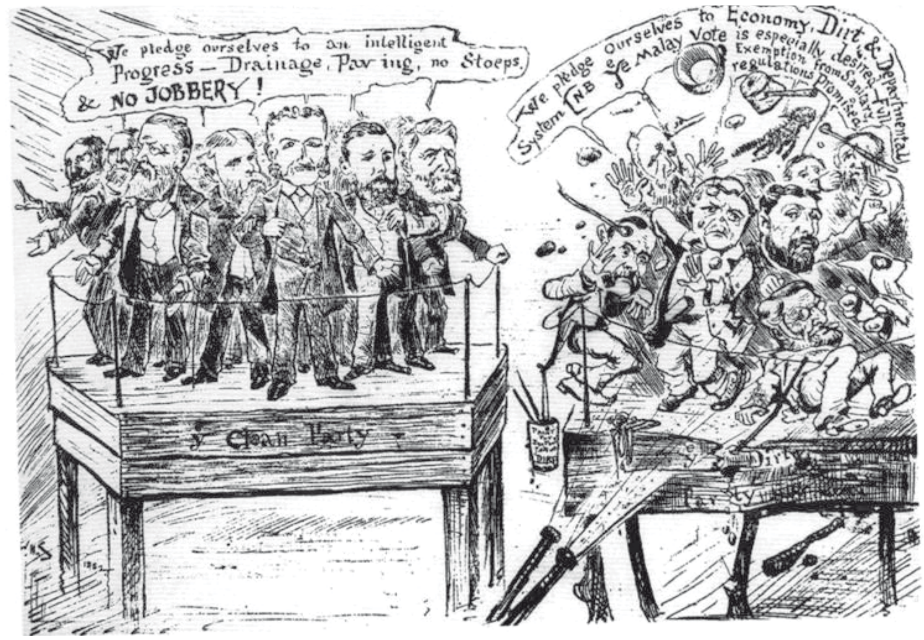
The scheme, as designed, provided for the construction of 163 000 feet of drainage, 845 manholes, 30 flushing tanks, 1573 gullies and 100 overflows from the sewerage system. The total cost was estimated at £338 700, but Rigby suggested that this was too large an outlay for one commitment. He proposed a "Plan B" (his own term) by which 52 000 feet of the most urgent drainage would initially be constructed at an estimated cost of £135 000. The Council agreed enthusiastically and the work was completed by 1899.

A new harbour

Rigby's scheme might have marked the conclusion of major drainage planning in the City Bowl, but there were to be further twists to the saga.

Gradual reclamation of Table Bay had been taking place for many years, but in the 1930s, the Railways and Harbours Administration planned a grand new harbour, the Duncan Dock. This entailed substantial filling of the bay, and about half a kilometre of precious developable land was created on both sides of the foot of Adderley Street. This would be an enormous boon to a city that was hemmed in on three sides by mountains, and where land was at a premium. However, in the early stages the City Council was not in control of the newly created foreshore – that was the prerogative of the State.

Suddenly somebody realised that the several stormwater outlets that discharged into



A cartoon *circa* 1885 supporting the campaign of the "Clean Party" against the "Dirty Party" (Worden *et al.* 1998)

Opposite page top: The Jetty in Cape Town, showing fishing boats and groups of people, with ships in Table Bay in the background, *circa* 1900 (Western Cape Archives)

Opposite page bottom: Undated photograph of Table Bay from Signal Hill, probably *circa* 1900 (Western Cape Archives)

the bay along the old shoreline had been completely forgotten. Something needed to be done in a hurry. A young consulting engineer who had been making quite a name for himself in the country districts, Ninham Shand, was appointed. Somehow he managed to keep the design just ahead of the departmental construction team, who worked in close conjunction with the engineers to finish the critical parts of the job without delay and the project eventually came to a satisfactory conclusion. The new Duncan Dock was complete in *circa* 1946.

The face of the harbour was to change yet again in the 1970s, when the tanker basin and container berths were constructed on the western side of the harbour. (More on this in Chapter 11.)

AN INTREPID REPORTER

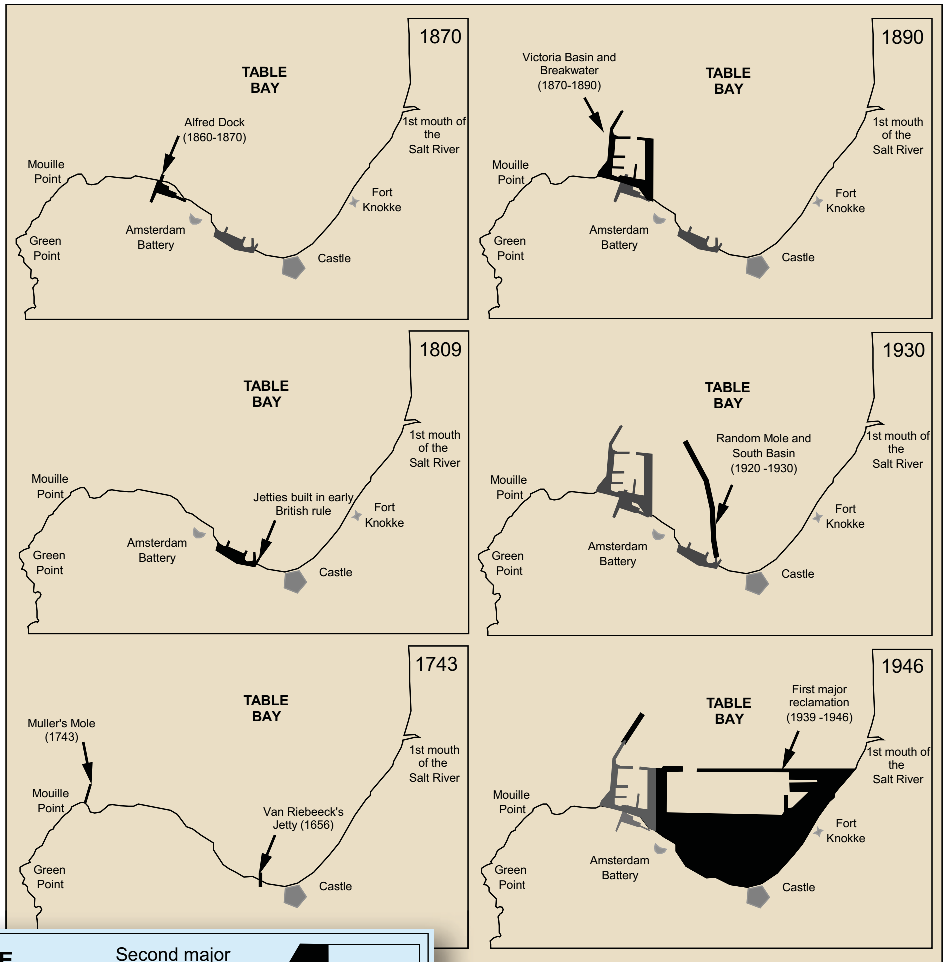
The Cape Argus of 14 July 1897 carried an enthusiastic four-column leading article on the merits of Rigby's drainage scheme, on the occasion of municipal voting for authority to raise loans for the completion of the scheme. The experiences of a dutiful reporter who ventured into the underground works bear repeating.

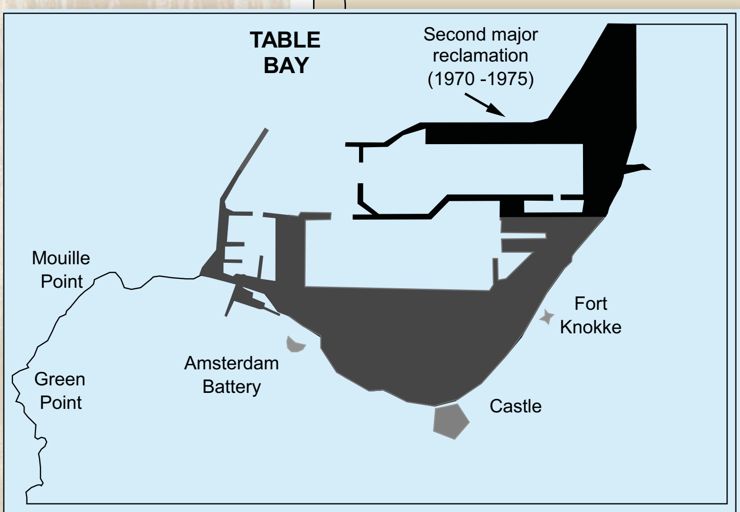
"Descending a ladder I made a bold plunge into the darkness and dampness of the sewer. For a few minutes I was kept busily employed in attempts to keep my candle lighted, but a tip from the foreman enabled me to proceed and I could examine the solid and substantial brickwork of the sewer. Undoubtedly it had been remarkably well done.

Crawling along a damp culvert four foot six inches high is not the best position for the manufacture of poetic thoughts, but, as I watched the bricklayers toiling at their craft, with the blackness of their surroundings hardly relieved by the feeble glimmer of their candles, the thought was suggested that they were employed in a life-saving operation, which needed courage and patience and skill, and that upon the success of their task depended the lives of many of our citizens."

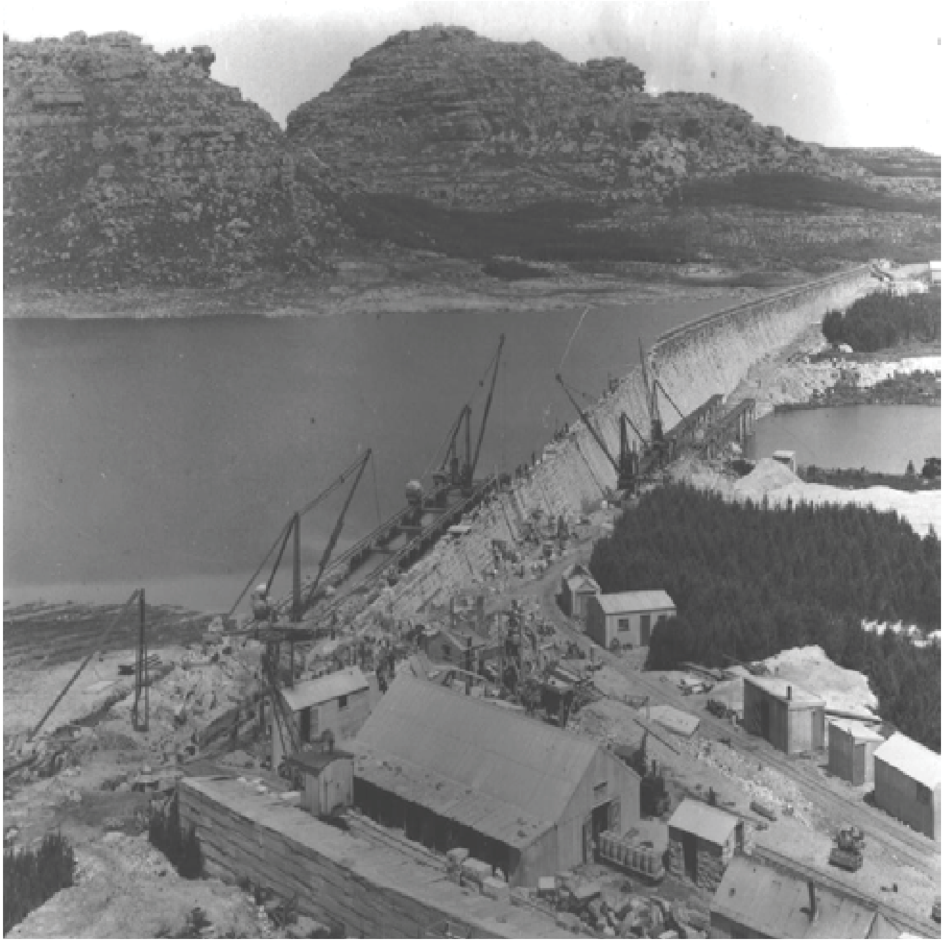
One can only imagine the real problems that existed with such unglamorous and almost forgotten work in the primitive conditions and facilities in existence only just over a 100 years ago.

The changing face of Table Bay harbour from 1900 to 1946 – clockwise from bottom left (Traced from maps)





The face of Table Bay harbour today (Traced from maps)



Western Cape Archives

Hely-Hutchinson Reservoir under construction *circa* 1905 (Photo: City of Cape Town Archives)

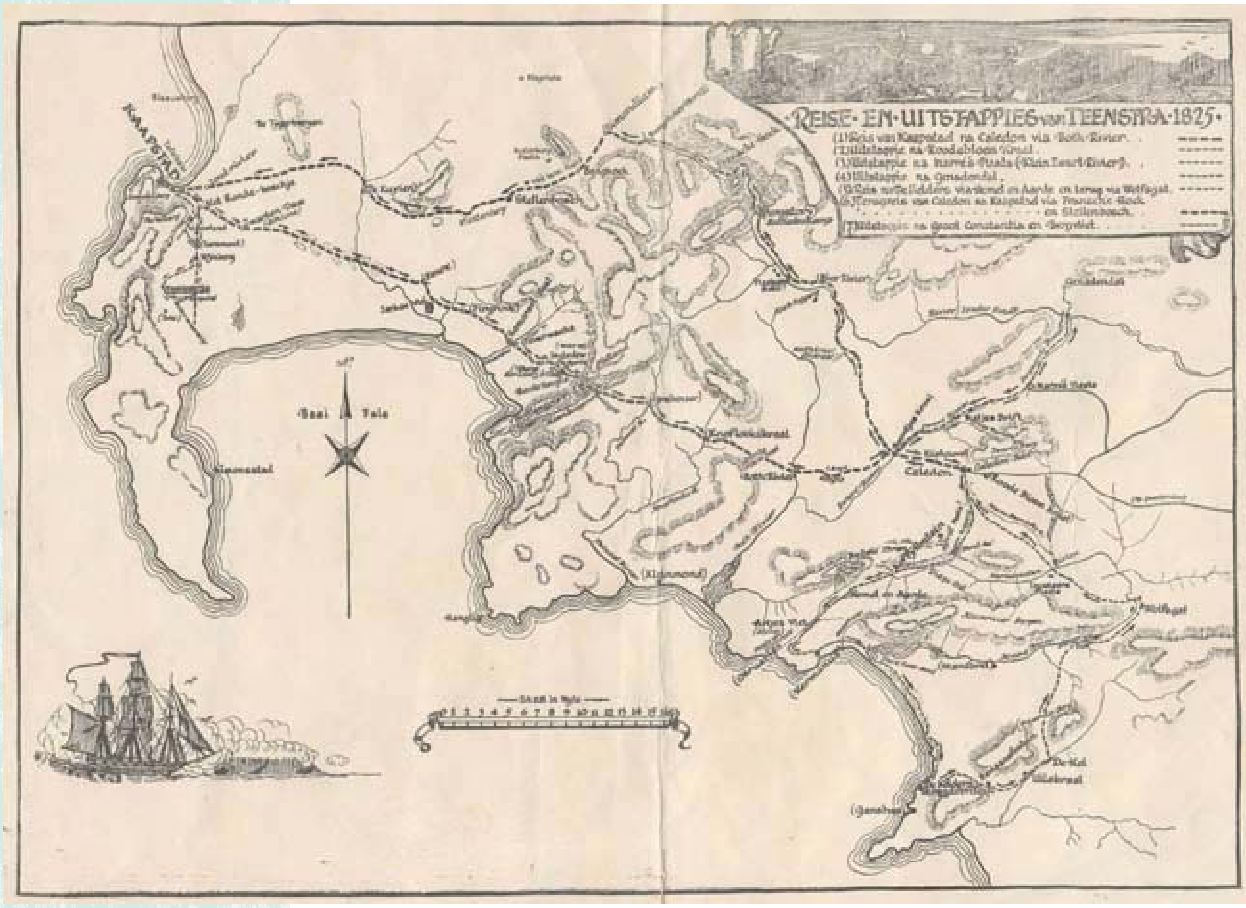
Chapter 5

Urbanisation: the spread of Cape Town

"Don't it always seem to go. That you don't know what you've got 'til it's gone. They paved paradise and put up a parking lot."

Joni Mitchell, American singer and songwriter

When the Dutch East India Company (VOC) established Cape Town as a company town, employees were not expected to live outside the settlement. Soon, however, the free burghers were allowed to settle along the banks of the Liesbeek on small farms. Development stretched further southwards as senior officials such as Simon van der Stel established country estates, and the town of Stellenbosch. By 1731 there were 185 free burgher households in the Cape. About half of these were involved in agriculture, while the rest were tradesmen and lodging-house keepers in the town.



An 1825 map showing journeys and outings from Cape Town, including a visit to Buitenverwachting Wine Farm in Tokai (Western Cape Archives)

At the time of the second British occupation in 1806, a great majority of the colony's 17 000 inhabitants still lived in the City Bowl. Gradually, however, affluent citizens and senior government officials began to move to less crowded areas, and the original free burgher farms were subdivided to accommodate the demand for land. Meanwhile, Dutch families, who fled from Cape Town when the English took control of the Cape, bolstered the population of Stellenbosch. Under British rule, villages began to evolve in areas such as Rondebosch and Claremont, and these received a measure of formal status when churches were built there in the 1850s.

A Mr Maynard began speculating in land in the Wynberg area at this time but land sales were slow because transport to the businesses in town was difficult and time consuming and there was no public transport. For this reason, the less wealthy settled closer to the town in areas such as Papendorp (Woodstock). The completion of the railway to Wynberg in 1864 gave a boost to development along the southern suburbs axis. The line was extended to Muizenberg in 1882.[1]

Some rich merchants settled in the Sea Point area in the 1850s and, when a tram service was introduced in 1862, the area rapidly became a popular suburb of Cape Town.

1 Burman (1984)

Timeline: Urbanisation

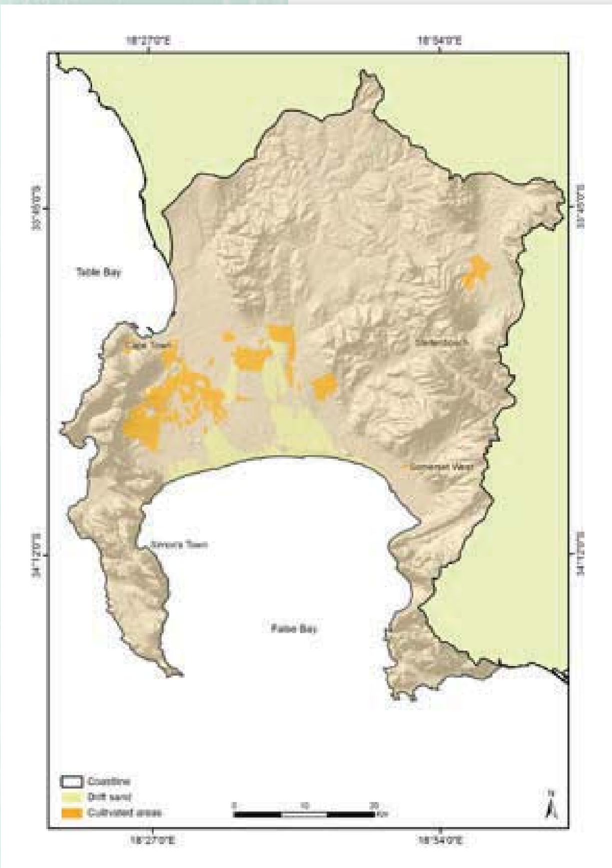
circa	
1652	van Riebeeck establishes a settlement and sets out the basic pattern of the town
1657	Free burghers settle on farms in the Liesbeek Valley
1679	van der Stel founds Stellenbosch
1699	van der Stel establishes farms in the Constantia Valley and builds road to Hout Bay
1830	Distinct communities develop at Sea Point, Wynberg and in the Liesbeek Valley
1840	Cape Town expands towards District Six
1845	Hard road built across the Cape Flats to Tygerberg and onwards to Somerset West
1862	Tram service to Sea Point introduced
1864	Railway line to Wynberg complete
1882	Railway line extended to Muizenberg, and the village of Somerset West established
1901	Small community established at Ndabeni
1912	Seven municipalities amalgamated to form Greater Cape Town
1927	Formal township established at Langa
1930	Athlone housing project started
1935	Development of Parow, Goodwood and Belville starts
1970	Rapid urbanisation around Durbanville Hills
1975	Mitchell's Plain development starts
1980	Informal settlement at Crossroads firmly established
1983	Khayelitsha commissioned
1990	Construction begins on homes in Blue Downs and Delft
2000	Unicity formed. Major development on the West coast axis, north of Milnerton

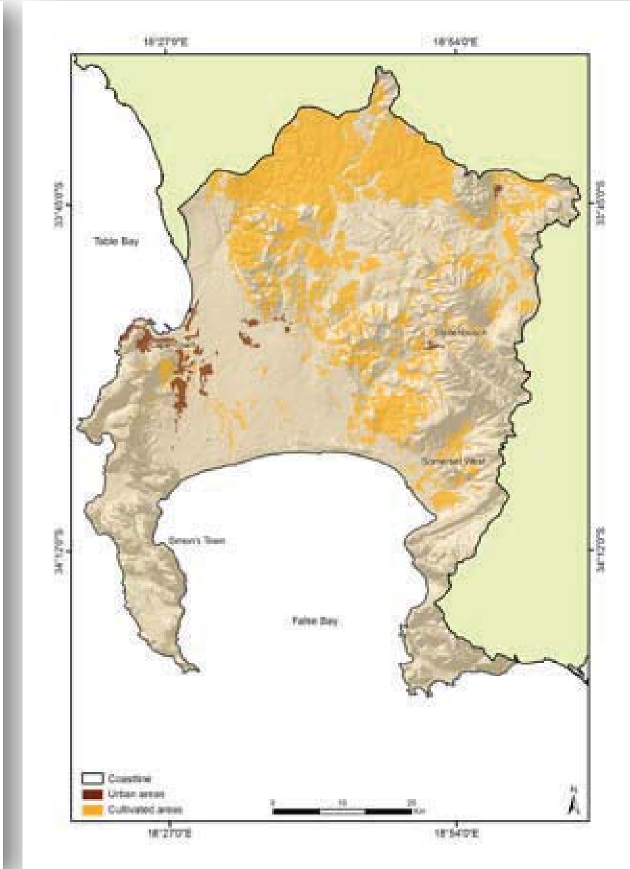
Initially little development took place along the "northern suburbs" axis beyond Maitland, and by 1900 Bellville still only comprised a few scattered buildings.

A small settlement of black people was established at Ndabeni in 1901, but the residents were forcibly moved to Langa in 1927.

*Over the last decade, the spread of urbanisation and agriculture in Cape Town and its environs has resulted in a loss of natural vegetation at a rate of 12 square kilometres per year.**

* Julia Woods, City of Cape Town, personal communication





(left) The dominant land use in Cape Town and surrounding areas remained agriculture until the beginning of the 20th Century, as shown in this depiction of land use in the early 1900s.

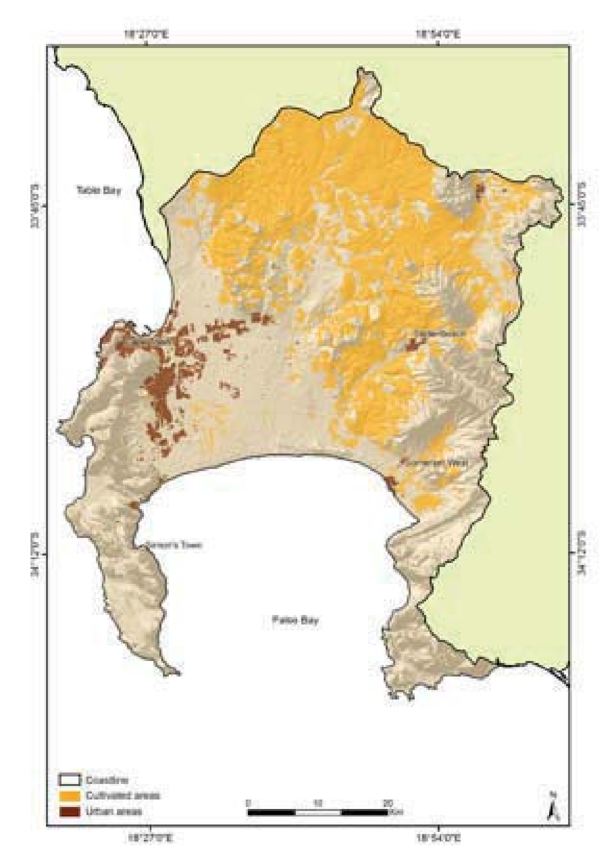
(right) The spread of the urban areas of Cape Town and Stellenbosch is clearly shown in this depiction of land use in the early 1940s.

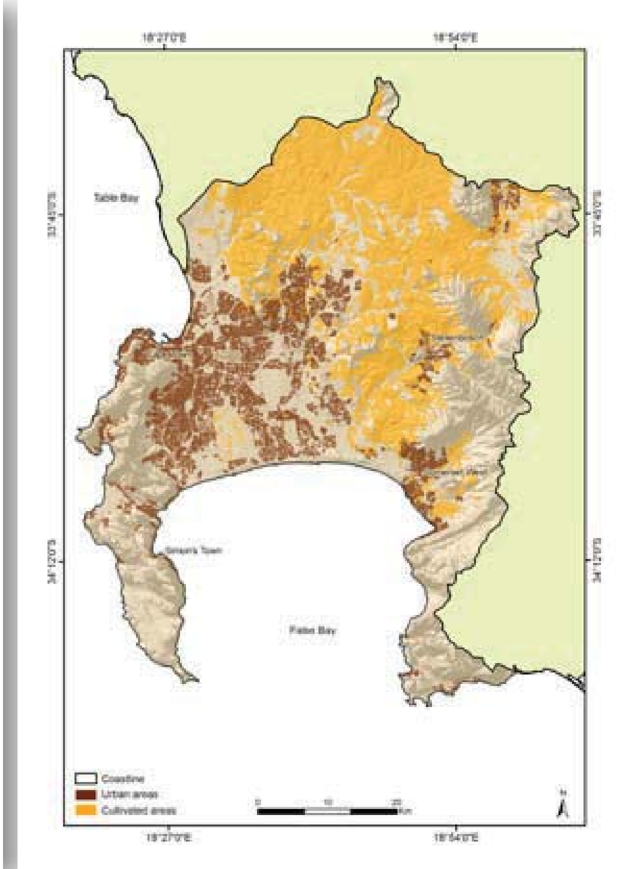
By 1930, the City of Cape Town had commenced with housing projects at Athlone on the Cape Flats. The towns of Parow, Goodwood, Milnerton and Bellville evolved between World War I and II when there was significant white and coloured immigration from the platteland during the Great Depression.

By the end of World War II, the population of Cape Town was about 500 000. New industrial areas were established at Epping and on reclaimed land at Paarden Eiland. The imposition of apartheid accelerated the provision of vast areas of state-funded housing in areas such as Bonteheuwel and Manenberg. A further major area, Mitchell's Plain, was developed from 1975, and when the available space was filled by about 1990, construction began on large housing projects in the Kuils River Valley at Blue Downs and Delft.

In the northern suburbs, the vast seasonal wetland of Tiervlei was drained to make way for the housing areas of Ravensmead and Uitsig. Belhar was established to cope with the overflow from Elsies River and the northern suburbs. Urbanisation of the areas surrounding the Tygerberg hills accelerated from about 1970, with upmarket suburbs being established around Durbanville and developments for the less affluent around Kraaifontein. After 1990, major development took place along the West Coast axis north of Milnerton.

Despite the harsh pass laws, significant numbers of black people managed to make





(left) Post-war developments saw a significant increase in the urban areas of Cape Town and Stellenbosch. This map depicts land use in 1960.

(right) By 2006 much of the Cape Flats was urbanised, and the towns of Stellenbosch and Somerset West/ Strand had expanded considerably.

the move to Cape Town in search of jobs and a better life. This led to the construction of the new townships of Guguletu and Nyanga. By 1980, the informal settlement at Crossroads had been established. After pressure to allow improvements, the government commissioned the demarcation of the suburb of Khayelitsha in the remaining area of the Cape Flats *circa* 1983. Originally it was envisaged that this would be a formal housing area, but as immigration continued, site-and-service development was allowed and informal shack-lands developed. As the area filled, there were overflows into pockets in the Hout Bay and Fish Hoek valleys, and in the Kraaifontein area. Further informal settlements formed in undeveloped areas along National Route 2 (N2), which the authorities are now trying to transform into acceptable townships.

Satellite towns such as Somerset West, Strand and Gordon's Bay grew significantly after 1970 when a freeway was built to these areas.

Water supply

Until recently, the historical growth of the urban water consumption of Cape Town was closely linked to the growth of the population and the economy of the region. Consumption patterns were characterised by periods of adequate supply, followed

Sea Point and Greenpoint, *circa* 1850 (Western Cape Archives)

by intermittent shortfalls and water restrictions as levels of water demand rose above the capacity of the water supply systems. These periods of shortages usually lasted until the next water supply augmentation scheme came online, and so the cycle continued. Between 1965 and 2000, the year-on-year increase in water consumption averaged around 4.1%, which means that annual water consumption doubled twice during this 35-year period.

Since 2000, water demands in Cape Town have frequently outstripped the available supplies. The combined effect of water restrictions and a high-profile public-awareness campaign has resulted in a substantial reduction in water consumption (consumption in 2005 was about 20% less than consumption in 2000), despite continued population and economic growth during this period.

The ever-expanding water requirements of Cape Town

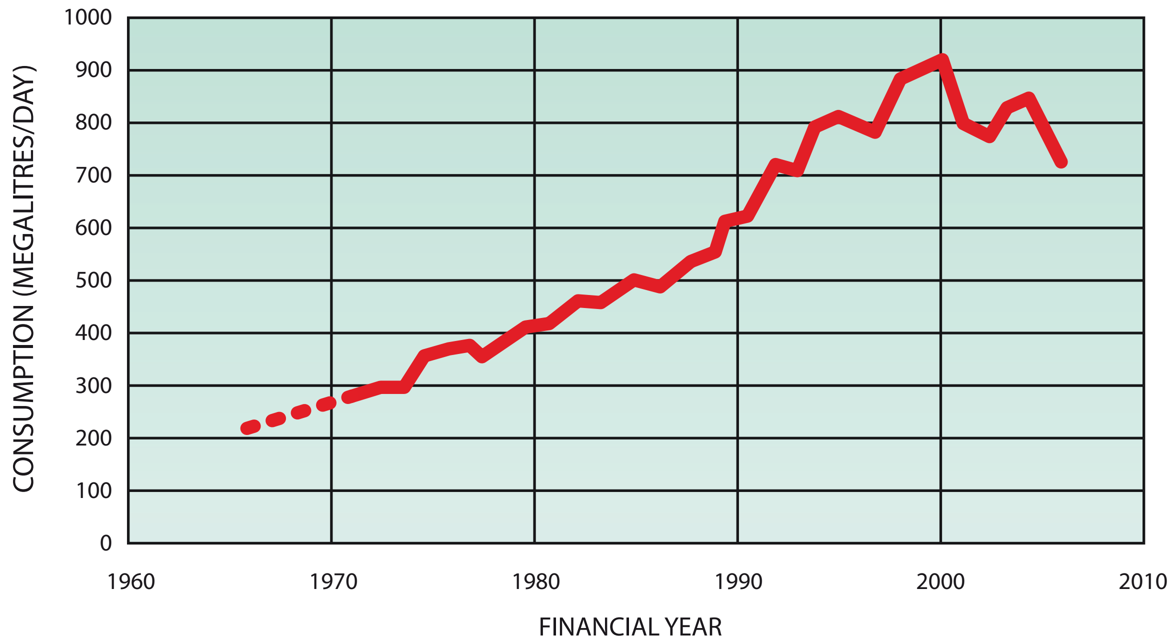
The planning that is done to anticipate and meet the future water requirements is usually based on a 20- to 25-year planning horizon and must consider the main drivers of water demand in the region. These include the effect of global warming on climate patterns in the south-western Cape, the growth of the population and economy, and the degree to which water conservation and demand management programmes can moderate future water demands.

(left) Aerial view of Cape Town, *circa* 1950 (Western Cape Archives)

(below) In Aerial view of Cape Town, *circa* 2005 (Photo: City of Cape Town)

Where to from here?

In the past 60 years the population of Cape Town has grown from about 500 000 to an estimated 3 million people (the 2001 census data for the City of Cape Town [www.capetown.gov.za], excluding Stellenbosch, estimates the size of the municipal population at 2 893 251 people living in 759 765 households). Attempts have been made to limit spatial growth and urban sprawl but, as the boundaries are reached, there is no certainty that such controls will be honoured. Apart from the lack of suitable housing land and the undesirability of penetrating further into agricultural areas, there are other factors such as limited water supplies, restrictions on power, currently deficient transport systems and uncertainty about future fuel availability, which will all affect the pattern and nature of future growth in Cape Town.



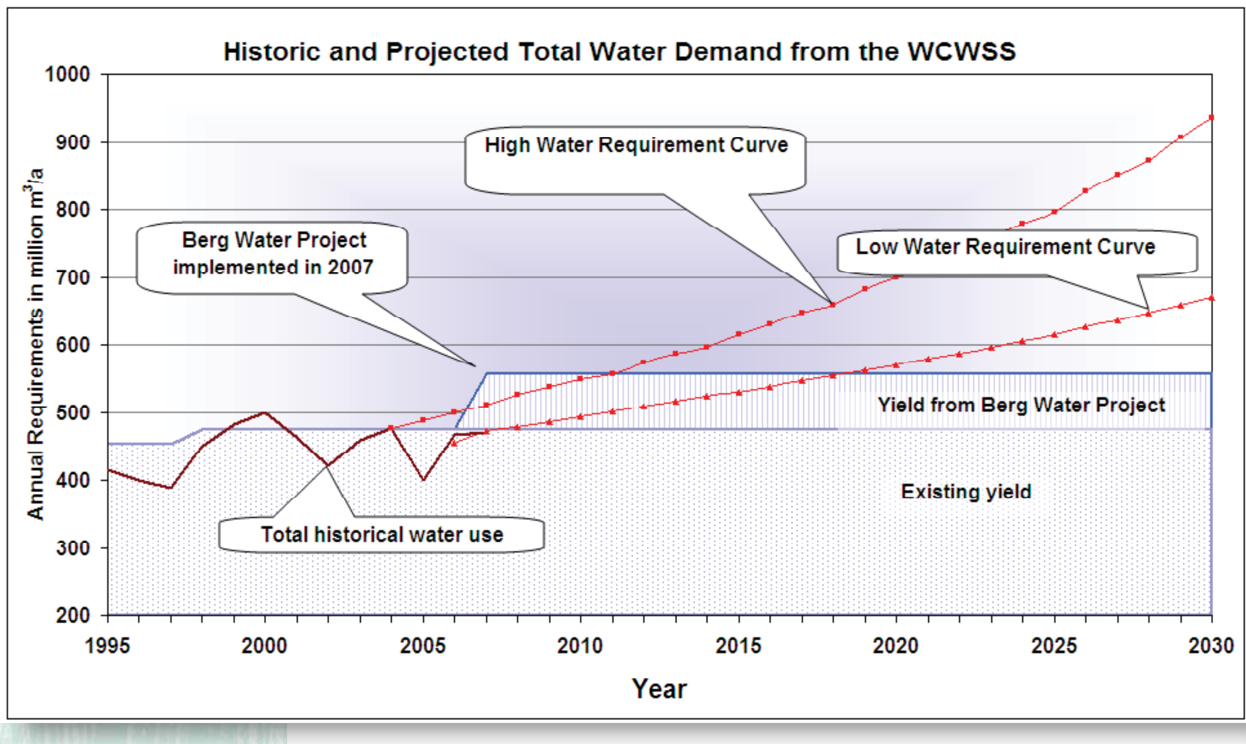
The growth in Cape Town's water consumption – 1960 to 2005 (Ninham Shand 2007)

Climate-change studies in southern Africa consistently predict that winter rainfall in the south-western Cape will decrease, while temperatures will rise. These changes are expected to result in increased consumer demand for water in both the domestic and agricultural sectors by a minimum of 0.7% per annum,[2] while supply will be decreasing over the same period.

Demographic projections indicate that the population of Cape Town will continue growing at a high (but slowing) rate, mainly due to immigration from the Eastern

2 New (2002)

Timeline: Water supply to the City: The first 300 years	
circa	
1652	Van Riebeeck established a VOC victualling station in Table Bay, main water supply is Platteklip Stream
1655	First environmental 'legislation' – aimed at protecting water supplies from human fouling
1660	Platteklip stream dug as a gracht/canal
1670	Wagenaar's cistern replaced van Riebeeck's reservoir at the jetty
1693	Engineering in the city 'improved', in particular that of the canals
1770	Fresh water from the foot of Table Mountain (i.e. Platteklip stream) to the jetty Buitengraght canal established
1813	Main spring of Platteklip covered and piped to a small reservoir (pumps for extraction)
1814	Reservoir built in Hof Street
1819	A "water house" built in Hof street. Water conveyed in iron pipes to Strand, Orange and Long Streets
1849	Drought – Platteklip flow measured at 10 litres a minute
1858	Water sources on Table Mountain surveyed
1866	Town Council purchased Platteklip Stream and constructed a filter bed
1880	Municipal washhouses built on Platteklip
1891	Twelve Apostles' Tunnel to bring water to the city from the top of Table Mountain is completed
1894	Construction of Woodhead, Hely-Hutchinson, Victoria, Alexandra and de Villiers reservoirs on the mountain top in the headwaters of the Hout Bay River started
1897	Construction of Woodhead, Hely-Hutchinson, Victoria, Alexandra and de Villiers reservoirs completed
1921	Steenbras Dam built on the Steenbras River
1927	Steenbras dam wall raised (and again in 1954)
1951	Lewis Gay Dam built on the Woel River (Simon's Town)
1952	Voelvlei Dam built to store water from Klein Berg River and a canal built to transport the water to the dam



The projected future growth water demands on the Western Cape Supply System. (Department of Water Affairs and Forestry 2007)

Cape. The population is expected to have grown from about 2.9 million people in 2001 to about 4.2 million people in 2021.[3]

Before 2000, the economy of Cape Town grew at a rate higher than the national average, but it has since fallen behind other metropolitan areas. The expansion of the area's economy in recent years has mainly been due to growth in the tertiary or services industry, which has a smaller impact on water demands than similar growth in the primary and manufacturing industries. Based on past performance and future potential, the economic growth rate of Cape Town between 2000 and 2010 could average between 4.0 and 4.5% per annum.[4] There is also a drive to reach the AsgiSA[5] target of 6%, which the City of Cape Town has subscribed to.

Despite this, the City of Cape Town has set a strategic objective to achieve a saving of 20% by 2010, i.e., economic growth must be accompanied by a decline in water demand. This requires the progressive implementation of a series of water-demand-management interventions, which include pressure management, education, the elimination of automatic flushing urinals, leakage repair programmes, metering and tariff controls, the promotion of private boreholes and greywater use and the introduction of water-efficient fittings.[6]

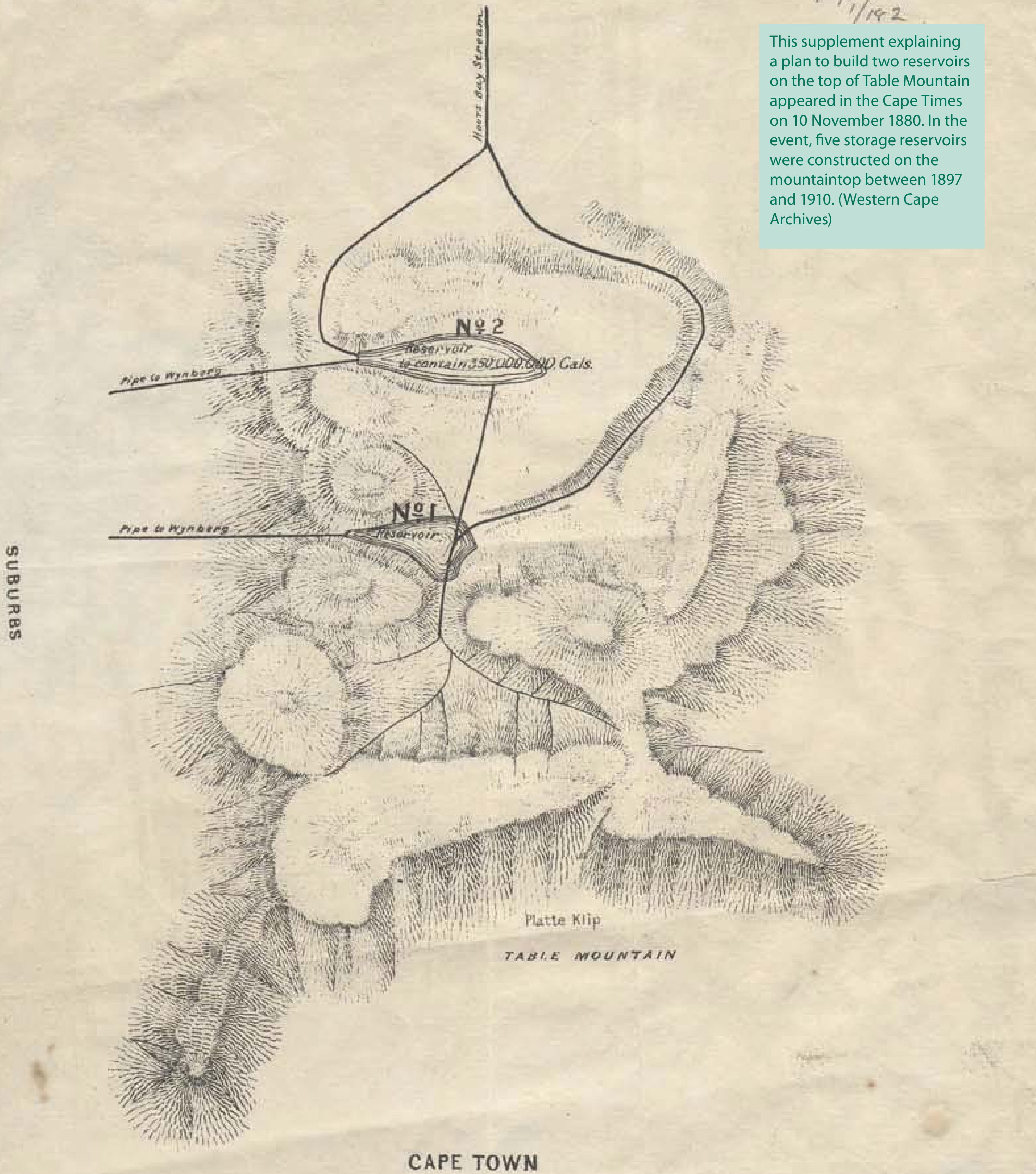
Even if the Council achieves the 20% savings target for 2010, additional sources of water will have to be developed soon thereafter to meet additional demand.

3 Department of Water Affairs and Forestry (2007), Dorrington (2005)
4 Department of Water Affairs and Forestry (2007)
5 AsgiSA is the Accelerated and Shared Growth Initiative for South Africa.
6 Ninham Shand and Arcus Gibb (2001)

SUPPLEMENT TO THE "CAPE TIMES," NOVEMBER 10, 1880.

Map 1/182

This supplement explaining a plan to build two reservoirs on the top of Table Mountain appeared in the Cape Times on 10 November 1880. In the event, five storage reservoirs were constructed on the mountaintop between 1897 and 1910. (Western Cape Archives)



A PLAN FOR THE EFFICIENT WATER SUPPLY OF CAPE TOWN AND ITS SUBURBS.

(SEE ARTICLE IN "CAPE TIMES" OF WEDNESDAY, THE 10TH OF NOVEMBER, 1880.)

Construction of the Hely-Hutchinson dam wall on Table Mountain, *circa* 1905 (City of Cape Town Archives)

Water supply to the modern city

The infrastructure that supplies water to Cape Town forms part of the Western Cape Water Supply System. It is a large, technologically sophisticated network of reservoirs, tunnels and interlinking pipelines that stretches from Saldanha in the north-west to Villiersdorp in the south-east.

The Western Cape Water Supply System is comprised of the following main subsystems, which are described in more detail later on:

- the Table Mountain schemes;
- the Steenbras Scheme;
- the Southern Peninsula schemes;
- the Wemmershoek Water Supply Scheme;
- the Voëlvlei Government Water Supply Scheme;
- the Lourens River dams;
- the Riviersonderend-Berg River Government Water Supply Scheme;
- the Berg River Government Water Scheme; and
- the Saldanha and Swartland Government Water schemes, which do not supply Cape Town.

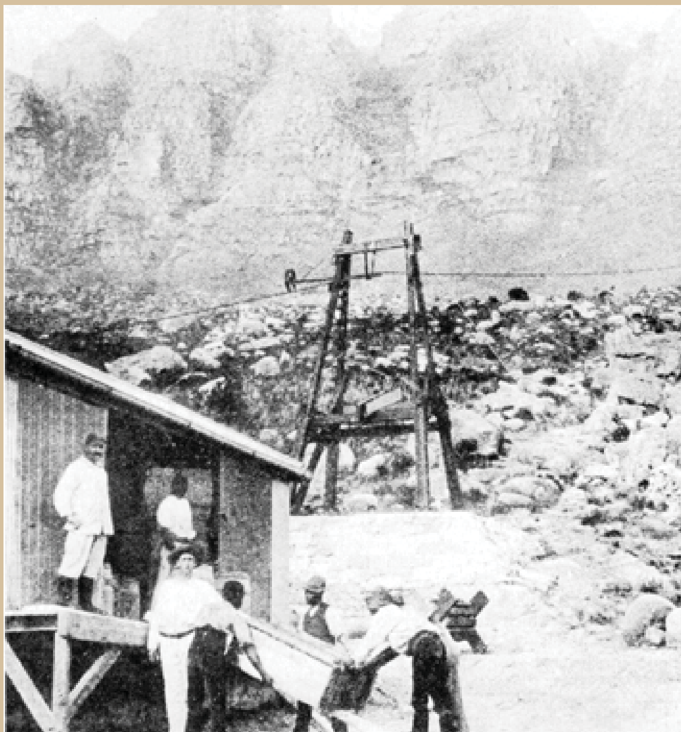
Table Mountain schemes

The Western Cape Water Supply System started more than a century ago with the construction of reservoirs close to Cape Town. Five storage reservoirs were constructed on Table Mountain in a relatively short period between 1897 and 1910. The Hely-Hutchinson and Woodhead reservoirs are located on the Disa River and supply water to the Kloof Nek Water Treatment Plant via the Disa Gorge and the Twelve Apostles tunnel. The Victoria, Alexandra and De Villiers reservoirs are on tributaries of the Hout Bay River. Water from De Villiers Dam is discharged into the Disa River and then diverted into a pipeline that delivers the water to the Constantia Nek Water Treatment Plant.

The Steenbras Scheme

The Steenbras Lower Dam was constructed in 1921 and the wall was first raised in 1928. Water from the dam is treated at the Steenbras Water Treatment Plant on the western side of the Hottentots Holland Mountains above Gordon's Bay. In conjunction with the Table Mountain reservoirs, the Steenbras Dam provided most of the water requirements for Cape Town until the 1950s, when the next phase of

Lower Steenbras Dam in the foreground with Upper Steenbras Dam just visible in the background. The water body on the left is a portion of the reservoir that is part of the pumped storage hydro-electric scheme. (Photo: City of Cape Town Archives)



Wemmershoek dam wall (Photo: City of Cape Town Archives)

water infrastructure development commenced. The Steenbras Lower dam wall was raised for a second time in 1954.

In 1977, the Steenbras Upper Dam was constructed to provide additional storage for water supply to Cape Town, and also to serve as an upper reservoir for the Steenbras Hydro-Electric Pumped Storage Scheme.

The Southern Peninsula schemes

The first of the South Peninsula schemes, the Lewis Gay Dam, was constructed on the Woel River in the mountains above Simon's Town in 1951 to augment water supplies to Simon's Town. A second dam, Kleinplaas Dam, was constructed on the Woel River in 1970.

The Wemmershoek Water Supply Scheme

The Wemmershoek Dam on the Wemmers River was completed in 1957, and remains an important component of the water supply for Cape Town.

Opposite page:

(*top left*) The cableway operated for dam construction that transported men and material from Victoria Road in Bakoven to the summit of Kasteelspoort, *circa* 1898 (City of Cape Town Archives)

(*top right*) Chief Engineer, Thomas Stewart, and colleague in the passenger version of the cable car, *circa* 1898, the journey took about 10 minutes (City of Cape Town Archives)

(*bottom*) Cement casks being lifted to the cableway summit at Kasteelpoort using a cable car, *circa* 1898 (City of Cape Town Archives)

Voëlvlei Dam, an off-channel storage facility near Gouda, constructed in 1952 and expanded in 1970. (Photo: City of Cape Town Archives)

The Voëlvlei Government Water Supply Scheme

Voëlvlei Dam was completed in 1952. Voëlvlei Dam is an off-channel storage facility that is fed by diversions from the Klein Berg, Leeu and Vier-en-Twintig rivers. The Voëlvlei dam wall was raised in 1970, when the Leeu and Vier-en-Twintig river diversions were constructed. The dam currently supplies treated water to Cape Town, and the Swartland and Saldanha regional water supply schemes, and raw water to irrigators along the lower Berg River.

The Lourens River dams

The Land-en-Zeezicht Dam, an off-channel storage facility, was constructed in 1976 to store water extracted from seepage wells (and directly from the Lourens River) for supply to the Somerset-West and Strand Water Treatment Works. For interest, when water quality in the Lourens River is good, water is diverted directly to the treatment works. When it is not, water is diverted into the Land-en-Zeezicht Dam.

The Riviersonderend-Berg River Government Water Supply Scheme

Theewaterskloof Dam is the largest dam in the Western Cape Water Supply System. It was constructed on the Riviersonderend River in 1980, and is the source reservoir for the Riviersonderend-Berg-Eerste River Government Water Scheme, a large inter-basin transfer scheme that supplies water for urban use in Cape Town and Stellenbosch, as well as water for urban and agricultural use in the Berg River catchment and some towns along the West Coast. The dam is connected to the Eerste and Berg River catchments by a tunnel system. In winter, water from the Riviersonderend River and water transferred from the Banhoek and Wolwekloof rivers, tributaries of the Berg River, is stored in Theewaterskloof Dam. In the dry summer months, water is transferred back through the tunnel system to outlets on the Berg River, as well as to the Eerste River at Kleinplaas Dam (not the similarly-named dam near Simon's Town), the Stellenbosch tunnel and the Dasbos outlet.

Construction of the Palmiet River Pumped Storage Scheme began in 1983 and was completed in 1988. The scheme consists of the lower Kogelberg Dam on the Palmiet River and Rockview Dam on the watershed between the Palmiet and Steenbras rivers.[7] The scheme serves a dual purpose in that it is used to generate hydro-electric power during periods of peak demand, and is also used to augment water supplies to Cape Town.

THE WATERWORKS MUSEUM

The Waterworks Museum takes visitors through the early history of water supply to Cape Town. The museum is situated on the "Back Table" between Woodhead and Hely-Hutchinson reservoirs, on the northern side of Table Mountain. The museum was founded by Terence Timoney but since his death it has been managed by the City of Cape Town Waterworks Department.

The Berg River Government Water Scheme

The latest addition to the Western Cape Water Supply System is the Berg Water Project, which consists of the Berg River Dam on Skuifraam Farm in the Franschhoek valley, and a supplementary pumping scheme with a diversion works some distance downstream of the new dam. The site of the new dam is considered to be the last site suitable for a large dam in the Berg Water Management Area. The scheme was subjected to intense scrutiny due to serious concerns about the potential environmental impacts of the dam on the Berg River and its estuary. After a lengthy consultation period and a requirement that the City of Cape Town demonstrate progress with the implementation of water demand management, the Department of Water Affairs and Forestry finally granted permission in 2002 for construction to proceed. The scheme started impounding water in the summer of 2008.

Looking to the future

The water supply infrastructure for Cape Town stretches far beyond the limits of the urban area. Until relatively recently, development of the system has taken place unquestioningly and in response to unrestrained growth in the demand for water in the region. The mounting economic and environmental costs associated with these developments, and the inefficient use of the water and the inequitable distribution of water between the various socio-economic groupings in the region, have forced a fundamental change in the way that national and local governments approach the planning of water provision.

7 The Rockview dam wall is clearly visible from the N2 just before Grabouw.

The Berg River near Franschhoek with the Berg River dam wall in the background (Photo: Dana Grobler)

During the past decade, a number of studies have been undertaken to identify options for reconciling future water requirements (beyond the additional increment that will be supplied from the Berg River Project), with available supply. All of the studies recommended that water demand management should be implemented before any other options, and that the re-use of effluent should be seriously considered as an option. It has been estimated that about 40% of the 180 million cubic metres of wastewater that is generated in Cape Town every year can be re-used at a viable cost.[8] Currently, water from Potsdam wastewater treatment works is reused for agricultural and industrial purposes. There are also a handful of golf and sports facilities that are irrigated with treated effluent.

Other options being investigated include development of the groundwater resources of the Cape Flats and Table Mountain Group Aquifers, a scheme to augment diversions to Voëlvlei Dam, diversion of Lourens River floodwater into Paardevlei and then to Faure Water Treatment Plant, and diversion of Eerste River floodwaters to the Faure plant. Desalination of seawater is also on the cards, with pilot plants planned for the near future.

Wastewater treatment

The perennial problem of the removal of human waste from urban areas, discussed in detail in the preceding chapter, remains with us today. Today the bulk wastewater infrastructure of Cape Town comprises 22 wastewater treatment works, three sea outfalls and 15 major interceptor sewers.[9] In 1999, a study commissioned by the Council found that the total replacement cost of this infrastructure amounted

8 Department of Water Affairs and Forestry (2007)
9 Cape Wastewater Consultants (1999), with some updates

to about R3000 million, and that at least R150 million per year should be spent to maintain and upgrade the wastewater works and marine outfalls.[10] This investment has not been forthcoming, with the result that most facilities are currently operating near or beyond capacity, with poorly treated effluent being released into the environment from some works. In 2006, the City announced a R1 billion five-year "emergency" plan to address the problem, and has issued a warning that new infrastructure projects may have to be postponed until the sewage system has been improved.

The Berg River Dam and the downstream environment

The Berg River Dam is the first dam in South Africa to have been designed, constructed and operated in accordance with the new Water Act (1998). The dam will release 31% of the mean annual runoff of the Berg River with the flow distributed in a manner that will result in the least impact to the downstream river and estuary. This water, known as the Ecological Reserve*, includes requirements for low-flows in summer and winter, and a series of floods that will maintain the channel and provide cues for various biological activities, such as the spawning of fish, the emergence of aquatic insects and the distribution of seeds along the riverbanks. There are also plans for a comprehensive environmental monitoring programme, which will monitor the efficacy of the releases and provide the information to support adjustments to the Reserve should these become necessary.

* National Water Act (NWA) (No. 36 of 1998)

10 Cape Wastewater Consultants (1999)

Photo: iStock Photo

"The art of land doctoring is being practiced with vigour, but the science of land health is yet to be born."

Aldo Leopold in "A Sand County Almanac" (1949)

Chapter 6

The effects of urbanisation on the rivers and wetlands

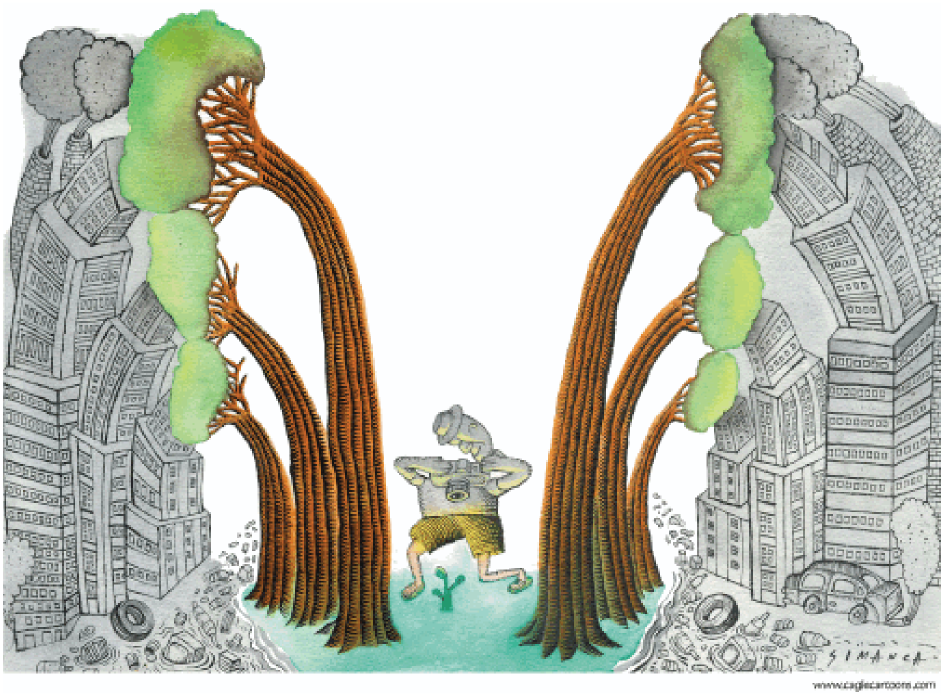
Human hands have brought about many changes to the rivers and wetlands of Cape Town. Reference has already been made to the isolating effects of urbanisation on the upper reaches of rivers in the Southern Peninsula and on the mountain, but what of the lower reaches?

The early inhabitants of Cape Town and Stellenbosch settled near rivers because they obtained their water from them and tilled the fertile soils in their floodplains. As the city grew, and the demand for water exceeded the local supply, water was sourced from farther afield and the central role of the city's rivers changed. Instead of being suppliers of water, the use of these rivers in removing unwanted water or wastewater became more important.[1]

One of the major effects of human activities on the aquatic ecosystems of Cape Town is a modification in the amount of water they receive. Thus, while numerous wetlands have been drained and filled in and lost entirely, many of the remaining once-seasonal vleis have had their characters altered to such an extent by the discharge of treated effluent from waste water treatment works that they are now perennial. Many rivers have been canalised and some, such as the Vaarsche River in the City Bowl, have entirely disappeared, being replaced by underground stormwater drains.

The construction of roofs, paths, tarred roads, freeways, pavements and parking lots has greatly reduced the surface area of soils able to absorb water falling as rain, and has increased runoff from the surrounding land, so that rivers carry more water than before during storms. This is called "catchment hardening". In some cases, more water, moving more quickly along river channels, has resulted in bank and bed erosion, prompting the construction of concrete canals to prevent this, and to convey water through urban areas more efficiently. The problem has been exacerbated by developments on the low-lying parts of the Cape Flats, forcing the construction of canals to drain what would naturally have been seasonal wetlands, and natural flood attenuation ponds.

The engineering of rivers in the area, necessitated by the increased runoff and effluent



Encroaching development by Simanca Osmani (Cagle Cartoons)

1 Harding and Brown (2001)

Floods and floodplains

In hydrologist's language, a storm, or "rainfall event" is a period of rain that causes the level of a river to rise after which it recedes. The size of a storm is measured by its "return period", a rather difficult concept, which denotes the expected average frequency of occurrence for storms of a specific magnitude. Thus a "1-in-10 year storm" will, statistically speaking, occur once every ten years, although in practice two such storms could occur in the same year. A "1-in-20 year storm" would occur once every twenty years, and so on.

The amount of water passing a point in the river at a particular moment is measured in cubic metres per second (m^3s^{-1}), often referred to as 'cumecs'. Note that the flood peak flow for a 1-in-20 year storm is not necessarily twice that of a 1-in-10 year storm.

The amount of water passing a point at a specific moment depends on several factors: the magnitude of the storm, but also the shape of the catchment, the nature of the catchment surface, and the shape and condition of the river.

The peak flood for a particular return period will inundate a specific area of the floodplain. Just as there is not a linear relationship between the magnitude of floods and their return period, the width of the floodplain is not proportional to the return period. For various reasons, the 1-in-20 year floodplain may be several times wider than the 1-in-10 year floodplain at the same point in a valley. Over time, the extent of inundation may also change due to several factors. Rainfall patterns may change; obstructions such as bridges and other structures may retard flow; and the nature of the river itself may alter due to vegetation and erosion. But the most important factor changing flooding in developed areas is usually the change in the nature of the catchment surface and its ability to absorb rainfall.

discharges, has also affected both the aesthetic quality of many river systems and the recreational opportunities offered by them.

In any city a healthy river is a valuable resource, improving the quality of life in and attractiveness of the urban area and providing benefits for public health, recreation and economic growth. Environmentally-sensitive management of urban rivers and wetlands requires scientific models to evaluate the effectiveness and ecological benefits of various management options. These in turn demand a greater understanding of the relative importance of flow, water quality and physical habitat in determining their ecological condition.[2] Increasingly, worldwide, it is being realised that greater environmental, social and economic success can be achieved if urban rivers and wetland fronts are designed with ecological principles in mind.

2 West *et al.* (1998)

Runoff factors

In natural conditions where the ground is soft, such as in a forest, as little as 10% of the rainfall would reach the rivers during or soon after a storm. On the other hand, in urban areas, because of catchment hardening, as much as 90% of precipitation can enter the stormwater system and reach the river shortly afterwards. The runoff factor thus has a major influence on the size of a flood, and, if it changes materially, the width of the floodplain will be altered.

In planning development, the width of the floodplain has to be determined. Within the designated floodplain, permanent structures should be avoided and even agricultural activities limited. However, it is economically impossible to impose restrictions that would cater for very rare storm events as this would exclude large areas of land from development. In practice, development is usually not allowed within the 1-in-20 year floodplain, and only limited development, which excludes housing, and industrial and commercial buildings, is permitted between the 1-in-20 and 1-in-50 year floodlines.

Water quantity

Cape Town has far outstripped its local water supplies, and much of the water consumed in the area is imported from outside its catchments. A lot of this water finds its way into the city's waterways. Effluent discharged from wastewater treatment works has become a major component of river flow, particularly in summer, and Cape Town's rivers are now carrying a significant amount of water that would not in natural circumstances belong in their catchments. Urbanisation has also seen the destruction of many of the wetlands and vleis that would naturally have absorbed or detained floodwaters. This includes a narrowing, straightening and canalisation of the rivers and an increase in flood peaks and volumes as a result of catchment hardening. Increased runoff augments the effects of spates so that flood peaks may be considerably higher than they would have been under the same weather conditions if the catchment were in its natural state.

Vulnerability to floods

Large areas of Cape Town are vulnerable to the impacts of flooding. The degree of vulnerability of communities to the impacts of flooding correlates closely with their socio-economic circumstances, with many of Cape Town's poorer suburbs having been constructed in natural floodplains/wetlands. This construction also resulted in the destruction of many, many seasonal wetlands.

Flooding is caused by swollen rivers overtopping their banks, but also by blocked stormwater drains, which are susceptible to clogging from litter and sediments. If stormwater drains are not cleaned regularly, silty deposits in the bottom of pipes become cemented into a hard layer, and eventually the pipe will be permanently clogged.[3] One of the greatest causes of waterlogged conditions on the Cape Flats is

3 This was the situation in Gugulethu and Nyanga in the mid-1990s when the entire stormwater reticulation had to be replaced because the old network had become solidly blocked as a result of neglect.

Elsieskraal Canal in Pinelands (Photo: Jenny Day)

the water table, which is usually close to the surface and may rise above ground level after heavy rains and remain that way for long periods.

Canalisation and channelisation of the rivers and wetlands

Many of the rivers in Cape Town have been canalised. Many of what are now canals were never rivers, the flat gradient being insufficient to support a river channel, but were instead longitudinal wetland areas. The Big Lotus "River", for instance, is artificial in its entirety (see Chapter 12). Encroachment onto these wetland areas necessitated extensive urban drainage and flood alleviation works, and often the need for these was exacerbated by "flood alleviation" measures upstream that increased flooding on the Cape Flats. (The Elsieskraal River is a case in point.)

Of the Cape Flats rivers that are not canalised (lined with concrete), many are "channelised", meaning their earthen channels have been dug and are maintained by earth-moving equipment.

River	% length canal-ised
Sir Lowry's	10
Eerste	10
Kuils	10
Bottelary	5
Black	55
Kromboom	85
Elsieskraal	65
Vygekraal	50
Liesbeek	40
Diep/Sand	75
Keysers	60
Lotus	95

Water quality

The water quality of rivers in the urban areas of Cape Town and Stellenbosch is often poor, with effluent discharges into the rivers being one of many factors contributing to the situation. To improve the water quality of the rivers, it would be necessary not only to improve the quality of effluent from wastewater treatment works, but also the quality and quantity of stormwater. Furthermore, the loss of riparian vegetation

Construction of the "cut-off canal" to protect Zeekoevlei from seepage from the Cape Flats WWT works. (Photo: Candice Haskins)

reduces the ability of rivers to purify water through natural processes, which contributes to the overall problem.

Sewage effluent

The river environments of Cape Town and Stellenbosch that are directly affected by effluent from wastewater treatment (WWT) works are:

- the Black River, which receives effluent from the Athlone and Borcherds Quarry WWT works;
- the Mosselbank River, a tributary of the Diep River, which receives effluent from the Kraaifontein WWT Works;
- the Diep River – Milnerton Lagoon system, which receives effluent from the Potsdam WWT Works;
- the Kuils River, which receives effluent from the Bellville, Kuils River, Scottsdene, Zandvliet, Mfuleni and SA Infantry Battalion WWT works;
- the Eerste River, which receives effluent from the Stellenbosch and Macassar River WWT works; and
- the Zeekoe outlet canal, which receives effluent from the Cape Flats WWT works.

Other sources of faecal contamination, such as leakages from pipelines or septic tanks, pump malfunctioning and power cuts, and runoff from informal latrine areas, also affect many other rivers in the area.

The discharge of treated effluent to vlei areas is also of environmental concern, since it usually results in the formation of permanent systems of the type unknown under natural conditions.

River maintenance

Silt and soil are washed into rivers from unstable areas, such as construction sites, farming areas or newly-burnt lands. The weather pattern in the Cape leads to low flows in all watercourses in summer. At such times, silt may settle out onto the river and canal beds, where it consolidates – often with the assistance of plant growth encouraged by this phenomenon. By the time flows arrive that are big enough to flush out the system, the silt bed has become established, the depth of the channel

Wastewater

In nature, water purification is brought about by biological processes, and minor pollution in a moving body of water is dealt with in this way.

Wastewater received at a WWT works consists of faecal matter diluted by considerable quantities of kitchen water, bathwater and laundry water. Industrial effluent may also be part of the total load in works serving industrial areas.

Pathogenic organisms, of which *E. coli* are the best known, are destroyed in the treatment process, solids are settled out in the form of sludge, and the remaining liquid effluent, after further modification, is discharged into a convenient watercourse.

In the normal course of business, the quality of the discharge from a WWT works must meet certain basic standards before leaving the works. If met, these standards ensure that effluent is not dangerous to the health of humans and animals, but it may still contain significant quantities of soluble salts, mainly nitrates and phosphates. Overloading and malfunctions occur, however, and incompletely treated or untreated effluent can and does get discharged into the rivers.

Urban stormwater is also discharged into rivers and canals. This may contain pathogens, oils, litter and other dirt. The quality is particularly bad after a long period of dry weather, when the “first flush” washes concentrated pollutants into the stormwater system. Occasional overflows from the foul sewers, also find their way into the stormwater reticulation.

Goldfish in a bowl

"Since 1936, I have observed the deterioration of these rivers with growing concern. In addition to pollution, there is the increasing extraction of water for irrigation and canalisation. From Jonkershoek, we followed up reports from riparian owners and anglers of the discharge of raw effluent into these rivers, taking water samples for analysis. In every instance of suspected pollution, three samples had to be taken in the presence of a factory representative and sealed. One was handed to the factory representative, one to the police and the third taken to Jonkershoek for analysis. I analysed many samples of effluent taken from wineries, tanneries, wool washeries and other factories, identifying and determining the concentration of the pollutants. Chemical samples can vary appreciably with time and at different points in the stream. In fact, two chemists collecting samples at the same time would seldom arrive at exactly the same analytical results. I soon discovered that this led to lengthy arguments in court and adopted the far simpler method of placing live goldfish in various concentrations of the effluent and observing the effect. If one could state that an effluent, even after dilution, killed healthy fish, there could be no argument in court and we usually succeeded in proving our case."

Dr Douglas Hey in "A Nature Conservationist looks back" (1995)

has been reduced and plant growth has proliferated – and the channel can no longer accommodate the required quantities of water.

Eutrophication, an increase in the concentrations of available plant nutrients in water, is an almost inevitable consequence of human presence. Nutrients come from runoff from farms and gardens, from wastewater treatment works and septic tanks, and simply from untreated human and animal waste. The result of this 'fertilisation' is that plants grow faster and often become larger, clogging river channels and hampering the passage of floodwaters.

Urban litter, such as plastic bags, tins, and bottles, that enters rivers on the wind, via stormwater discharges or is dumped by members of the public, also blocks river channels and impedes the flow of floodwaters.

The combination of increased runoff, an increased propensity for channel obstructions, development within the natural floodplain of rivers and the naturally high rainfall in the Cape winter, has necessitated the development of an intense, expensive, and often ecologically-destructive river maintenance programme aimed at the prevention of flooding in urban areas.[4]

4 Harding and Brown (2001)

Monitoring of rivers and wetlands

City of Cape Town's Scientific Services laboratories maintain an extensive water-quality monitoring network on both the natural (for example, rivers, wetlands and estuaries) and built (for example, canals, detention ponds and stormwater outlets) networks within the City's boundaries.

A range of chemical, microbiological, algal and biological constituents is analysed and the data interpreted from both public health and ecosystem health perspectives. Specialised monitoring is also undertaken in support of research projects that address specific management needs. Collaborative work with tertiary institutions also forms an integral part of the City's efforts to understand the functioning of aquatic ecosystems within the urban environment.

Analytical results are provided to managers to support decisions relating to the management of stormwater, sewage, bulk water and biodiversity resources. Information is also presented at various public forums, such as the Sand River Forum, Zandvlei Action Committee and the Western Cape Wetlands Forum.

The National River Health Programme

The City of Cape Town contributes to the National River Health Programme[5] through its participation in provincial biomonitoring surveys and the implementation of its own local city-wide programme.

Since 2003, two comprehensive "state-of-rivers" reports detailing the ecological health of major rivers in Cape Town and Stellenbosch have been produced in conjunction with the provincial implementation team, and a third on the Berg River has relevance due to the role that the Berg River plays in the area's bulk water supply system.

Once a year, City of Cape Town's Scientific Services also monitor the ecological health at approximately 40 river sites in Cape Town.

Ecological health

The National River Health Programme data provide a bird's-eye view of the ecological health of the rivers. Unsurprisingly, given the pressures to which they are subjected, the ecological health of the rivers plummets once they leave the mountains. In general, rivers in the Southern Peninsula are in the best ecological health, while those in the central suburbs of Cape Town (Salt River catchment) are in the worst ecological condition.[6]

The two State-of-Rivers reports that have been produced on rivers in Cape Town and its environs, plus a third on the Berg River, which has relevance due to the role that the Berg River plays in the area's bulk water supply system

5 www.csir.co.za/rhp
6 www.environment.gov.za/enviro-info/sote/citysoe/cape/water_a.htm

Estimated ecological health of the rivers of Cape Town and Stellenbosch *circa* 2002 (www.environment.gov.za)

Catchment	River	Reach	Condition
Salt	Elsieskraal	Middle	Fair
		Lower	Poor
	Vygekraal		Poor
	Black		Poor
	Kromboom		Poor
	Liesbeek	Upper	Natural
		Middle	Fair
		Lower	Poor
Zeekoevlei	Lotus	Lower	Poor
Zandvlei	Diep	Upper	Good
		Lower	Poor
	Sand	Lower	Poor
	Spaanschemat	Upper	Fair
	Grootboschkloof	Lower	Poor
	Keysers	Lower	Fair
	Westlake	Lower	Fair
Southern Peninsula	Silvermine		Good
	Bokramspruit	Upper	Good
		Lower	Fair
	Schusters		Good
	Klaasjagters/Krom		Good
	Elsjes		Good
Eerste	Jonkershoek		Natural
	Eerste	Upper	Good
		Middle	Fair
		Lower	Poor
	Plankenbrug		Poor
	Blaauwklippen		Fair
	Bonte		Poor
Kuils	Bottelary	Lower	Poor
	Kuils		Poor
Lourens	Lourens	Upper	Natural
		Middle	Fair
		Lower	Fair
Sir Lowry's	Sir Lowry's	Upper	Natural
		Lower	Poor
Hout Bay	Hout Bay	Upper	Good
		Middle	Fair
		Lower	Fair

Western Cape Archives

A sketch by Peter Mundy in 1634 shows Platteklip Stream (marked C) as a dominant feature of Table Valley, described as "a prettie Brooke that cometh from a Monstrous Cleft". Molenwater, marked E, is also shown. (Mundy 1634)

Chapter 7

Rivers of the City Bowl

> *"A prettie Brooke that cometh from a Monstrous Cleft"*
>
> Peter Mundy (1634) – An early traveller to the Cape

Table Mountain provides a platform that receives some of the highest precipitation in the Peninsula, and is the source of countless streams and springs. There are four main perennial streams flowing into Table Valley, namely the Platteklip Stream, Molenwater, Third Stream and Zwaartrivier. There are also several small seasonal streams draining the slopes of Devil's Peak and the saddle to the east, and Tamboerskloof to the west.

The whole process of water management by the Dutch was to direct water flow through the city in a series of grachts, including Buitengracht, Kaisersgracht and Heerengracht. There were furrows in the Company Gardens and along the many streets, for example, Long Street, that were fed by irrigation canals in the same way that Stellenbosch still is. By 1863, the canal system of Cape Town was covered over, partly because of the stench created by pollution, mainly nightsoils, disposed into them (see Chapter 4), but also because people fell into them at night – no streetlights and a time-honoured fondness for wine!

Platteklip Stream

When the first Europeans reached Table Bay, the stream flowing from Platteklip Gorge on the face of Table Mountain was a dominant feature of Table Valley, and was the source of fresh water for passing seafarers. A sketch by Peter Mundy in 1634 shows the prominent position of the Platteklip Stream, which he described as "a prettie Brooke that cometh from a Monstrous Cleft".[1]

Some early maps show the stream splitting into two near the area now occupied by the Mount Nelson Hotel, with the western arm possibly confluencing with Molenwater, which originated from a group of springs at Oranjezicht. Van Riebeeck named this "prettie Brooke", the Varsche (Fresh) River, and for almost 200 years it was the centre of Cape Town's existence. He established the Company Gardens just below the natural split in the river, and diverted some of the water around the sides of the cultivated area, and the rest into a system of minor irrigation furrows. Downstream of the gardens, the river flowed in a substantial furrow, the Heerengracht, alongside what is today Adderley Street,[2] where it was a source of drinking water for both the new settlement, the "Caabse Vlek" village, and for passing ships.

With time, the canal was lined with stonework, and straddled with bridges for crossing. Over the years, as polluted stormwater and untreated sewage entered the system, the waters of the stream became unfit for consumption. To reduce stenches and misuse, and to improve access over the canals, the entire system was covered over with stonework barrel arches (see Chapter 5).[3]

Today the rivers coming off the mountain have been diverted into stormwater drains, but the urban portion of van Riebeeck's Varsche River can still be seen at the gates of Tuynhuys just off Government Avenue. The more natural upper portion of the stream flows as far as a weir in Upper Oranjezicht, and the waterworks on Oranjezicht Estate still exist.

A popular Cape Town urban legend has it that Varsche River river still runs underneath Adderley Street. This appears unlikely. With the implementation of Rigby's scheme in the late 1890s (Chapter 4), or sometime shortly thereafter, the stream was diverted into Capelsloot and the Adderley Street drain was closed off. The covered, and presumably relatively dry, canal remained sealed beneath the road until 1905, when the time came for tramlines to be laid along Adderley Street. A spark from a welding torch ignited town gas[4] that had leaked into and collected in the closed-off canal and,

1 Mundy (1634)
2 So named in 1850 when Sir Charles Adderley (an MP at Westminster) successfully persuaded the British Government to divert a convict ship bound for Cape Town to Tasmania.
3 Flower (2003)
4 The underground gas mains also ran down Adderley Street underground.

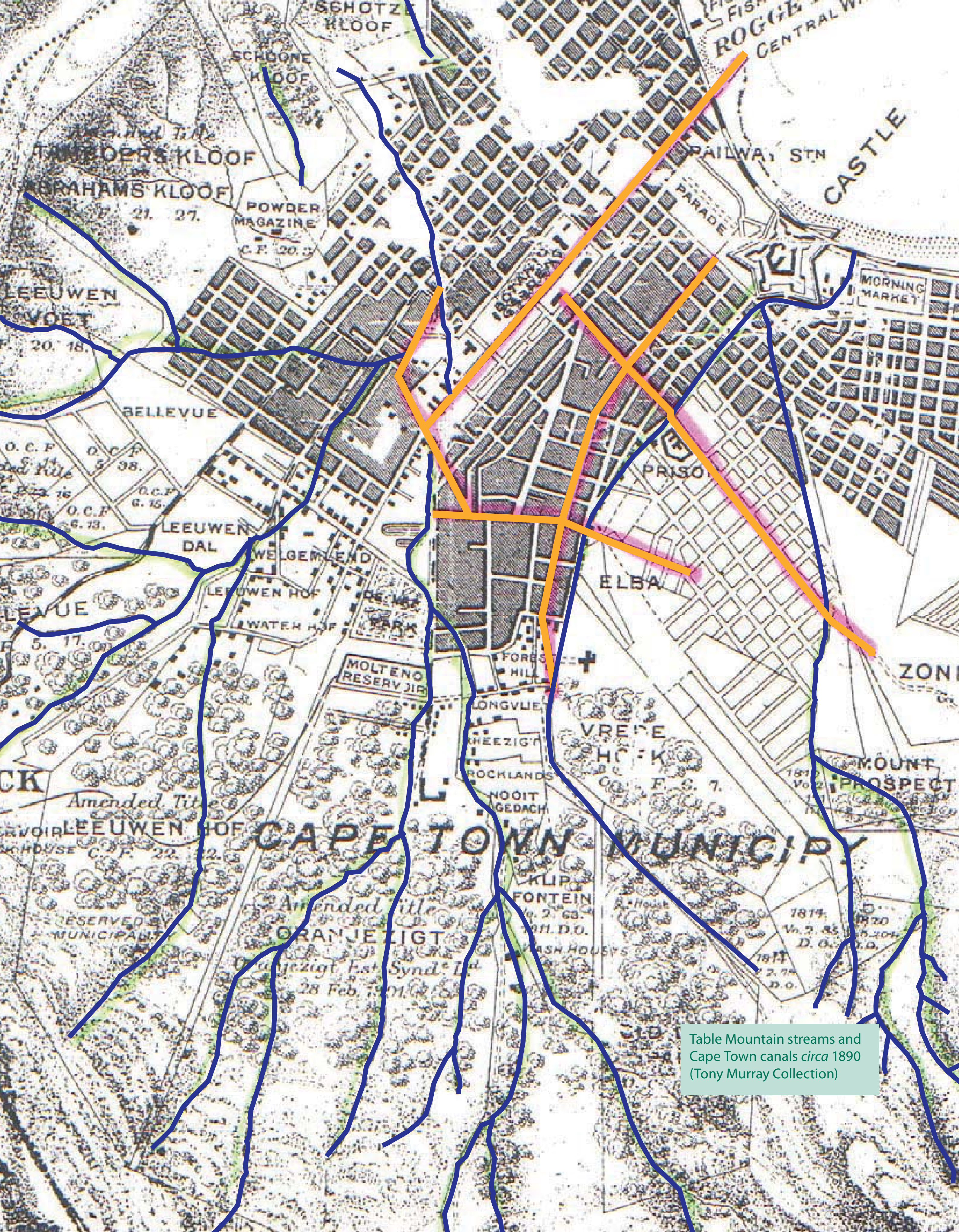


Table Mountain streams and Cape Town canals *circa* 1890 (Tony Murray Collection)

Burst water main after the gas explosion in Adderley Street, 1905 (City of Cape Town Archives)

in a dramatic and lethal explosion, the old canal blew up, creating a 400-foot-long crater. An immigrant nurse was killed, several other citizens received serious injuries, hansom cabs were destroyed, water mains sprung spectacular leaks and there was general chaos.[5] In the aftermath, the old canal was filled in.[6]

And so, the Platteklip Stream has all but disappeared. The flow in the upper reaches has become intermittent, and once it enters the city the entire river is diverted into underground drains, which skirt around the Castle and discharge into the sea in the vicinity of the present yacht basin.

It is a dull and unromantic end for the little Varsche River that so delighted the early settlers.

5 Picard (1969)
6 Burman (1969)

Timeline: Platteklip Stream	
circa	
1634	"A prettie Brooke"
1652	Becomes the focus of Dutch victualling station
1653	Company Gardens created in a split in river and flow diverted in furrows
1655	Van Riebeeck issues plakkaat to protect water quality in main furrow
1660	Main furrow widened and deepened – Heerengracht starts to take shape – and a small dam built at jetty
1670	Wagenaar's cistern built at jetty
1693	Simon van der Stel orders Heerengracht upgraded
1707	Willem Adriaan van der Stel brings piped water from mountain to jetty
1806	Flow partially diverted into Capelsloot. Upper reaches extensively used by washerwomen
1827	Heerengracht covered with stone arch
1897	Flow completely diverted into Capelsloot
1905	Original channel/canal filled in

Third Stream, Zwartrivier and Molenwater

Molenwater (Mill Stream) originated from a group of springs at Oranjezicht and flowed northwest to the top of the present Queen Victoria Street. At the top of the Company Gardens, just above the mill which was turned by its water, Molenwater was joined by Third Stream. Third Stream flowed from the Leeuwenhof and Waterhof springs and Zwartrivier (18th century), and had its source near Kloof Nek. It flowed along Kloof Street to join Molenwater near the present Grey's Pass.

In 1769, the Company reached an agreement with Michael Van Breda of Oranjezicht to harness the flow from a major spring on his farm for public use. The spring had hitherto formed the headwaters of the Molenwater. Van Breda received land "unencumbered by conditions" as compensation.[7] The spring, which became known as Stadsfontein, was owned by the Company and was the main source of water supply for Cape Town until the mid 19th century. In British times, the spring was known as the Main Spring, and the flow was diverted into the Service Reservoirs below Camp Street and later into the Molteno Reservoir. The spring is still in existence and can be seen in a chamber on Council property on the corner of Orange Street and Sidmouth

7 Flower (2003)

RIEBEECK SQUARE

An area alongside the Buitengraght was set aside as a trading square for farmers and their slaves, who used it to trade wine, wheat and other rural produce. The Square was known variously as Hottentots Plein and De Boerenplein, but the name Riebeeck Square endured the passage of time. Today, Riebeeck Square is situated on the corner of Buitengracht and Church streets.

www.givengain.com.

Avenue – a remnant of the old Oranjezicht farm. However, the waters are no longer considered suitable for human use and are discharged into the stormwater system.

In 1771, the Burgherraad decided that water pipes should be laid in the more important streets in Cape Town and Engineer Carel Wentzel was engaged to carry out the work. His first instruction was to construct a cut-off canal on the western edge of the town approximately along the line of the present Bree Street. Wentzel, however, alleged the ground was too rocky in Bree Street and instead he chose to install a drain further up the slopes of Signal Hill where, presumably, conditions were easier. His change of plan was only discovered once the work was a *fait accompli*. The combined waters of Third Stream, Zwartrivier and Molenwater were diverted along the Buitengracht (outside canal), which then demarcated the boundary of the town, albeit that such was unintended on the part of the City's fathers.

Capelsloot

When the Castle was built in 1665-1680, a stream draining the western slopes of Devil's Peak was diverted into a ditch known as the Capelsloot to form a moat around it. In 1902, initial attempts were made to divert this flow into an underground drain but they had to be abandoned in May and June because of the enormous amount of water in the drain. The new underground drain was completed in 1905 and now included the Platteklip Stream. It continues past the eastern side of the Castle in an unusual sharp triangular alignment around the buttress - presumably the line of the moat - before crossing under the railway lines. The line then runs behind the Culemborg goods sheds, parallel to the coast, before turning at the corner of the building and entering the harbour in the vicinity of L berth.[8]

An undated photograph entitled "Devil's Peak waterfall" (Western Cape Archives)

District Six was originally known as Kanaldorp and, although is has been suggested that this was named after the Capelsluit, this watercourse was somewhat on the edge of the district, and there were several other ditches and canals that flowed through the area before draining into Capelsluit. A well-defined drainage line from the northern face of Devil's Peak joins the Capelsluit as it finds its way around the Castle. A larger catchment, which includes the Zonnebloem College area, is drained via Ravenscraig Road and joins the Capelsluit as a box culvert behind Culemborg. Originally, these streams must have flowed through the heart of District Six and may have been the "canals" referred to in the name. The name has, however, been lost to antiquity and the streams and canals are now major features of the town drainage system, but alas, devoid of any romance.

And so Platteklip Stream, Molenwater, Third Stream and Zwaartrivier are today no more than drains, beneath the City.

8 Burman (1969)

Laundry in the Liesbeek *circa* 1800 (Western Cape Archives)

Chapter 8

The Liesbeek Valley

"The loveliest of fresh rivers"

Jan van Riebeeck – first Dutch Governor of the Cape (1652)

The Liesbeek rises on Table Mountain above Kirstenbosch Botanical Gardens as a number of streams draining the eastern slopes of Table Mountain. The southernmost tributary, and the source of the Liesbeek, is known as Protea Stream. This originates as the Vaalkat, Nursery and Skeleton streams, which rise on the southern side of Window Buttress at the catchment divide with the source of the Hout Bay River. The Vaalkat, Nursery and Skeleton streams merge in Kirstenbosch. The Protea Stream is joined just below Rhodes Drive by Window Stream from the gorge on the northern side of Window Buttress. In rainy weather, the stream is marked by a spectacular waterfall, which can be seen from as far away as the Cape Flats. Near Paradise Road, the Liesbeek is joined by the Hiddingh Stream, which arises at an altitude of 920 metres near Maclear's Beacon on the top of Table Mountain. The remaining streams join the Liesbeek after being piped in stormwater drains though the developed areas. These include the Papenboom, Newlands, Albert and Mount Pleasant streams. The Liesbeek joins the Black River about 2 kilometres from their mouth in Table Bay.

Although the Liesbeek is now severely impacted by urbanisation, it still retains some features of the natural river and is a valuable recreational and educational resource. Because it arises on a steep coastal mountain, the river is most unusual in that it displays, in microcosm, many of the features of much bigger rivers. The river itself is no more than 9 kilometres long, and much of the lower part is canalised, yet most of the zones found in much larger rivers can be discerned: the mountain torrent from the source on Table Mountain to the upper boundary of Kirstenbosch Botanical Gardens, the mountain stream through Kirstenbosch, the foothill zone from Kirstenbosch to Newlands, some remnants of the middle reaches in the uncanalised reaches in Newlands, and a short remnant of the mature river in Observatory.

Today, the Salt River is canalised, the Diep River severely silted up, and the once-seasonal Black River is perennial and canalised for much of its length. Thus, of all the rivers draining into Table Bay, the Liesbeek retains the most character of a natural river, while the rest are no more than ghosts of their pasts.

Snippets of history

First settled by the San, then the Khoikoi, and then the Europeans, the Liesbeek has long been a source of grazing, water and fertile soils for those drawn to its banks. Unlike the Europeans, however, the San and Khoikoi left little evidence of their presence.

Van Riebeeck is credited with naming the Liesbeek. On encountering it on 28 April 1652, he described it as "the loveliest of fresh rivers".[1] He originally named it "Varsche" (not to be confused with the Platteklip Stream, which was also called the Varsche River) and later referred to it as the "Soete" and the "Amstel", but it appears that by 1657 he had settled on the name "Liesbeek".[2]

The name is possibly derived from the words "lies" (a reed) and "beecq" (a stream), but Burman[3] suggests that van Riebeeck named it after his niece Elisabeth van Opdorp, who married the Secunde (Deputy Governer) Jacob Reynierz. This is given credence by the name appearing as "Elisenbeek" on a map dated 1698.

Van Riebeeck[4] described the Newlands area, which he called the Groenvelt, in some detail:

"The banks of the Liesbeek were covered with shrubs, reeds, fern, brambles and Arum

1 Thom (1954)
2 *ibid.*
3 Burman (1969)
4 Thom (1954)

This painting by D'Oyley shows a bridge across Protea Stream *circa* 1883 (Western Cape Archives)

lilies, and the adjacent forest on the slopes of the mountain was so dense from the top to the bottom, close to the river, that no opening could be found, except for the wagon road from the fort, made for the freemen. The river was deep but fordable in parts. Game abounded, with large herds of antelope, zebra and wildebeest while in the woods warthogs, porcupines and small animals hid in the undergrowth. Elephant and rhinoceros were about, and hippopotamus disported themselves in the waters. Numerous predators, lion, leopard, wild cats and wolves (hyenas), as well as barking baboons, chattering monkeys and plentiful ostriches, geese, duck, partridge, snipe, heron, egrets and flamingos were daily visitors."

RUSTENBERG HOUSE

The original manor house on Rustenberg Farm dates from the earliest years of the Dutch settlement at the Cape and was declared a National Monument in 1941. It has an interesting place in South African history, as the terms of surrender of the Dutch to the English after the Battle of Muizenberg were signed in Rustenberg House on 16 September 1795. Today, Rustenberg House, is the heart of Rustenberg Girls Junior School.

www.rgjs.co.za

The Liesbeek splits into two in its lower reaches. One arm once flowed into the Salt River Lagoon, possibly along with the Diep, Salt and Black rivers. The second arm had a confluence with the Black River before it too flowed into the Salt River Lagoon. Old maps show a body of water labelled "Varsche Vlei" in the area where the railway lines split to Bellville and Simon's Town, now occupied by the railways electrical works. North of this, between the vlei and the Salt River lagoon, is an area labelled "Salt River Marshes", which was reclaimed and occupied by the railways coal yards during the 20th century. Before the railways and Voortrekker Road were built, the Liesbeek, Varsche Vlei, the Black River marshes and the Salt River Lagoon presumably all linked up. Today, however, although the (canalised) Liesbeek still splits into two at the entrance to the River Club in Observatory, one arm makes an abrupt turn to join the Black River, while a second continues straight along what may be the original course, before it too makes an abrupt right turn to join the Black River.

The Liesbeek Valley exerted an early and powerful pull on the European immigrants to the Cape and is steeped in the history of Europeans in South Africa. In February of 1657, the VOC issued the first permits to free nine company servants, the so-called free burghers, to farm along the Liesbeek. These allotments were of the order of 40 morgen[5] each and stretched continuously from van Riebeeck's lookout, Keert-de-Koe, at the confluence of the Liesbeek and Black rivers (see Chapter 9) to the beginning of the forests near what today is the intersection of Edinburgh Drive and Protea Road.

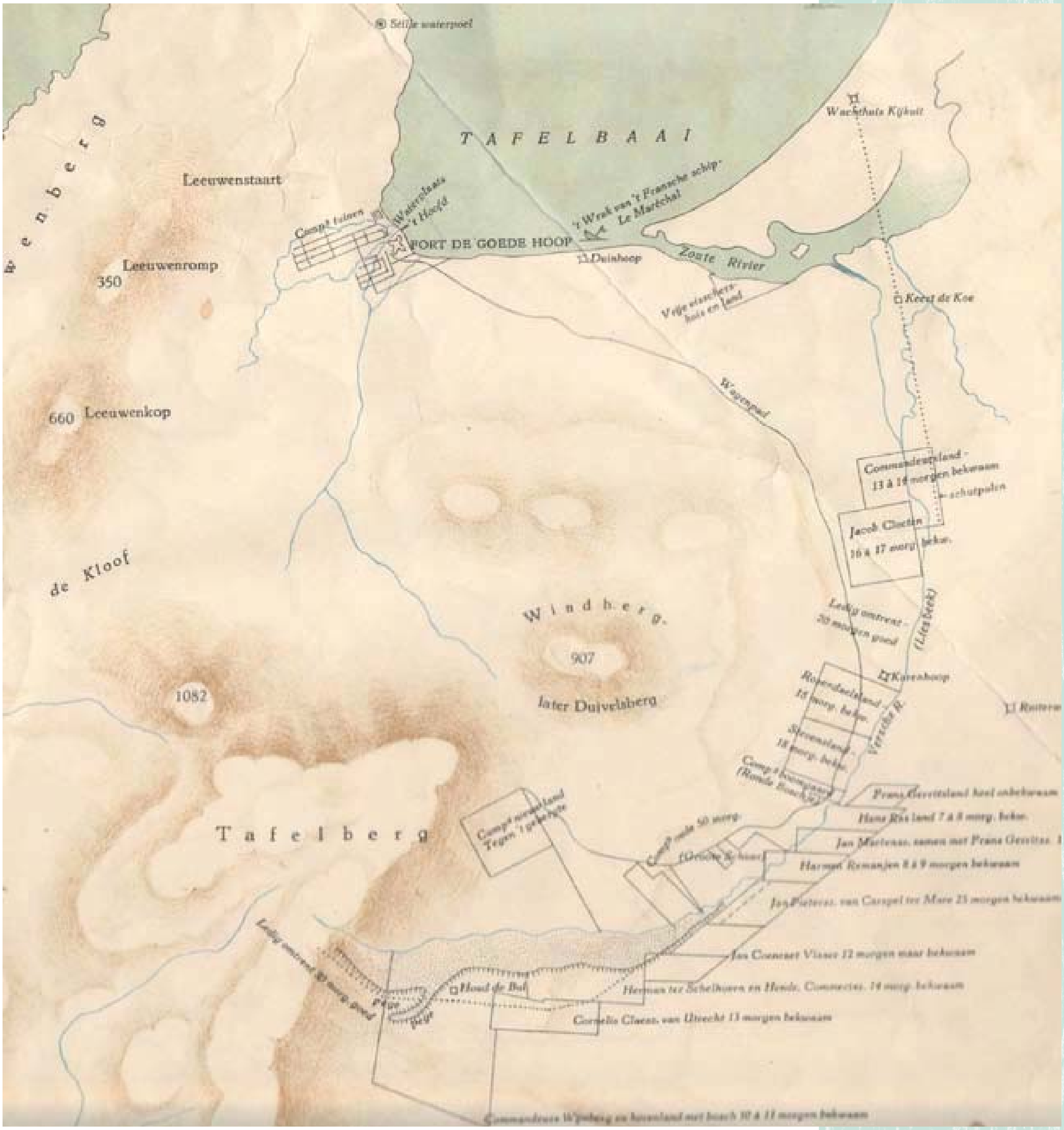
Initially grain crops for the colony and the passing ships were grown in Table Valley, but these were continually flattened by the strong Peninsula winds and plagued by drought. Later, sheltered land was sought beyond the Windberg (Devil's Peak) and trial crops of wheat, oats and barley were grown in the lush soils of the Liesbeek Valley. These were so successful that, in 1657, the VOC transferred all grain farming to the south.

New farms were soon established at Rondebosch in the valleys of the Black and Kromboom Rivers, including Rustenberg, Vredenberg and Valkenberg, and the watersheds between these valleys were used as common grazing land, of which only Rondebosch Common now remains. The present-day alignment of Sandown and Park Roads follows that of the "doordrifts" or "trekpaths" that linked the common grazing land with the Cape Flats vleis. Farming remained the dominant activity of the area for some hundred years.

Company servants, freed from their duties, created independent farms along the valley in the areas now known as Rondebosch and Rosebank. In 1658, further upstream on the Liesbeek, van Riebeeck acquired an estate, known as Bosheuvel, on which he established the first extensive vineyard, now known as Wynberg Hill. In 1686, a ford or "voort" was built across the river at present-day Westerford ("Westervoort") to enable wagons and cattle to cross more safely.

The rapid European settlement of the Liesbeek Valley (and other parts of the Cape) pushed the Khoikhoi from the area. They lost their grazing lands and slowly their herds were eliminated. In 1713 a smallpox epidemic massively affected the Khoi at a time when the herds were weakened from drought conditions and stock diseases.

5 1 hectare = 1.167 morgen



A map of the Liesbeek Valley dated 1661, showing the river (called Versche Rivier here), Salt River lagoon (Zoute Rivier) and the land concessions in the valley. Van Riebeeck's lookout, Keert-de-Koe, at the confluence of the Liesbeek and Black rivers is also shown, as is Wachthuis Kijckuit on what was to become "Paarden Eiland" – see Chapter 10. (Western Cape Archives)

FRIENDS OF THE LIESBEEK

Friends of the Liesbeek were formed in 1991, in response to a call from the then Wildlife Society of Southern Africa Western Cape Branch. The members aim to educate the residents of the area by organizing guided river walks, seasonal newsletters, campaigns and exhibitions and informative river signage. They run the weekly Liesbeek Maintenance Project as well as hacking and weeding parties and periodic major cleanups. They also lobby and network for best management practice of all rivers and engage in numerous networking activities. Visit their website www.fol.org.za for more information.

The Khoi never recovered from this, and their attempts to resist colonial repression and maintain their cultural separation from the colony, proved ineffectual. Many fled the colony to become refugees up-country, others became farm workers for the colonists and intermarried with slaves.[6]

Residential development started in the early 18th century, with many of the farms being bought by affluent city merchants as summer homes. In the mid 1700s, a large granary, known as De Schuur, was built near a round grove of thorn trees known as Rondedoornbosjen (modern Rondebosch). The estate on which the barn stood later became known as "De Groote Schuur". The residence, also known as Groote Schuur, reconstructed in 1896 on this site, was once the residence of Prime Minister Cecil John Rhodes and was bequeathed by him as the official residence of the Prime Minister of South Africa[7]. Today it is known as Genadendal.

The construction of the main road between Cape Town and Wynberg in 1807–1811 encouraged residential settlement, as did the railway connection to Wynberg, established in 1864. In 1814, Westervoort Bridge, one of the first formal bridges across the Liesbeek, was built to a design by Louis Michel Thibault. A number of manned forts were also built along the Liesbeek at this time to protect the farms and homes from attack.

With time, farms were subdivided and suburban villas increased from the mountain slopes to the Kromboom River. By the mid-19th century, smaller villages had developed along the main road and these proliferated with the extension of the railway. The expansion of the villages brought with it industries such as breweries, flourmills and a tannery. Later a mineral water factory (Schhh – you know who) was also established at Albion Spring, Rondebosch.

In 1855, the Liesbeek flooded extensively and the newly-built St Michael's Church in Rondebosch was washed away. However, the Presbytery was saved, and the two front rooms of the Presbytery served as a "church" until 1858 when the second or missionary church was built.[8]

The Ayres family on a boating outing on the Liesbeek River. The family farm was on the site of today's Starke Ayres nursery in Mowbray. (Photo: Ayres family)

Until the middle of the last century, cattle still grazed on the banks of the Liesbeek but these animals belonged to the State Veterinary Research Institute, and were relocated when the research farm made way for the Liesbeek Parkway[9] and the Reygersdal Municipal Sports Club.

Some land has remained in relatively large parcels for institutions such as the Observatory and the Valkenberg Hospital, the various sporting complexes and some major schools, but apart from the breweries complex in Newlands, most industrial uses such as the tannery and flour mills at Rondebosch have since been transformed into office parks.

6 www.scienceinafrica.co.za
7 www.cape-town.net/html/history.htm
8 www.st-michaels.co.za/history.html
9 Liesbeek Parkway was constructed in 1961

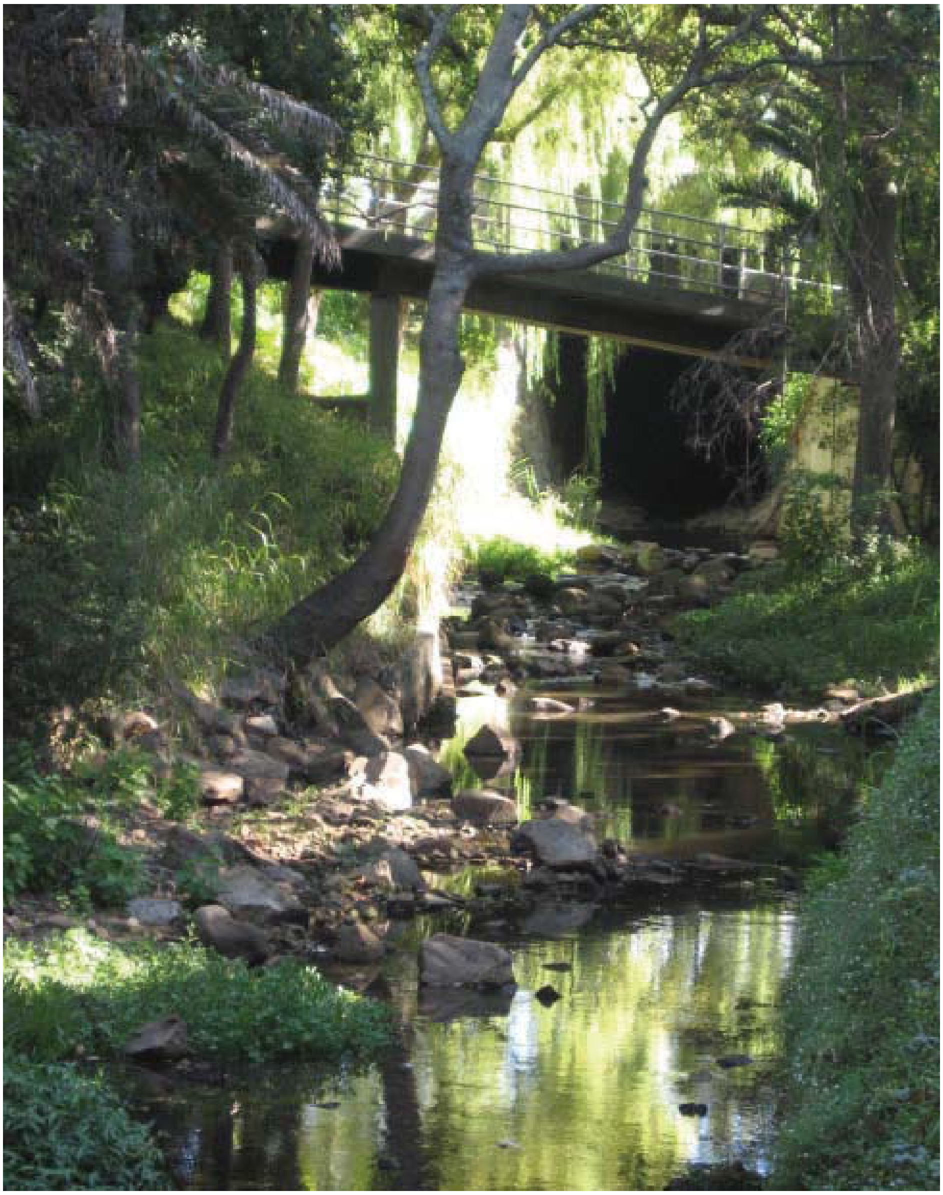
The Westervoort Bridge, named after Westervoort Farm, was built across the Liesbeek in 1814 at the site of the ford that had been in use since 1689 (Western Cape Archives)

Mountain springs and beer

In the years of the VOC (see Chapter 4), permission to brew beer was only granted on a monopoly basis for an annual fee.[10] The Newlands area became the site of several breweries, both legal and "illegal", because of the excellent quality water that could be obtained from Newlands Spring and other springs in the area, such as the Kommetjie Spring.

Brewing in the area received a boost when, in 1664, the Company sent the brewer Rutgert Mensing to the Cape to establish a brewery. Mensing was granted 30

10 Worden *et al*. (1998)

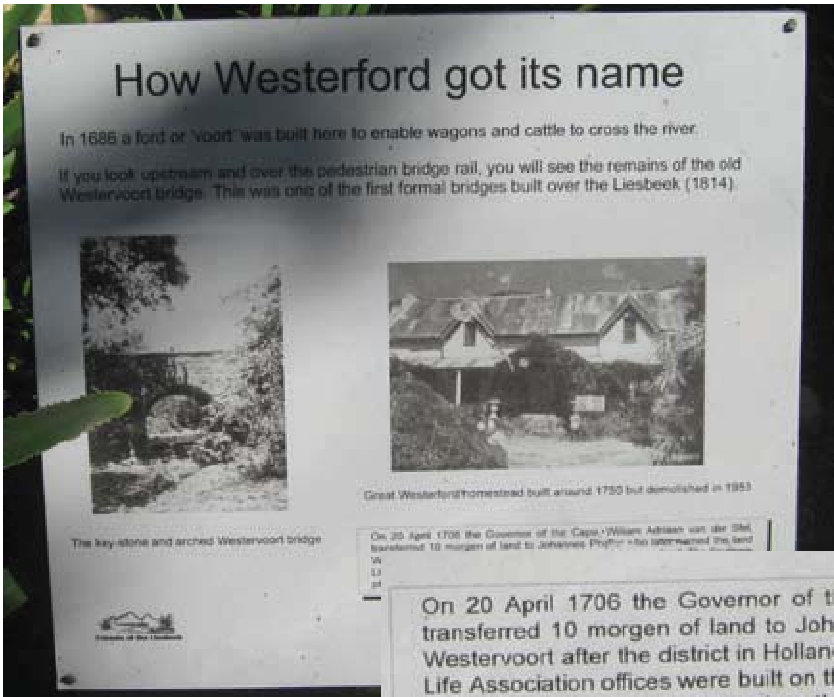


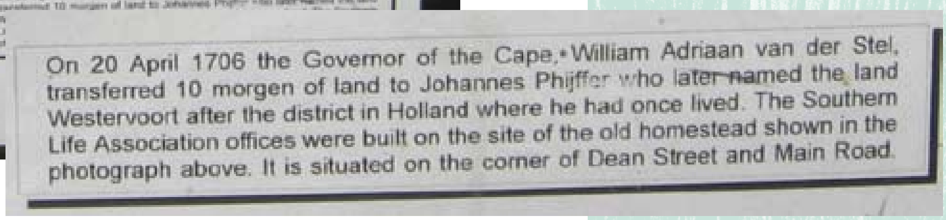
In this photograph of the Liesbeek taken in 2007 downstream of Westerford Bridge, the opening of the bridge is visible under the footpath. (Photo: Cate Brown)

morgen[11] of land, named Papenboom, which extended between the Liesbeek and Newlands Forest, just south of Westervoort. The Company also supplied him with boilers for the brewery and, at least initially, also with hops. It seems the water was fine, but the quality of the local hops was not up to much at that time. The first malt beer was brewed in the Cape in 1669.[12] When Rutgert Mensing died in 1700, the licence to brew beer was transferred to his son, Willem, and his widow, Gerbreght. After the Mensings, various people were licensed to brew beer at Papenboom, which was referred to variously as De Brouwerji, La Brasserie and, later, Anneberg.[13]

11 1 hectare = 1.167 morgen
12 Law (2007)
13 *ibid.*

The headwall of the original bridge built at Westerford in 1814, which crossed the stream at right angles thereby necessitating a kink in Main Road, is still visible alongside the modern bridge at the start of the Liesbeek Trail. (Photo: Cate Brown)





This signage on the Liesbeek Trail, erected by the Friends of the Liesbeek, explains how Westerford got its name. (Photo: Cate Brown)

The present South African Breweries site on Main Road, Newlands was apparently on the farm Mariendahl, which was granted to Jan Louw in 1659. He brewed beer for his own consumption and trade with the locals. A Swedish businessman, Jacob Letterstedt, later inherited Mariendahl farm through marriage and began brewing on a commercial basis in *circa* 1826. Letterstedt was a prominent and influential early

The Friends of the Liesbeek Maintenance Project

The Liesbeek Maintenance Project is a joint initiative between Friends of the Liesbeek and the City of Cape Town. It aims to ensure a litter-free Liesbeek and a well-maintained River Trail. In the process it also creates jobs and develops skills, improves safety and reduces antisocial behaviour, and encourages sound environmental practices.

After a trial phase, the project was launched officially in December 2004. Currently, a three-person team works three days a week mainly from Sans Souci Road, Newlands to Burg Road, Rondebosch. Monthly visits are made to Protea, Bishopscourt, Paradise Park and Kildare Road Bridge and periodically to Rosebank and River Park, Mowbray. They remove litter, cut back overgrown vegetation, weed, sweep the walkway and gutters, clear drains and remove graffiti. City departments provide support by mowing and removing all waste collected. The team have also planted and watered numerous trees and ground covers some of which they have propogated themselves. The Team also do litter audits and simple water quality testing. They have visited other rivers and water bodies in the City, participated on a bird count and visited the Biodiversity Exhibition at Kirstenbosch and the City's Exhibition on Water Saving. They have attended AIDS, first aid and financial management courses.

The major sponsors since inception have been SA Breweries and Tuffy Brands. Individuals have also made generous donations.

Source: Friends of the Liesbeek.

resident of the valley, but in 1849, he fell foul of the colonists when he ignored the boycott on the convict ship Neptune[14], and supplied provisions to its crew and their charges. He left the colony, largely as a result of his breaking the boycott, settled in France and died in Paris in 1862. In about 1848, before the Neptune incident, his estate in Cape Town was estimated at 75 000 pounds "a considerable sum for the time".[15] After his death it took a considerable time to wind up his estate and dispose of his interests, which included Moeders Bewys Farm on Campground Road and Albion Springs Farm downstream on the Liesbeek.[16]

By 1880, there were many small breweries scattered about the area: Mariendahl Brewery owned by the Late Jacob Letterstedt, Anneberg Brewery on Papenboom (then owned by David Ireland), Newlands Brewery owned by Daniel Cloete, and Canon Brewery owned by Dr Jonas Hiddingh (and situated on a subdivision of Papenboom), all of which drew their water from the Newlands Spring. [17]

14 On board of which was the famous Irish rebel, John Mitchel, and his colleagues
15 Dictionary of SA Biography (1988)
16 See map "Shewing the water courses to and on Mariendahl, Moeders Bewys and Albion Springs and other properties belonging to the Estate of the Late Joacob Letterstedt Esq" later in this chapter
17 Including Mariendahl, which was situated on the Liesbeek, with no border on Mill Stream

In 1881, Anders Ohlssen (1841-1912) bought Anneberg from David Ireland, and thereafter set about consolidating many of the smaller breweries into an operation on a much larger scale. In 1888, he gained control of Mariendahl Brewery when the Lettersetdt Estate leased him both the brewery and Josephine Mill. Between 1888 and 1889 he bought several other properties in the area, many of which had been part of the original Papenboom Farm, which had been subdivided over the years. In 1889 Ohlsson's Cape Town Breweries was registered in London. In 1956, this merged with South African Breweries (now SAB Miller), whose Newlands brewery still obtains water from the Newlands Spring.[18]

Water power

The Liesbeek and its tributaries also supplied waterpower for milling flour. Initially, the right to mill corn in the Cape was held by the VOC, and the Company mills were let to millers who received a sixteenth portion of the grain they milled as payment. But, in about 1693, burghers were granted the right to erect mills on their own property, and milling (mainly using wind-power) became an established part of daily life in Southern Africa, especially along the Liesbeek.[19]

It was not until 1818, however, that the first watermill in the valley was built on the farm by Johannes Fredrick Dreyer, who established the mill below Westerford Bridge by damming the river at the site of present Newlands municipal swimming pool and leading the water through pipes to drive a waterwheel.[20] Also in about 1818, Dirk Gijsbert van Reenen, who had inherited Papenboom from his father-in-law in 1783, established a mill for grinding corn on the Mill Stream adjacent to the present Forester's Arms.[21]

Other water mills were also established in the valley, despite the fact that steam power had reached the Cape in 1831. Dreyer's widow, Maria Barendina Bekker, later married the Swede, Jacob Letterstedt. In 1840, Letterstedt built the Josephine Mill, naming it after the then Swedish Crown Princess.[22] In the mid-1800s, John Forrest established the Lothian Water Mill in Belmont Road, Rondebosch. There was also a mill located near the Albion Spring, but which used the power of Mill Stream.

Of these, only Josephine Mill remains. In 1975, Myra East (who was born at Papenboom in 1890) donated the Josephine Mill, which by then was in a sad state of disrepair, to the Historical Society of Cape Town. They restored the building and the milling machinery, and it now operates as a demonstration museum (see www.josephinemill.co.za).

18 The idea of a merger with SAB was first mooted back in 1899 and then abandoned. Although resuscitated many times, many years would pass before this became a reality. (www.sabreweries.com)

19 www.millsofsa.co.za

20 The headwall of the original bridge at Westerford, which crossed the stream at right angles thereby necessitating a kink in Main Road, is still visible alongside the modern bridge at the start of the Liesbeek Trail.

21 Law (2007)

22 Public information signage on the Liesbeek Trail.

This signage erected by Friends of the Liesbeek on the Liesbeek Trail explains some of the history of Josephine Mill. (Photo: Cate Brown)

Lothian Mill was used until 1980. It was demolished in 1990 when the Belmont Office Park was built.

After the mill at Albion Springs closed, it became an ice factory.[23] Some time after that the Schweppes mineral water company took over the property and exploited the spring for many years. When the company ceased operations there in the early 1970s, the spring, which provides about 4.5 megalitres per day, was diverted into Cape Town's water supply system, and further exploitation is still regarded as a possibility to augment the city's supply.

Rondebosch Common

Rondebosch Common was used as a military camp up until the mid-1800s; hence the name given to Campground Road, which runs along the western edge of the common. In 1854, Bishop Gray, the first bishop of Cape Town, acquired the land as glebe[24] land and granted the rector of St Paul's Church permission to graze his cows thereon. There was, however, a stipulation that the land was to remain open for public use.

An area opposite the old Rondebosch Cottage Hospital[25] was also used as a quarry for many years. The excavations filled with water after rain, and were used as a communal laundry area. The quarry was filled in the late 1940s and early 1950s.

Between 1891 and 1910, the Rondebosch Golf Course used the common as their links, which presumably included some novel hazards, such as washerwomen, cows and other users. A pavilion belonging to the Villagers Football Club, whose ground was on the first fairway, was rented as a clubhouse.[26]

23 Owned by Lydia Letterstedt, the daughter of Jacob Letterstedt
24 Glebe land: Church land forming part or all of a clergyman's benefice (Collins Concise English Dictionary 1978)
25 Now the Child and Family Unit of the Red Cross War Memorial Children's Hospital
26 www.rondebosch-golf-club.co.za

Washerwomen used to do their washing on Rondebosch Common *circa* 1879. Note the arum lilies in the foreground. (Western Cape Archives)

The Rondebosch Common is dry here because it is summer (January 2006), but the wetland-type vegetation serves as a reminder that it was once and is still a wetland. (Photo: Jenny Day)

Over the years, bits and pieces of the original common have been lopped off and put to various uses, one of them being the Red Cross War Memorial Children's Hospital,[27] which opened its doors in 1956. In 1961, the Rondebosch Common was proclaimed a National Monument and remains so to this day.

27 A memorial for soldiers who died in World War II

This undated photograph, probably *circa* 1900, is incorrectly labelled “The Old Newland Reservoir”. It is neither the Upper nor Lower Newlands Reservoir refered to in the text, but a small circular reservoir used by Parks and Forests .(Western Cape Archives)*

* David Kriel, City of Cape Town, personal communication

The Common boasts an extremely high diversity of plants (230 species), many contained in some of the last remaining seasonal wetlands in the area, which are now being restored to their former glory by the Friends of the Rondebosch Common.

Some reservoirs of the Liesbeek catchment

Kirstenbosch Reservoir

In Kirstenbosch Gardens, pipes from weirs on both Nursery and Window streams divert winter water to a plastic-lined off-channel storage reservoir with a capacity of 110 000 cubic metres. A further 40 megalitres or so is extracted directly from the streams for irrigation during summer.[28] Unfortunately, since no hydrological data are available for either of these streams, it is not possible to ascertain exactly what proportion of the Liesbeek’s flow is abstracted over the course of a summer, although rough calculations suggest that over half of the natural summer flow is diverted to Kirstenbosch Gardens. It is not surprising, then, that in late summer, the river, which

28 Barry Woods, City of Cape Town, personal communication from Mr Le Roux, Gardens Manager, Kirstenbosch, in 1995

Plan showing the water courses to and on Mariendahl, Moeders Bewys and Albion Springs and other properties belonging to the Estate of the Late Jacob Letterstedt Esq (City of Cape Town Archives)

used to be perennial, frequently stops flowing, and sometimes disappears entirely downstream of Kirstenbosch.

Newlands reservoirs

There are two reservoirs situated in Newlands Forest, the Upper and Lower Newlands reservoirs. The upper reservoir was built in 1905, mainly to capture water from the Cloete Spring, but presumably also other water sources as it has a large storage capacity of 132 megalitres. The lower reservoir was built in *circa* 1950.[29] The reservoirs are still in use today, but now receive most of their water from Steenbras Dam.[30]

29 David Kriel, City of Cape Town, personal communication
30 Alfred Moll, City of Cape Town, personal communication

Mariendahl and Hendrick Dreyer's reservoirs

A large reservoir on Mariendahl Farm is shown clearly on a plan "Shewing the water courses to and on Mariendahl, Moeders Bewys and Albion Springs and other properties belonging to the Estate of the Late Jacob Letterstedt Esq". The map is undated but is presumably from the late 1800s. It appears from the map, that the reservoir on Mariendahl was fed from the Liesbeek, via a canal marked Mill Stream (this is a different Mill Stream from the one that flowed from Newlands Forest). It was located between what is today the railway line and Campground Road, possibly at or near the Newlands Cricket Grounds. A considerably smaller reservoir on Moeders Bewys Farm, labelled Hendrick Dreyer's Reservoir, lies just to the north of the large one. This reservoir is probably in the grounds of present day Kelvin Grove, as Kelvin Grove was the name given to the homestead on Moeders Bewys by John Brodie in 1881.[31] Hendrick Dreyer's Reservoir (labelled H) was also fed by the Mill Stream canal, but led into a complex set of furrows (Upper and Lower Furrow), which extended some distance north along Campground Road and south-west in the general direction of Mariendal Brewery (today's SABMiller), before heading due south into a pipe. These could have been part of an early sewage system.

Mount Pleasant Reservoir

Mount Pleasant Stream was dammed above Rhodes Drive in 1978, adjacent to the Upper Campus of the University of Cape Town (UCT), to provide water for their sports fields. The reservoir was also intended to control floods through the built-up area, such as occurred while it was under construction. Today, helicopters fighting fires also use the water.

UCT Dam

UCT Dam, situated at the top of Woolsack Drive on the Upper Campus of the University of Cape Town, is fed by groundwater.

The realignment and canalisation of the Liesbeek

The Liesbeek, because of the high rainfall in its upper catchment and the fact that it flattens out so dramatically across its valley, is prone to flooding. In the first half of the twentieth century, as urbanisation began in earnest, buildings situated close to the river were regularly flooded in the winter. At Rondebosch, for instance, the river routinely flooded the Main Road at the Fountain, blocking off the bus route, and Church Street (past St Paul's Church and the Rondebosch Police Station) had to be used as a detour. Consequently, between 1942 and 1962, much of the Liesbeek was canalised to increase conveyance downstream of Claremont and Rondebosch.[32]

31 www.kelvingrove.co.za/history.aspx
32 Martin Vershoyle, City of Cape Town, personal communications

Unlabled photo from somewhere in the Liesbeek River *circa* 1900. (Photo: Western Cape Archives)

From upstream to downstream …

Plans to canalise the section of the river from just upstream of Paradise Road to the Vineyard Hotel in Newlands were drawn up as early as 1943, but the work itself was only completed in 1950. The section between the Vineyard Hotel and Roukoop Road in Rondebosch was canalised between 1956 and 1960.

Formal canalisation in concrete from Rouwkoop Road to Durban Road, Mowbray was undertaken shortly after World War II, after severe annual flooding in Rondebosch Village. Canalisation of the section between Forrest Road, Rondebosch and Durban Road took place between 1945 and 1947, with the remainder being completed in 1952. Hart states that, in the vicinity of Stark Ayres, on the old Ayres Farm, the river flowed several metres to the west, so presumably this meander was removed during canalisation.[33]

The stretch of the Liesbeek between Durban Road and the N2 bridge was canalised as part of the construction works for the Liesbeek Parkway, which was completed in 1961.

The section between the N2 bridge and Hartleyvale is an earthen channel. In *circa*

33 Hart (1998)

Liesbeek Lake was created when an elaborate scheme was put forward to create a boating lake in the reach past Hartleyvale (visible in the top right). The river was diverted into old borrow pits to widen the river, and the riparian wetland areas were filled with spoil transported hydraulically from upstream river works. (Photo: Jenny Day)

1943, a scheme was put forward to create a boating lake in the river opposite Hartleyvale. Although this plan never reached fruition, the river was diverted into old borrow pits (quarries) to widen the stream, and the riparian wetland areas were filled with spoil transported hydraulically from upstream river works. The result was Liesbeek Lake.

Beyond the bridge to the Observatory and Valkenberg Hospital, the original split in the river was maintained: one arm of the river skirts the River Club (see below), while a canal takes a more easterly and direct route between the River Club and the Observatory to the confluence with the Black River. The canalisation of the lower Liesbeek notwithstanding, the grounds of the River Club regularly flood in winter.

The channelisation of the arm skirting the River Club was started in *circa* 1942. This is the arm of the Liesbeek that originally flowed into the Salt River Lagoon, although the lagoon was of course long gone by 1942. The river was substantially realigned to create a confluence with the Black River, and material excavated from the new alignment was dumped in the adjacent wetlands to create the Malta Park sports fields (on the opposite side of Liesbeek Parkway from the River Club).

Reconstructed wetland along the side of the Liesbeek Canal, Mowbray. (Photo: Rembu Magoba)

Fish and insects of the Liesbeek

In late summer from about 1980 to 2000, second-year students reading a course in ecology in the Zoology Department at UCT were required to sample the invertebrates of the Liesbeek and to write a report on their findings. By 2000, however, the biota was so depleted that students were unable to collect useful material and the sampling programme was moved to a river outside of the city precincts.[34] The decline in the invertebrate fauna of the Liesbeek has been attributed to reduced river flow resulting from water abstraction, mainly by Kirstenbosch Botanical Gardens, and pollution in the form of pesticides and nutrients.[35]

No data are available on the natural microbiota, such as bacteria, fungi and protozoans, of the Liesbeek, despite the fact that these organisms are a vital component of any normally functioning ecosystem, since they decompose dead material and mineralise nutrients. Data from City of Cape Town's Scientific Services Branch indicate contamination by human waste down the entire length of the river and the water is seldom fit for either drinking or recreational purposes. Contamination is even greater in the lower reaches of the river.

34 A more frequent sampling programme has been implemented recently by the City of Cape Town's Scientific Services Branch

35 Jenny Day, UCT, personal communication

University of Cape Town second-year ecology students sampling the Liesbeek near Albion Springs *circa* 1995 (Photo: Jenny Day)

In the 1990s, the number of aquatic invertebrate taxa was highest in the upper reaches and declined downstream, as did water quality based on bio-assessment techniques.

It seems that no quantitative estimates have been made of the fish fauna of the Liesbeek. It is known that trout (probably the brown trout, *Salmo trutta*) were introduced some decades ago for angling purposes. There are numerous anecdotes of the Liesbeek being a fine trout stream in the past, so much so that Piscator, the journal of the Cape Piscatorial Society, devoted a regular column to Liesbeek Notes. (There were also Eerste Notes.) This is no longer the case. Trout require cool, fast-flowing water and would not survive the present reduced discharges in the upper reaches of the river.

Trout are voracious predators of smaller fish and may well have eliminated most native fish from the river. The only fish routinely collected in the annual UCT survey was the small (<100 mm) Cape galaxias, which was common from Bishopscourt to Hartleyvale in most years. CapeNature has records only for this fish in the Liesbeek, although it is possible that the longfin eel (*Anguilla mossambica*) and perhaps a species of the endemic redfins of the genus *Pseudobarbus*, may have occurred in the river before the introduction of trout.

Other alien fish have occasionally been collected from the river at Hartleyvale. These include carp, mosquito fish and guppies (*Poecilia reticulata*). Carp are widespread aliens throughout the south-western Cape and inhabit many of the rivers in Cape Town and its environs. It is unlikely, but possible, that the old practice of the Cape Department of Inland Fisheries to introduce mosquito fish for the control of mosquitoes and as forage fish for bass was carried out in the Liesbeek. The presence of guppies and mosquito fish is more likely as a result of periodic releases by aquarists but populations of these fish have been unable to become established in the Liesbeek.

In March 1991, there was a severe but transient increase in turbidity in the river that was accompanied by an apparent flush of toxins that killed large numbers of carp in Liesbeek Lake. Interestingly, fair numbers of galaxias were found alive and apparently unharmed in the very turbid waters immediately upstream of Hartleyvale.

The Liesbeek Trail(s)

In about 1990, Friends of the Liesbeek, in partnership with the City and with sponsorship from local businesses, landscaped the banks of the river from Main Road and Belmont Road and constructed the "Liesbeek Trail". At the same time, Prof. Bryan Davies (then of UCT) led some attempts to re-establish aquatic life in the canalised river. Despite problems with theft and general security, the trail remains an attractive feature that is used daily. Similar more recent initiatives by the City, Friends of the Liesbeek and other residents associations have resulted in the transformation of, *inter alia*, the Liesbeek and her banks opposite Riverside Road and alongside Liesbeek Parkway. Congratulations!

This signage is at the start of the Liesbeek Trail. (Photo: Cate Brown)

"ENGLISH FISH"

On setting up the fort and other infrastructure in 1652, Jan van Riebeeck introduced several rules to prevent employees from wasting company time on fishing, although he did remark on the excellent capture of harders and large freshwater eels from the Liesbeek.*

There were no further fisheries controls, until 1867 when the Cape Parliament passed the first piece of legislation relating to inland fisheries. This legislation was designed to protect introduced species, thereby encouraging entrepreneurs or civic-minded individuals to introduce non-native fish into the Cape Colony. Carp had been introduced into the Liesbeek and Black River system eight years prior to this but, apparently, the first carp caught was a 6 pound fish netted in the Black River in February 1866. Presumably, the unlucky carp was then eaten. This prompted a second inland fisheries regulation, which required that "Persons netting 'English fish'. . . should return them to the water".**

* Thom (1954)

** Harrison (1966)

Photo: Rembu Magoba

"The beautiful valley, the good grass and water, and the extraordinary wild flowers."

Simon van der Stel – 9th Dutch Governor of the Cape (late 1600s)

Chapter 9

The Elsieskraal River and the Black River

The Elsieskraal River rises in the Tygerberg Hills on the farm Altydgedacht. There are three springs located on the farm but the river obtains most of its flow from the winter rainfall on the Tygerberg. Its long and winding path to the sea takes in the most diverse and densely populated range of suburbs of all the rivers of Cape Town. Together, the Elsieskraal River and its tributaries drain, among other areas, Durbanville, Tygervalley, Parow, Bellville, Goodwood, Elsiesrivier, Pinelands and Langa.

The Old Bridge over the Elsieskraal River at Mile 12, Bellville was probably built in 1845. (Photo: Duminy 1971)

The early years

When Simon van der Stel undertook his journey north in the late 1600s, he chose the route along the Atlantic coast, keeping the Tygerberg Hills to his right and "walked … mostly through level and watered land". The party halted at a freshwater spring on what later became the farm Rooseboom and van der Stel commented on "the beautiful valley, the good grass and water, and the extraordinary wild flowers".[1]

During the early 18th century, the spring became a popular outspan, known as Pampoenkraal, and was the central crossing point for farmers on their way to the coast or inland. Initially, farmers who settled in the area focused on cattle breeding, as there was a substantial demand for meat, but they soon sowed grain and planted vineyards. Within a decade or two, most farmers were producing enough wine for themselves and their dependants. Mainly white grape varieties were planted, the favourite wine being "Cape Madeira", which was usually Muscadel-based.

In 1806, a town was established around Pampoenkraal and, in 1824, the Dutch Reformed Church, today a National Monument, was built. In 1836, the town was renamed D'Urban to honour the governor of the Cape, Sir Benjamin D'Urban. This was changed to Durbanville in 1886 to avoid confusion with Durban in KwaZulu-Natal.[2]

1 www.durbanvillehockey.co.za/history.html
2 www.durbanville.co.za/dbnvl_history_dbnvl.php

The Elsieskraal River

The Elsieskraal River was a rural stream until the end of the 19th century, when progressive urbanisation and general disregard for nature's grand plans, changed it into the important "drainage path" that it is today.

Flooding and the Elsieskraal River

The Elsieskraal River has a natural tendency to overflow its banks and much of the land adjacent to the river was naturally riparian wetland. Well before the catchment became densely built-up, large areas of Tiervlei and Elsiesrivier were under water each winter, which was typical of many seasonal rivers in the area. In the early years, detention dams along the river length and contour ploughing were used as mitigation measures against flood damage. As the catchments of Cape Town became more developed, and buildings encroached onto the seasonal floodplain, so the annual flooding of the Elsieskraal River became a problem for residents. Scope for reducing flooding of houses situated in the natural floodplain of the river was further limited by the capacity of the Black/Vygekraal system, which was also under pressure from peak flows resulting from hardening of its catchment.

In 1945, the various local authorities met and agreed to canalise the river, but the scheme floundered. In the early 1950s, Walter Stanley Lunn, the recently retired City Engineer, suggested diverting the Elsieskraal River at Goodwood directly to the sea near the Diep River mouth at Milnerton. This seemed a logical scheme, as the Elsieskraal River, on its natural route, is no closer to the sea when it joins the Vygekraal River than it is some 5 kilometres upstream at Goodwood.

While the proposal found favour with the engineers, it was not acceptable to the financiers as each local authority was expected to pay for work in its own area. Under the Lunn scheme, Cape Town City Council would have had to contribute considerably more than if the improvements were made along the natural course. Since the other authorities were not prepared to cover more than their portion of the costs, the scheme died.

The Divisional Council then suggested that the river be diverted across the Cape Flats to Zeekoevlei, draining Guguletu, Nyanga and the Lotus River Estate en route. This might have posed severe problems for the farms in the area, which already had a high water table in winter, and the Cape Town City Council opposed the scheme. The Divisional Council did, however, proceed with an independent canal now known as the Big Lotus River (see Chapter 12).

Meanwhile, the construction of Settlers Way and extensions to the railway system, forced the Council to take action, and bridges were built across the Elsieskraal River near to its intersection with the Vygekraal River. These were subsequently found to be too small to accommodate the flood peaks of the Elsieskraal River (they are reportedly about half the required size). The result was a hydraulic bottleneck where the Elsieskraal River crosses under the railway at Settlers Way. The lower part of Pinelands is thus liable to be flooded in very heavy rainstorms, although this is

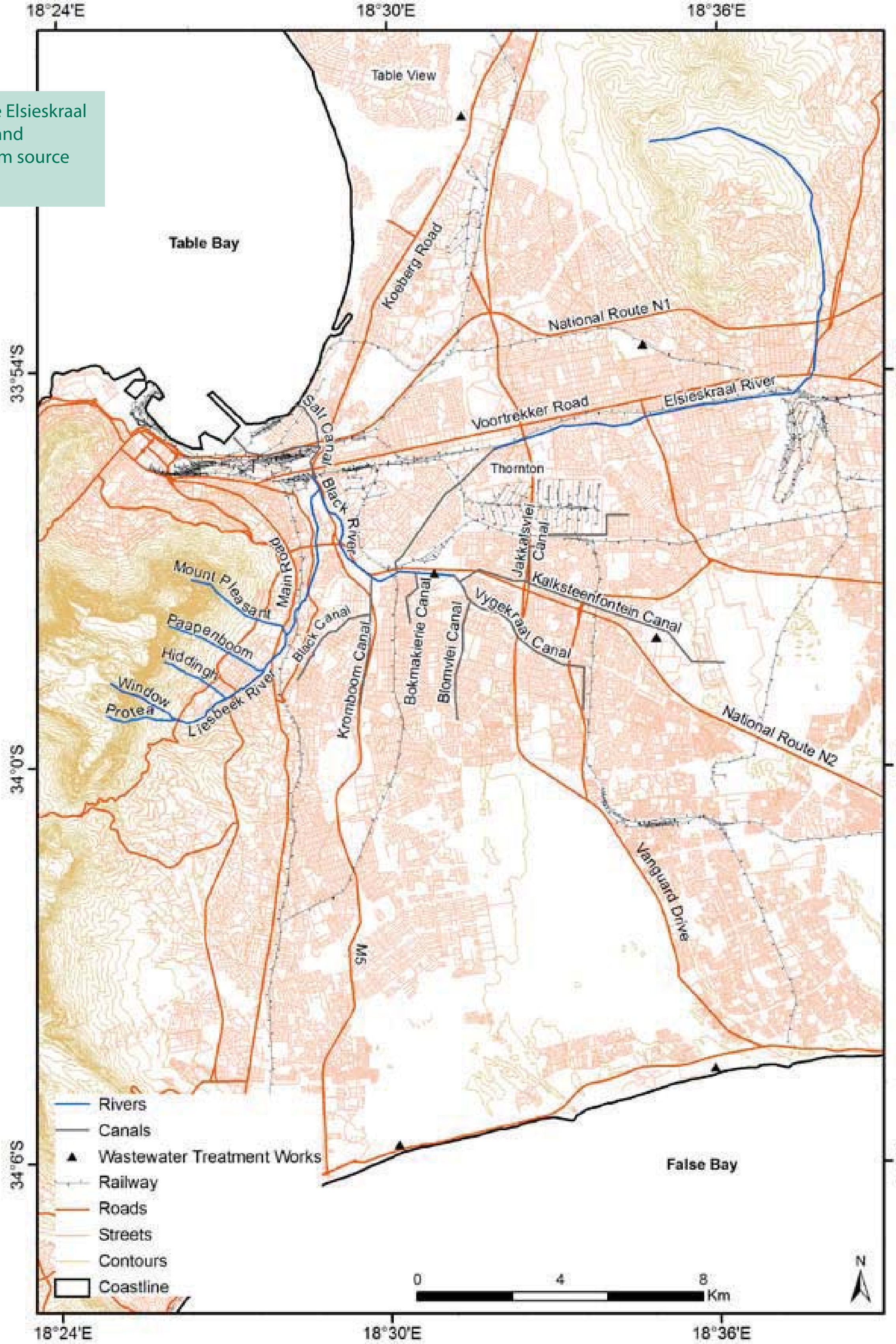
WHO WAS ELSIE?

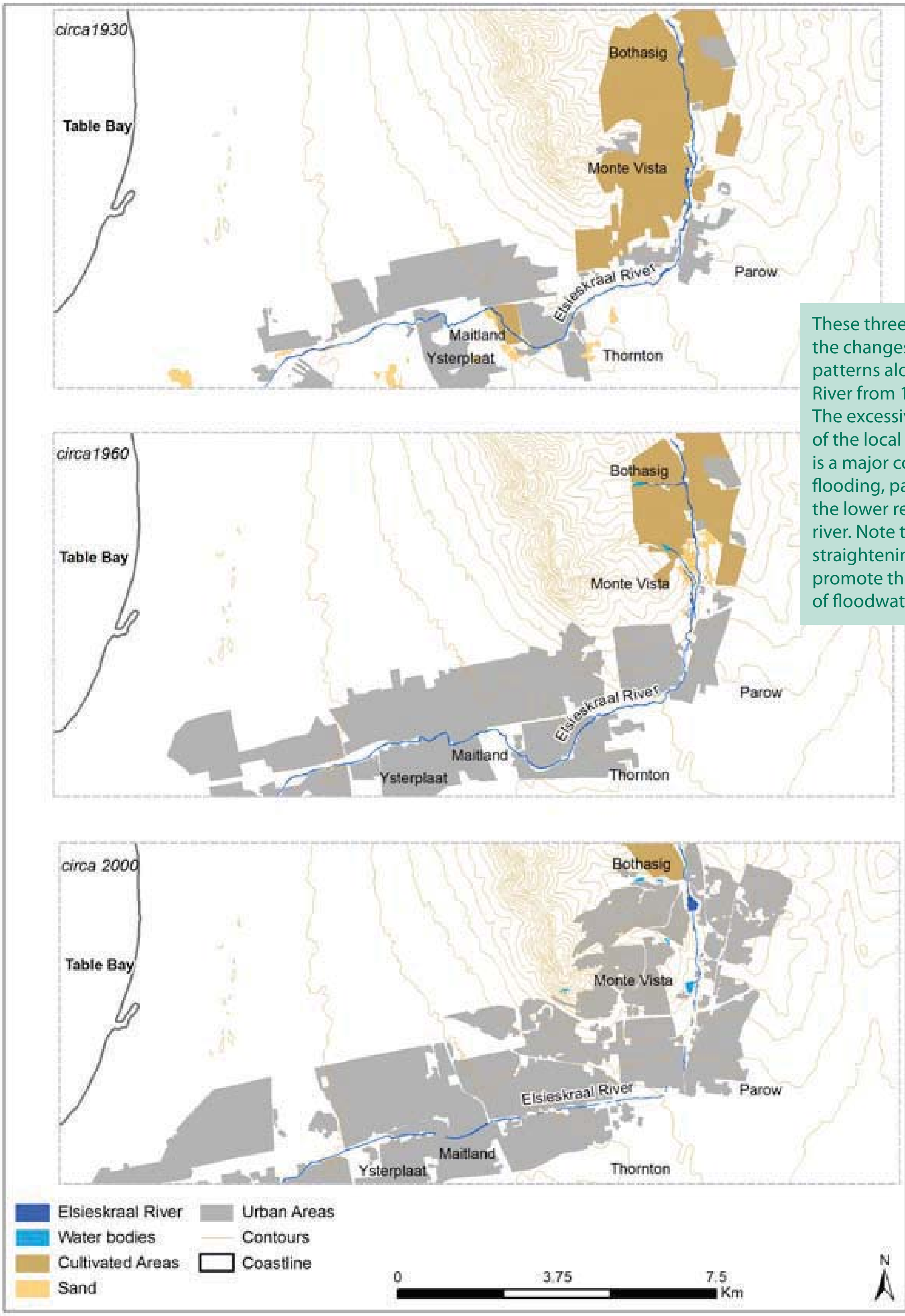
Elsie of the Elsieskraal River (also known for a time as Elsie and Prime's Kraal River)* was Elsje van Suurwaarde, widow of Andries de Man, the Secunde to Simon van der Stel. She was the first owner of the farm Altydgedacht (then named Tygerberg) in the Tygerberg area, near the headwaters of the river that now bears her name, which she took possession of in 1698. She also gave her name to the suburb of Elsiesrivier.

* www.sahistory.org.za/pages/town&c/villages/elsie'sRiver.htm

Walter Stanley Lunn, Cape Town City Engineer 1936-1951 (Photo: Courtesy of G. Lunn)

The courses of the Elsieskraal River, Black River and Liesbeek River from source to mouth





These three maps illustrate the changes in settlement patterns along the Elsieskraal River from 1930 to *circa* 2000. The excessive hardening of the local catchment is a major contributor to flooding, particularly in the lower reaches of the river. Note the progressive straightening of the river to promote the speedy removal of floodwaters from the area.

WHY TYGERBERG?

The first title deeds of Altydgedacht were signed by Simon van der Stel in 1698. At that time, the farm was known as Tygerberg. A "tiger" was the name given to a leopard by the early Dutch settlers and the name Tygerberg comes from the "spots" one sees in the fynbos of the Tygerberg during the hot summer months. The spots are thought to be from termite mounds that give plants in that soil a different colour.

www.altydgedacht.co.za/history.htm

infrequent. A more significant consequence is that the water velocities below the culvert are slowed, thereby reducing flushing and increasing the problem of siltation in the Black River.

Tiervlei

Until the second half of the 20th century, Tiervlei, a large seasonal vlei near modern-day Ravensmead (which was known as Tiervlei until 1972), acted as a natural detention pond, receiving stormwater overflow from the Elsieskraal River and retaining the local inflow from its local catchment until the rains were well past. In winter, should mainline railway passengers, approaching from Belville, have looked to the south, they would have seen vast areas of standing water interspersed with fields of arum lilies and waterbirds.

Tiervlei was drained in the 1960s, and developed into the residential suburbs of Parowvallei, Ravensmead and Florida. The Elsieskraal River, which had happily discharged its excess capacity into Tiervlei, could no longer do so and became even more overloaded. Flooding in the lower end of the catchment became commonplace. Canalisation and the excision of a slow-flowing meandering loop were the only remaining engineering flood-alleviation solutions.

Then, in the early 1970s, two further developments with high runoff factors, which were to have a considerable negative influence on drainage, took place: the enormous Tygerberg Hospital complex; and the new railway marshalling yard and container depot in Bellville South. Undoubtedly, this added further to flooding risks for communities downstream in the suburbs of Elsiesrivier, Epping Garden Village and Pinelands.

Between 1974 and 1976, the Divisional Council coordinated extensive canalisation along the lower reaches of the Elsieskraal River in the suburbs of Elsiesrivier, Ruyterwacht and Pinelands where seasonal flooding had become prevalent. The alignment generally followed the path of the original stream, except in Elsiesrivier where two appreciable meanders were removed, and the reach through the main business area was confined in a covered canal. In the same period, many of the smaller tributaries and the runoff from Goodwood developments north of the main Voortrekker Road were also placed in to culverts.

The Town Council of Pinelands decided to spend additional funds on turning the reach through its area into an urban amenity – one of the first efforts of this nature in Cape Town. The designers, Ninham Shand, introduced some meanders to break up the straight canal lines. The low-flow (perennial) channel was concreted, but the high-flow section was grassed. Tow paths were built in the river reserve, and trees and shrubs were planted. For some years, the residents of Pinelands enjoyed this amenity and it was very popular for jogging, children's birthday parties and exercising dogs. In recent times, however, usage has diminished because of security problems.

In the early 1990s, the Regional Services Council funded the construction of two detention dams in old quarries upstream of the N1 crossing in Bellville. While downstream communities benefited as the flood flows in the river were attenuated,

Timeline: Elsieskraal River canalisation	
circa	
1945	Canalisation through Parow, Bellville, Goodwood and Pinelands
1948	Drainage scheme completed in Goodwood Municipality
1949	Channel cleared, widened and deepened in Epping Garden Village
1950	Balancing dams completed in Tygerberg Municipality (Tygerberg Conservation Scheme)
1960	River diverted into pipeline below ground below N1 Road bridge in Bellville catchment
1960	Goodwood Municipality discharges stormwater along Townsend Street, under Vanguard Drive into watercourse draining into the Elsieskraal River
1973	Southern drainage area drained to Jakkalsvlei from outfall in Epping Industria along Owen Road into Clarkes Estate
1974	Canalisation in Tiervlei, removal of 5 kilometre loop to increase gradient
1975	Loops removed in industrial area, box culvert constructed, near 7th Avenue, Elsiesrivier
1976	Pinelands reach completely canalised
1990	Additional land acquired for detention ponds to improve drainage
1993	Stormwater discharge culvert along Townsend Street system upgraded

the major beneficiaries appear to have been the property developers. The area around the dams is now known as "The Tygerberg Waterfront" and is the site of flourishing office parks.

The Black River

The authority on old Cape Town rivers, Jose Burman,[3] found little mention of the upper parts of the Black River in the old literature and it appears that in van Riebeeck's time, the more significant stream was the Kromboom River. The upper reaches of the Black River scarcely deserved a mention.

£20,000 for Cape Flats Flood Relief

The Government has decided to spend £20 000 on relief against flooding along the Elsieskraal River on the Cape Flats this winter, the Cape Times yesterday learnt officially.

It has been decided to appoint regular water watchers. Silt traps will be built along the banks of the river, and it is understood that general measures will be taken to combat flood damage.

A meeting of the Cape Divisional Council yesterday discussed the Cape Flats flooding problem and decided to send a deputation to the responsible Minister.

Cape Times, 20 March 1946
(Source: Cape Times)

3 Burman (1969)

The water seeps evident on the left-hand side of the upper Black River Canal in Lynfrae are groundwater that would, under natural circumstances, have sustained the summer flows in the river. (Photo: Cate Brown)

The Black River rises in the present Arderne Gardens and flows along Water Street in Lynfrae, and through Rondebosch Boys High School and Keurboom Park. Today it is canalised from its source to its confluence with the Kromboom Canal.

The lower reaches of the Black River featured more prominently in the early life of Cape Town. Historically, the river was seasonal, flowing through a vast area of marshland and shifting sands extending from the Cape Flats to its confluence with the Salt River and expanding beyond this into an estuarine lagoon and delta. Consequently, few land grants were made, and apart from a series of windmills, the Oude and Nieuwe Molen, the area remained relatively undisturbed for centuries, although a road network extended into the area with a number of crossing points over the various river channels. Notable exceptions were Valkenberg and Molenvliet farms between the Black and Liesbeek rivers. In fact, the focus on the area between the two rivers was not new, as the confluence of the Black and Liesbeek rivers had played an important role in Khoi ceremonies.[4]

Van Riebeeck's lookout post, Keert-de-Koe, was located at the confluence of the Liesbeek and Black rivers. (The street name Keert-de-Koe near where the Black River

4 www.riverlodge.co.za

This pencil drawing by Thomas Bowler, looking towards Devil's Peak, shows the Royal Observatory *circa* 1834. (South African Royal Observatory)

crosses Milner Road in Rondebosch is not the location of the fort. It was simply an attempt to perpetuate the historic name, as adopted from a suggestion by Councillor Mrs Jo Bakker *circa* 1959.)

In 1845, Colonel Charles Michell constructed a bridge across the Black River on the alignment of the present Voortrekker Road. This was the first step in building a hard road across the sandy, windblown and often impassable Cape Flats. The bridge was known as the Montagu Bridge as the first tribute to John Montagu, the energetic (but somewhat unpopular) Colonial Secretary who had devised a way of paying for public works at the Cape by selling guano from the West Coast islands to Britain, which had begun to appreciate the advantages of fertilisers.[5]

Valkenberg

Valkenberg derives its name from the farmer Cornelius Valk who purchased the land in 1720. In 1881, the Colonial Government bought the land to build a reformatory. This was never built and instead a "lunatic asylum", as it was then called, was established to accommodate patients transferred from Robben Island.[6] The extensive pastures and fields of grain that characterised the farm in the 19th century have all but disappeared under suburban development, yet the open nature of the landscape around the hospital buildings still evokes a gentler, more rural time.

THE ROYAL OBSERVATORY

In the 1820s, finding a site for a permanent observatory in Cape Town was not easy as most sites were "plagued by sand and dust storms or local 'tablecloth' clouds, and finding a site took nearly a year". The site eventually selected was between the wetlands at the confluence of the Black and Liesbeek rivers, which, although reportedly damp, was spared dust storms and the worst of the influence of the black southeaster clouds. The Observatory was constructed on a barren rocky mound known as Slangkop. The main instruments were finally moved into the new observatory in 1829.

www.saao.ac.za/about/history/history-detailed

5 Montagu also developed the system of convict labour that enabled many mountain passes to be constructed.

6 www.capegateway.gov.za/eng/pubs/news

BEFORE: The Black River wetlands, with the Observatory in the background *circa* 1910. The river is now channelised in this section to accommodate increased run off from the tributaries and to make space for the Black River Parkway. (Western Cape Archives)

Molenvliet

In 1693, land along the Liesbeek River was granted by the VOC for the construction of a mill, subsequently to be known as Molenvliet. Molenvliet Farm was sold in about 1725, and the mill on it (probably a water mill) was replaced by the Oude Molen windmill, the first windmill in South Africa. It is believed that the mill was eventually blown down by the southeaster.

Nieuwe Molen Mill

The Nieuwe Molen mill, which was completed in 1782, is the oldest surviving windmill in Cape Town. Today it stands in the grounds of the Alexandra Hospital in Maitland, overlooking the M5 highway. The mill was built for the Burgher council who owned it until 1807, whereafter a free burgher named KC Dekanah acquired the property. It remained in his family until 1847. Ownership from 1847 to 1901 is unclear, but in 1901 the Colonial Government of the Cape purchased the mill and erected the hospital around it.

Water quality problems in the Black River

It is likely that the Black River received its name because it naturally carried water darkly stained by the organic material leaching from the fynbos vegetation through which it flowed. More recently, however, the name has become appropriate for other reasons: the water is indeed dark, but mostly with particulate material growing in the rich effluents emanating from the Athlone Wastewater Treatment Works. Like the other rivers of the Flats, the Black was a seasonal river. For many years, though, it has been perennial, receiving the purified effluent from the Athlone WWT works. When the works are functioning efficiently, and the effluent is low in nutrients (as they were for a period in the mid-1980s to 1990s), the quality of water in the Black

AFTER: The Black River from the Black River Parkway, looking towards Devil's Peak and the Observatory, March 2008 (Photo: Rembu Magoba)

River is fair. Indeed, during those periods fish survive in the water, as do invertebrates, and waterbirds frequent the area. When the works are overloaded, the water quality becomes extremely poor. The effluent often includes significant quantities of organic material and sometimes even spills of raw sewage. From the point of view of human health, microbiological tests regularly demonstrate significant faecal contamination of the water, while none but the most tolerant invertebrates (sludge worms of the genus *Tubifex*) are able to survive in the river.

The low gradient of the river's bed, typical of Cape Flats wetland-rivers, means that even heavy rainfall events are unable to flush the accumulated sludge from the bottom of the river. In consequence, the river frequently has to be dredged, at great cost to ratepayers.

A tribute to a dead river: Water Road in Lynfrae, running alongside the Black River Canal (Photo: Cate Brown)

Timeline: Black River canalisation

circa	
1940	Black River widened to 100 feet below Raapenberg Road to increase capacity
1949	Canalisation of Black River proposed - work done over next two years
1960	Construction of Settlers Way and intersection with the Black River Parkway – Black River moved 100 metres west and wetlands filled
1970	Width of Black River increased in two phases from 20–60 metres through Rondebosch Golf Course
1994	Kromboom canalised as part of freeway construction
1998	Settlers Way/Black River Parkway intersection reconfigured – portion of original wetland uncovered

WATER HYACINTH IN THE BLACK RIVER

Few Capetonians could have failed to notice that the Black River is prone to excessive blooms of water hyacinth, which may completely cover the surface of the water from mid summer until it is cleared by the Council's maintenance crews just before winter.

This is not a new phenomenon. From a letter dated 30 March 1933, and signed by E.H. Crogham, Chief Chemist to Cape Town City Council:

"It is purely engineering works which have led to the recent physical conditions of flow allowing those favourable conditions for the tremendous spreading of water hyacinth since about 1930, which coincides with the works of the Railways and Harbour's Administration. Previous to such year, the Black River Valley was entirely free from water hyacinth."

Death of a(nother) wetland

The original Raapenberg Road Bridge was one of the first reinforced concrete bridges in Cape Town. In 1940, the Black River below the bridge was widened to "100 feet" to increase its capacity as development in the catchment areas increased flow.

The river was canalised between 1949 and 1951, during a period that also saw the covering over of a considerable portion of the Black River wetlands.

In 1960, the construction of Settlers Way and its intersection with the Black River Parkway required that the river was "moved" some 100 metres to the west. The entire exercise required careful programming, as the bridges were built in the dry season and the river diverted under them, enabling the original bridge to be demolished.

M5-N2 Interchange wetland[7]

In March 1998, changes to the interchange between the M5 and N2 near Raapenburg Road provided an opportunity to "turn back the clock", albeit fractionally. As part of the necessary road works, the authorities adopted a proposal to re-create a portion of the once extensive Black River wetlands in this area, and thus provide potentially valuable wetland habitat within a green corridor. The land is adjacent to the degraded Black River Canal, but is also close to the wetlands around Valkenberg and thus part of a series of linked open space/wetland habitats. The restored area was designed as a seasonal wetland that would be filled by rising groundwater levels and stormwater runoff during winter and dry out during the summer. Fill, deposited on the wetland some 47 years previously, was removed down to the original peat layer, thereby exposing the winter water table. The area was replanted with indigenous plants, but remarkably some spontaneous regeneration of the original vegetation took place when the sand that had smothered it 40 years previously was removed.

This project showcases an innovative and cost-effective approach to dealing with open space alongside roadways, which so often are simply landscaped as bowl-shaped, grassed areas, perhaps inundated annually by stormwater that drowns and rots the grass but seldom provides quality habitat as seasonal wetland. An added bonus for the City is that wetlands do not require regular mowing.

Exposure of the winter water table is thus deemed to be a more sustainable solution to wetland rehabilitation than a simple reliance on stormwater runoff, which is inclined to alternately accumulate and soak away with each rain event.

The (side)canals of the Black River

The present day lower Black River receives flow from a series of canals, which were built to carry the increased runoff caused by the development of the areas that became Athlone, Langa, Epping Industria, Guguletu, Manenberg, Rondebosch East, Bonteheuwel and Bishop Lavis.

7 Freshwater Consulting Group (2001)

The Bokmakierie Canal in Hazendal, Athlone (Photo: Tracy Blues)

The Kromboom Canal

The Kromboom River rises near Kenilworth Racecourse. The stream was once a seasonal watercourse through wetlands. It was canalised almost along its entire length as part of the construction of the M5 freeway, which is positioned directly on top of those wetlands.

The Vygekraal Canal

Like the Kromboom River and others, the Vygekraal River was essentially a longitudinal seasonal wetland before development took place in its catchment. The original settlements of Kew Town and Bridgetown were built during the 1940s. Surrey Estate, Manenberg and Guguletu followed in the 1950s and 1960s and the Vygekraal River was "formalised" to drain these areas.

The lower reaches of the Vygekraal flows in an earth channel through public open space. Here possibilities exist to improve the public amenity value of the area through rehabilitation of the river.[8]

The Bokmakierie Canal

The Bokmakierie Canal was constructed before World War II to service the first developments in the growing area of Athlone. Sadly, the Bokemakerie canal today is severely polluted with solid waste. It is thought that much of this is the result of disposal of household waste by backyard dwellers, as they are not formerly catered for in the municipal waste collection/disposal system.[9]

8 Candice Haskins, City of Cape Town, personal communication
9 *ibid.*

THE FIRST "DETENTION" POND

Detention ponds are designed to hold rainwater that has run off the surrounding landscape of lawns, roads, and rooftops (so called stormwater runoff). The stormwater is retained (detained) in the pond for a while and slowly released to a nearby river or canal. In this way, detention ponds reduce the speed at which runoff enters the waterways. This protects areas downstream from flooding and erosion.

The first detention pond in the Western Cape is reputedly on the corner of Modderdam Road and 35th St in Elsiesrivier (Stellenbosch Arterial) and was the brainchild of P.A. Myburgh of Ninham Shand.*

* Records of Ninham Shand Inc.

A RECURRENT PROBLEM WITH DATUMS

Until metrication was adopted, the two major local authorities operating around Cape Town worked with different datum levels. The Cape Town City Council used Low Water Ordinary Spring Tide as its reference level, while the Divisional Council used Mean Sea Level. In absolute terms, Mean Sea Level is 2.2 feet (± 66 centimetres) higher than Low Water Ordinary Spring Tide.

Where engineering works were confined to one authority, the different datums were no problem - but where works of one council had to tie in with the other, engineers and surveyors had to be alert and "beware of the 2.2!"*

The Divisional Council built the Northern Areas Sewer, and the City Council engineer setting out the Langa Pump Station applied the correction, but in the wrong direction, with the result that the floor of the wet well was built 4.4 feet too high, resulting in very little storage capacity.

After the metric system was adopted, all authorities adopted Mean Sea Level as the datum, but errors were still possible when referring to old plans.

* Alan Walker, City of Cape Town, personal communication

The Jakkalsvlei Canal

The Jakkalsvlei Canal joins the Vygekraal Canal at the Langa interchange on the N2. It skirts the southern and eastern sides of Langa and crosses the railway line east of Vanguard Drive before turning and running parallel to the railway alongside Bofors Circle. Turning north again, it receives the outfall of the main drainage from the south of Elsiesrivier.

The scheme was built as an earth canal at the time when Epping Industria Stage 2 was laid out. In the early 1990s, the section through Langa was lined with concrete.

The Kalksteenfontein Canal

The Kalksteenfontein Canal joins the Jakkalsvlei Canal at the interchange between the N2 and Vanguard Drive. It can be seen between the N2 and Bonteheuwel until it follows the line of Modderdam Road. This canal takes stormwater runoff from parts of Bonteheuwel, Bishop Lavis and the Modderdam Road developments. It also receives treated effluent from Borcherd's Quarry Wastewater Treatment Works and a section of Belhar.

The Blomvlei Canal

The Blomvlei River drains an area of some 11 square kilometres. It was canalised upstream of Klipfontein Road in 1942. Construction of Hanover Park housing estate commenced in the mid-1970s, which would have necessitated widening of the canal, but for a long section of box culvert under Klipfontein Road, the widening of which proved impractical. Instead the City of Cape Town installed a series of detention ponds upstream of Klipfontein Road. There are now four detention ponds in the area.

The Manenberg Waterfront, July 2007 (Photo: Emily Fairburn)

Proudly Manenberg and "The Waterfront"

Manenberg is one of the townships created on the Cape Flats in the late 1960s. Along its Vygekraal Road border lies an area once known as Isoetes Vlei. Consol Industrial Minerals began mining this area more than 40 years ago, creating a vast lake known to Manenberg residents for many years as "Die Dam." Today, residents call the area "Die Waterfront" as it forms part of the plan for Manenberg that is being developed by a community organisation, Proudly Manenberg. The aim is to create a conservation and recreation area, which residents and tourists alike, can visit for one of Cape Town's best views of Table Mountain. Birders can also visit the breeding site of the white-breasted cormorant and watch red bishops amongst the reeds.

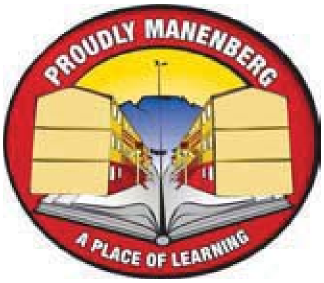


Photo: Rembu Magoba

Chapter 10

Paarden Eiland and the Salt River Lagoon

*"Die pos was ideaal vir perde geskik. Daar was volop vleigras en water, en droë duinsand vir die perde om op te rol. Die sout seewater het gesorg dat hulle hoewe vry van swamme kon bly."**

Helena Liebenberg – www.hdn.co.za

* The post was ideal for horses. There was an abundance of grass and water, and dry sand dunes for the horses to roll in, and the seawater kept their hooves free of fungi.

Today, the Salt River is no more than a canal that receives water from the Liesbeek River and the Black River. Although flow in the canal is still tidal, the once great Salt River Lagoon and its estuary, the grave of Wolraad Woltemade and his trusted steed, are no more.

According to one source, in 1726 there were "two staff, 42 horses, 28 donkeys, a pickaxe, two spades, a set of oars and a musket" on the Island.

The early days

The Salt River originally comprised the Salt River Lagoon, which received water from the Liesbeek and the Black Rivers, and possibly at some point, Platteklip Stream.[1] The lagoon stretched from Eerste Mond (the first mouth of the Salt River), at the Church Street Interchange to Tweede Mond (the second mouth), which it shared with the Diep River. Tweede Mond was located some three kilometres south of the present Diep River mouth.

The area around the Salt River Lagoon was probably widely used by San hunter-gatherers and early Khoi nomadic pastoralists. Certainly, Jan van Riebeeck's diaries make reference to hunting game in the wilderness around the mouths of the Salt River, Black River and Diep River – with the caution to beware of hippos.

The Salt River was one of the early frontiers to European settlement at the Cape. It was impossible to cross in winter, and even in summer provided a useful border to the colony that could be defended against attack, such as during the slaves' uprising in 1808. The lower reaches of both the Salt River and the Liesbeek River were also extensively fished by townspeople.[2]

Between the mouth of the Diep River (Milnerton) and that of the Salt River there was a long narrow strip of land, comprised mainly of dunes and vleis. In 1659, a wooden guard house, called De Kijckuit (also Uijtkijk) was built on a high sand dune on this strip of land. De Kijckuit was multi-purpose post, which looked out to sea and was used to announce ships arriving in Table Bay and monitor signals from Robben Island. It also served as a base for cattleherders, and its staff was charged with collecting and storing ship wreckage washed ashore.

When the Company moved its activities further eastwards, De Kijckuit was no longer needed as an outlook, but the strip of land on which it stood had become known as "het Eijland de Uitkijck". There is some doubt as to whether it was in fact an island at this point, as some sources suggest that the Salt River only had one mouth to the sea, and that a second mouth, 'tweede mond', north of the first was then dug, encircling the land strip with water. Geological evidence, however, suggests that it was highly likely that the Salt River formed a delta, and that the location of the river mouths constantly changed, shifting up and down the Table Bay coastline. Whichever the case, by 1786, maps clearly showed the Salt River with two mouths: the first near the current confluence with the Black River and the second north of that, exiting near the present-day Duncan Docks. (More on the estuaries of Table Bay in Chapter 11.)

Gradually the wilderness of the area gave way to agriculture, and the island was used for stabling the Company's horses (paarde). According to one source, in 1726 there were "two staff, 42 horses, 28 donkeys, a pickaxe, two spades, a set of oars and a musket" on the Island. In 1728 the description "'t paarden eijland" was used for the first time by Vaandrig (Reserve Officer Candidate) E.W. Cochius, reporting to Governor P.G. Noordt, although the official name was still "eijland de Kijckuijt". A solider, Steeven Gudden, who was posted to the island in 1731, habitually referred to

1 Burman (1969)
2 Worden *et al.* (1998)

Sketch of the Salt River Swamp, Observatory, by Sir John Herschel, *circa* 1837 (South African Observatory)

his post as Paarde Eijland in his correspondence. It was only much later, however, that that name was quoted in official documents: " ... het soo genaamte Paarden Eijland aan deese kant van de Soute Rivier".[3]

The island was used until 1790 to stable the VOC's horses and the oxen that pulled the wagons from the outposts in the interior.

In 1791, the Company horses, coaches, carts and other equipment on Paarden Eiland were sold. Arend van Kielligh, who had been awarded the contract for the ox-wagon transportation between Cape Town, False Bay and elsewhere, then rented Paarden Eiland to keep his oxen, as well as some horses, which he supplied under contract to the Company. He was not allowed to chop any wood, to plough, or "in any way loosen" the ground. This was because the Company had stablised the dunes, at great cost and trouble, to prevent the sand blowing into the town.

Then, in October 1803, a decision was made to survey the island and, apart from certain servitudes, to offer the island for sale. The island was put on the market at an asking price of 20 000 gulden.[4]

Industry visited the island early. Lime was produced from mussel shells washed up on the beach, and the first lime kilns were fuelled with the timber of ships wrecked on the beach. Paarden Eiland was also used variously as a leper colony and as a waste dump. The municipal stables for the horses that pulled the refuse carts are reportedly still in existence on the isolated strip of land between Koeberg Interchange, Section

3 Helena Liebenberg - www.hdn.co.za

4 *ibid.*

A painting by Johannes Ramner Marquard, circa 1860, showing Woodstock Beach, with fishing boats, cottages and Craige Tower* in the background (Western Cape Archives)

* Craige Tower was a blockhouse built by General Craige (Burman 1969).

Street and the canal. (We could not find them when we went looking, however.)

It is not clear when the lagoon declined and Paarden Eiland became, for all practical purposes, part of the mainland. Beaumont and Heydenrych[5] suggest this might have been as early as 1840, but 1960 aerial photographs clearly show two mouths of the Salt River, although the configuration of the lagoon had obviously changed dramatically over this period. In any event, over the years, the condition and extent of the lagoon declined as a result of upstream abstraction of water and dumping of all manner of objects. It was also partly filled in for railway embankments and residential suburbs, making Paarden Eiland a part of the mainland. In 1935, Paarden Eiland was proclaimed and actively promoted as an industrial area. Land was sold for 4½ pence per square foot (roughly equivalent to 35 cm^2). Landfill took place until about 1960.

Today, the Salt River enters the sea via a canal that follows an entirely artificial route to the sea. All that remains of the lagoon is a small wetland area, Zoarvlei, between Paarden Eiland and the residential suburb of Brooklyn, and the wetlands at the confluence(s) of the Liesbeek and Black River.

Wolraad Woltemade[6]

The mouth(s) of the Salt River is the site of one of South Africa's most famous "held verhale"[7], that of the dairy farmer/zoo keeper Wolraad Woltemade and his trusty steed.

5 Beaumont and Heydenrych (1980)
6 www.women24.com
7 Hero's stories

"De Held Woltemade Te Amsterdam" by de Wed. Loveringh and Allart, 1775 (Western Cape Archives)

As the story goes, on 1 June 1773, the Jonge Thomas from Amsterdam berthed in Table Bay Harbour to avoid an oncoming winter storm. The storm raged through the night, ripping the Jonge Thomas from its anchor chains. Rather than be driven ashore at the mercy of the storm, Captain Barend de la Maire decided to cut the last anchor and beach the vessel. The Captain ordered the ship's cannon fired to warn the people on shore that they may need help.

Unfortunately, the spot where he chose to beach was close to the mouth of the Salt River, which was in full flood. Within minutes the ship was broken in two. There were 270 men, women and children on board the ship, along with a valuable cargo from the East. Apparently the cargo attracted more interest from the "helpers" on shore than did the suffering of the passengers.

Into the fray leapt 70-year old Oom Woltemade, who grabbed a horse (nobody is sure it was his own) and took to the stormy sea. After saving 14 people with seven trips, the horse staggering with exhaustion, Woltemade wanted to call it a day. But the crowds cheered him on, and he got back on and rode towards the wreck one last time. Half a dozen desperate souls jumped into the water and grasped the horse. It was all over in a moment: both would-be rescuer and rescuees disappeared beneath the waves.[8]

8 www.vocshipwrecks.nl

Klein Zoar, *circa* 1960, with Zoarvlei visible in the foreground (Photo: Cape Camera)

KLEIN ZOAR

The National monument, Klein Zoar, an original Dutch farmstead where Wolraad Woltemade lived for a time, is situated adjacent to Zoarvlei, Paarden Eiland.

Zoarvlei

Zoarvlei is also known as Paardeneilandvlei, although perhaps we should call it Zoarvleitjie, because it has diminished so much over the years. This marsh is the last remaining remnant of the coastal wetlands that once dominated the northern shores of Table Bay, and was probably the northern arm of the Salt River Lagoon. It was certainly once part of the channel and associated wetlands linking the Diep and Salt rivers (see Chapter 11). Development in the surrounding area destroyed the ecologically important links with both these systems.[9] It exists today as a seasonal, freshwater coastal lake fed by groundwater intrusion and stormwater runoff, with a small outlet to the sea via a culvert leading into the Milnerton Lagoon.

In 1982, it was identified as an area of significant biological diversity and earmarked for conservation, although considerable efforts will be required if its full potential is ever to be realised.

Despite its poor ecological condition, Zoarvlei performs a vital role in the successful migration of birds. Approximately 125 species of birds have been recorded in the wetlands, many of them rare. In recent years, however, illegally-released sharptooth catfish (*Clarias gariepinus*) have caused considerable damage to the wetland ecosystem and its role as a migratory stopover. These catfish, which can grow up to a metre in length, are ferocious predators of frogs and small fish on which the birds feed.

9 Snaddon and Ractliffe (1999)

A portion of Zoarvlei with Devil's Peak and Table Mountain in the background, January 2005 (Photo: Jenny Day)

Century City and Blouvlei

The Century City Development is located north of the N1 at its intersection with the N7. It is one of the largest multi-faceted developments in the country and is situated on previously undeveloped land, which comprised the most northerly section of the once extensive Cape Flats. In 1997, during site clearing for Century City, a heronry on one of the seasonal pans was uncovered, which was home to vast numbers of breeding birds.

After much deliberation and expert opinion, it was decided that 16 hectares would be set aside as a multi-purpose nature area to conserve waterbirds and Sand Plain Fynbos, and to cleanse the water for Century City's network of canals. A system of landscaped wetlands and detention ponds was created to complement the planned development and a new heronry was constructed at the site, providing alternate but similar bird habitat.

Formaly known as Blouvlei, the area is now called Intaka Island (meaning "bird island"). The wetlands provide a nature area that lies at the heart of the Century City property. The Century City Property Owners' Association finances the ongoing management of the wetland.

The source water is partially treated effluent from the Potsdam Wastewater Treatment Works, about seven kilometres away,

STONE DRAGON EDUCATION

Stone Dragon Education is an environmental education organisation that uses the West Coast Field Studies Centre at Zoarvlei to assist schools and interested groups with the teaching of science and biology. The organisation also provides field camps and excursions in the greater Cape and Overberg areas.

and the wetlands act as a natural water quality improvement system through which the water flows before entering the "Grand Canal", one of the central features of the leisure and residential sections of the development.

Hailed as a success, the Blouvlei/Intaka Island experience demonstrates the possibilities for a win-win situation for development and freshwater ecosystems in the city. A UCT student, Catherine Wynn-Jones, recently made Intaka Island the subject of her thesis for a Masters in Economics, quantifying the effect of green areas on property prices and the public's attitude towards Century City.[10]

The present-day condition of the Salt River catchment

The Salt/Black/Liesbeek/Elsieskraal river catchment is possibly in the poorest ecological condition of all of the major catchments in the city. Apart from some of the upper reaches of the tributaries of the Liesbeek River, most of the rivers are canalised or in pipes. The system also receives wastewater from Athlone and Borcherds Quarry Wastewater Treatment Works, and the lower sections are seriously polluted.

The Black River, which forms part of the Salt River catchment is the first major system encountered en route to the city from the airport on the N2, and another major road, the M5, tracks the Black and Salt rivers for part of their course. Despite its current condition, considerable opportunity exists for its return as a visual and recreational asset for the city and its people. The Raapenburg Nature Reserve, which is located opposite the River Club's golf course, was proclaimed in 1980, and the whole area is targeted for the development of the Two River Urban Park, proposals for which include public and residential developments (possibly utilising the historic buildings in the area and along the edges of the park), parks, wetlands, urban agriculture (market gardens), walkways and bridle trails.

10 University of Cape Town (2004)

Photo: Gordon Richardson

Chapter 11

The Diep River

"As the Berg River is the product of the mountains, so is the Diepe the stream of the plains. This is no mighty waterway, no highway to the sea – yet those who knew the river named it the Diepe …"

Jose Burman – well-known Cape Town author of books on rivers, wetlands and railways*

* Burman (1970)

The Diep River has its source well outside of the borders of Cape Town. The river rises in the Perdeberg and Riebeeck-Kasteel Mountains to the east and north of Malmesbury and flows in a south-easterly direction for approximately 65 kilometres, broadening out near the coast to form an extensive vlei known as Rietvlei. This vlei is located on the Table Bay coastline, about 100 metres inland from the sea, between Milnerton and Table View. These days, the Diep River is linked to the sea via the narrow and winding Milnerton Lagoon.

Various tributaries join the Diep River on its way to the sea. They include the Klein

DRIFT-ALIGNED DELTAS

The Salt and Diep River deltas of the past were classic "drift-aligned" deltas. Such deltas typically form when rivers with ephemeral or periods of reduced flow (such as experienced in the Cape summer) discharge into high-energy coastlines with strong long-shore currents (such as the coastline of Table Bay). In these instances, sand barriers formed by wave action deflect the river mouth. Drift-aligned deltas are dynamic sedimentary environments and are inherently unstable and unsuitable for development. Indeed, Hughes and Brundrit express grave concerns over the plight of Woodbridge Island and other developments around Milnerton Lagoon in the face of climate changes, which is predicted to result in an increase in wave action in Table Bay.

Hughes and Brundrit (1995)

River, the Groen River and the Mosselbank River, the last draining the Durbanville/ Kraaifontein area.

The Diep River has been called, variously, the Jacqueline River, the Hollands-Rietbeecq River and the Zout River, and on some maps appears as the Visser's Hok River. Urban legend has it that the name the Diep River was settled on because the river was extremely deep, some say deep enough to allow grain barges, or sailing boats[1] to sail up as far as Vissershok (about 13 kilometres upstream of the mouth). An 1806 plan of the area by Lieutenant Fanshawe of the Royal Engineers shows points on the river and vlei that were fordable by guns and calvary, implying that the system was deep enough to have to worry about river crossings, and may well have been deep enough to allow the passage of non-keeled barges. However, it is unlikely that the river was ever deep enough to allow the passage of keeled boats.

1 Green (1948)

Rietvlei bird hide and salt marsh (Photo: Rembu Magoba)

The Diep River estuary

"The Diep River estuary comprises the Rietvlei and Milnerton Lagoon (estuary) and is about 600 hectares in extent.

Rietvlei is triangular in shape with a maximum width of over 2 kilometres in an east-west direction and 1.5 kilometres in a north-south direction. The Diep River enters the vlei at the north-eastern corner. References to the Rietvlei date back to 1608, with Jourdain describing elephant spoor adjacent to a fish-filled river, which flowed into the vlei.[2] The vlei originally comprised a series of seasonally flooded pans. These were inundated during the early winter when the Diep River would break its banks. Water and silt that had washed into the pans, gradually dried up through evaporation to stand empty for several months in late summer before the return of the winter floods. Silt deposited during the wet phase was removed during the dry phase through strong winds lifting dust and sand from the dry pans.

2 Jourdain (1912)

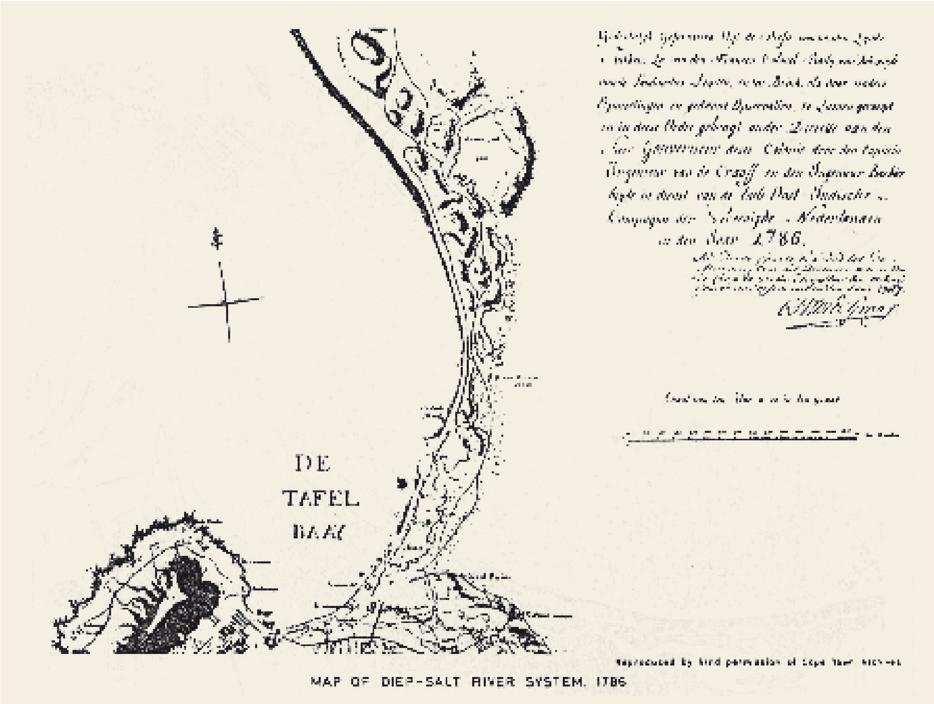
Children fishing on Milnerton Lagoon *circa* 1900 (Western Cape Archives)

The lower estuary, generally known as the Milnerton Lagoon, follows a narrow winding channel from the southern tip of the Rietvlei to the estuary mouth. Earlier studies indicate that the mouth was more or less permanently open to the sea[3], although mouth closure may have occurred during extended dry periods. One of the earliest maps of the area, drawn by Barbier in 1786,[4] shows the river occupying much the same position as it does today, with the exception of this lower lagoon section, which joined up with the Liesbeek River and Black River along the alignment of the present-day Zoarvlei (see Chapter 10) before flowing out to sea. The mouth was located some three kilometres south of its present position.[5]

The banks of the Diep River were cultivated from as early as 1690, and the removal of riparian vegetation, combined with poor land management, resulted in extensive erosion from the surrounding farmlands and the silting up of the river, vlei and lagoon. Survey plans of the lower river drawn up by F. Skead in 1858 are noteworthy for two reasons. Firstly, they indicate Rievlei Basin silting up, as evidenced by the labelling of "quicksand" on maps where, in 1806, Fanshawe had indicated the channel was too deep for guns and cavalry to cross. Secondly, they show that a new mouth had opened up close to its present-day position, resulting in a complex interaction between the Diep River, with its "delta" and the Salt River "delta".

Originally, Rietvlei was a series of extensive saline seasonal pans connected to

3 Beaumont and Heydenrych (1980)
4 Barbier (1786)
5 Beaumont and Heydenrych (1980)



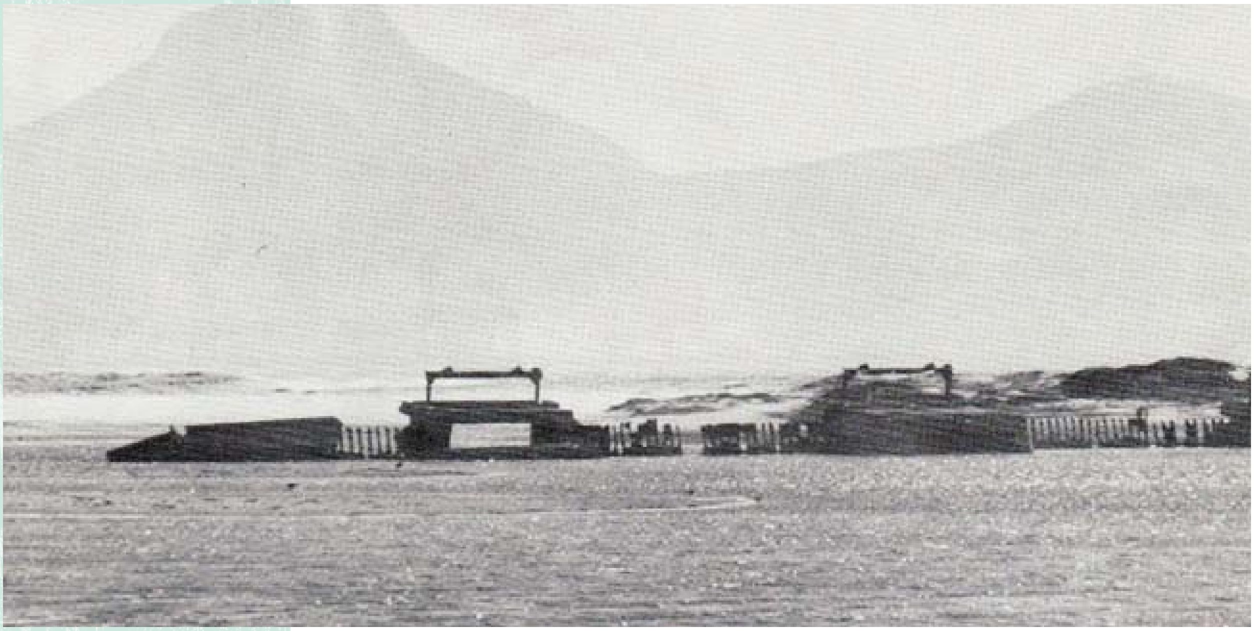
Barbier's map of the Salt-Diep River system in 1786, shows the convergence of the Liesbeek River, Black River and Diep River systems with a common mouth near the present day outlet of the Salt River canal. (Western Cape Archives)

Milnerton Lagoon. Today, however, Rietvlei is relatively fresh with an elevation of 1.0 to 2.0 metres above Mean Sea Level (with the exception of Flamingovlei, which was dredged in the mid-1970s). The decreased depths can be attributed to increased erosion from the catchment and the resultant increased sedimentation occurring when the river overtopped into the seasonal wetland area. In the last 6 – 8 years this has been exacerbated by dust-control practices that were initiated in late summer to prevent the Flamingo Vlei residents being blanketed in fine silt on exceptionally windy days. The dust control measure currently being used involves pumping water from Northvlei onto the Central Pan during dry periods to keep this area damp. This activity prevents the removal of sand and silt from the system. In the long term, the rise in level will transform Rietvlei into a dry land habitat.

The first direct evidence of large-scale siltation in the Milnerton Lagoon area dates back to 1905, when steam dredgers were used to deepen parts of the lagoon for rowing regattas.[6] The decreased depths in Rietvlei also contributed to reduced tidal volume and thus reduced scouring action by tidal waters moving into the lagoon. By 1920 a sandbar had developed that closed the mouth to the sea. Boating activities were seriously curtailed by the shallowing of the system and in 1928 attempts were made to address the problem by building a weir across the river mouth to increase water levels. The weir was not a universal success, however, as it caused floodwaters to back up and flood the adjacent residential areas. It was eventually demolished after it was damaged during flooding in 1941 and 1942.[7]

Information from the 1940s and 1950s indicates that the estuary was closed during

6 Green (1948) cited in Beaumont and Heydenrych (1980)
7 Beaumont and Heydenrych (1980)



The remnants of the old weir across the mouth of the Diep River are visible in this photograph from *circa* 1942. (Beaumont and Heydenrych 1980)

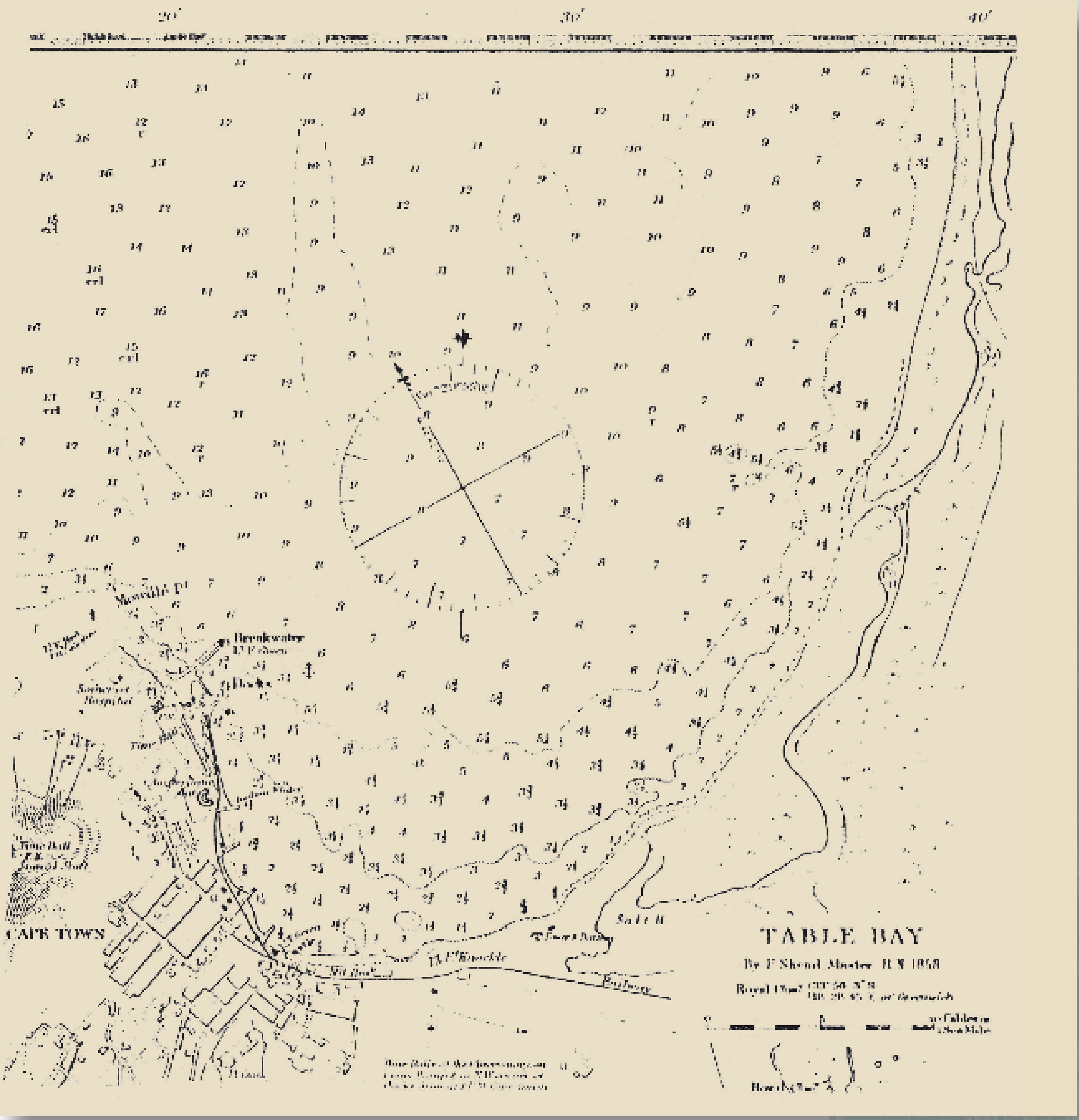
most summers.[8] Salinity in the estuary was very variable, from fresh during high flow periods to 198 parts per thousand (about 5.5 times seawater) measured in isolated pools when the estuary dried up.[9] In 1960, the Potsdam Wastewater Treatment Works started discharging into the Diep River Estuary. Since then, a gradual increase in wastewater discharges over the years has contributed to less mouth closure and lower salinities in the system.

Today, the lagoon, with its confined channel, stabilised by road embankments and bridges, has a maximum width of 150 metres and the current channel bed is below Mean Sea Level. The mouth now migrates between a gabion (rock basket) structure and concrete wall to the north and a natural high area about 250 metres to the south. The Milnerton Lagoon is once again nearly permanently open, partly as a result of the dredging activities that resulted in Woodbridge Island, and partly because of discharges from Potsdam Wastewater Treatment Works. Periodically there are serious concerns regarding the water quality of the estuary.

The construction of a permanent lake at Rietvlei

In the 1960s, there was considerable controversy when proposals were made to convert Rietvlei into a fishing harbour. Thereafter, several studies and reports were produced about various possibilities in the proposed area, including using the area for a tanker basin. Ultimately a decision was made to modify Duncan Dock and build a tanker basin and container berths on the seaward side in Cape Town Harbour. As part of this initiative, in the early 1970s, a section of Rietvlei was dredged to a depth of nine metres to provide fill for the building of the Ben Schoeman container berth

8 CSIR (1994)
9 Millard and Scott (1954)



The survey plans drawn up by Skead in 1858 (Western Cape Archives)

(see Chapter 3). The fill was transported to the harbour hydraulically by a pipeline laid along the coast (on land).

The resultant deep-water area now known as Flamingovlei (which comprises Northvlei and Southvlei) became an important water-sport recreational area, and the Milnerton Aquatic Club was formed. The remaining shallow seasonally-inundated pans to the east of Flamingovlei formed an important biodiversity asset. On 3 August 1984, Rietvlei was proclaimed a Protected Nature Area by Government Notice 1632.

In 2008, the proposal to develop a harbour in the area 're'surfaced. The proposal includes a harbour entrance to the sea just north of the Dolphin Beach development, a yacht harbour in the Dolphin Beach ponds (west of the R27), and what appears to be marina development in the reedbeds on the northern shore of North Lake.*

* www.friendsofrietvlei.co.za

Estuarine fish

Twenty-eight fish species have been recorded from Rietvlei and the Milnerton Lagoon, although five of these are aliens introduced over the last century. Historically, fish recruitment into Rietvlei was likely to have been during wet years when the entire area was inundated with water. Fish would have survived in the deeper ponds and vleis once the waters receded and their residence in Rietvlei may have been for as long as ten years.

Nowadays, the Flamingovlei section may provide fish with a refuge from the poor conditions in the Diep Estuary/Milnerton Lagoon. Frequent perturbations in the estuary have seen almost complete switches in the fish assemblage over relatively short time periods. Ammonia plugs arising from malfunctions in the wastewater treatment works have resulted in the complete loss of the benthic gobies (*Caffrogobius salhana*, *Psammogobius knysnaensis* and *C. nudiceps*), the burrowing sandprawn (*Callianassa kraussii*) and other invertebrate species. Loss of these food sources has contributed to a drastic decline in the number of important linefish species in the system, including the juveniles of the white steenbras (*Lithognathus lithognathus*) and white stumpnose (*Rhabdosargus globiceps*). The estuarine fish assemblage is now dominated by the opportunistic partially-estuarine-dependent harder (*Liza richardsonii*), although, on a brighter note, more recent perturbations have seen an influx of the vulnerable freshwater mullet (*Myxus capensis*) into the system.

Bridges

In *circa* 1904, a wooden bridge was constructed across the lagoon at Milnerton, partly to enable the British to gain access to the coastline near Milnerton so that they could defend it against would-be invaders. In 1927, a second bridge was built across the river at Killarney for the use of Durbanville farmers on route to Blaauwberg. A new concrete bridge was built over the lagoon in 1985 when the Woodbridge Island Township was developed. Happily, the old bridge has been retained as foot access, and has been declared a Provincial National Monument. The bridge on Otto du Plessis Drive was constructed in 1961. This narrow span bridge now forms a clear boundary between the upstream floodplain and the downstream channel.

Woodbridge Island

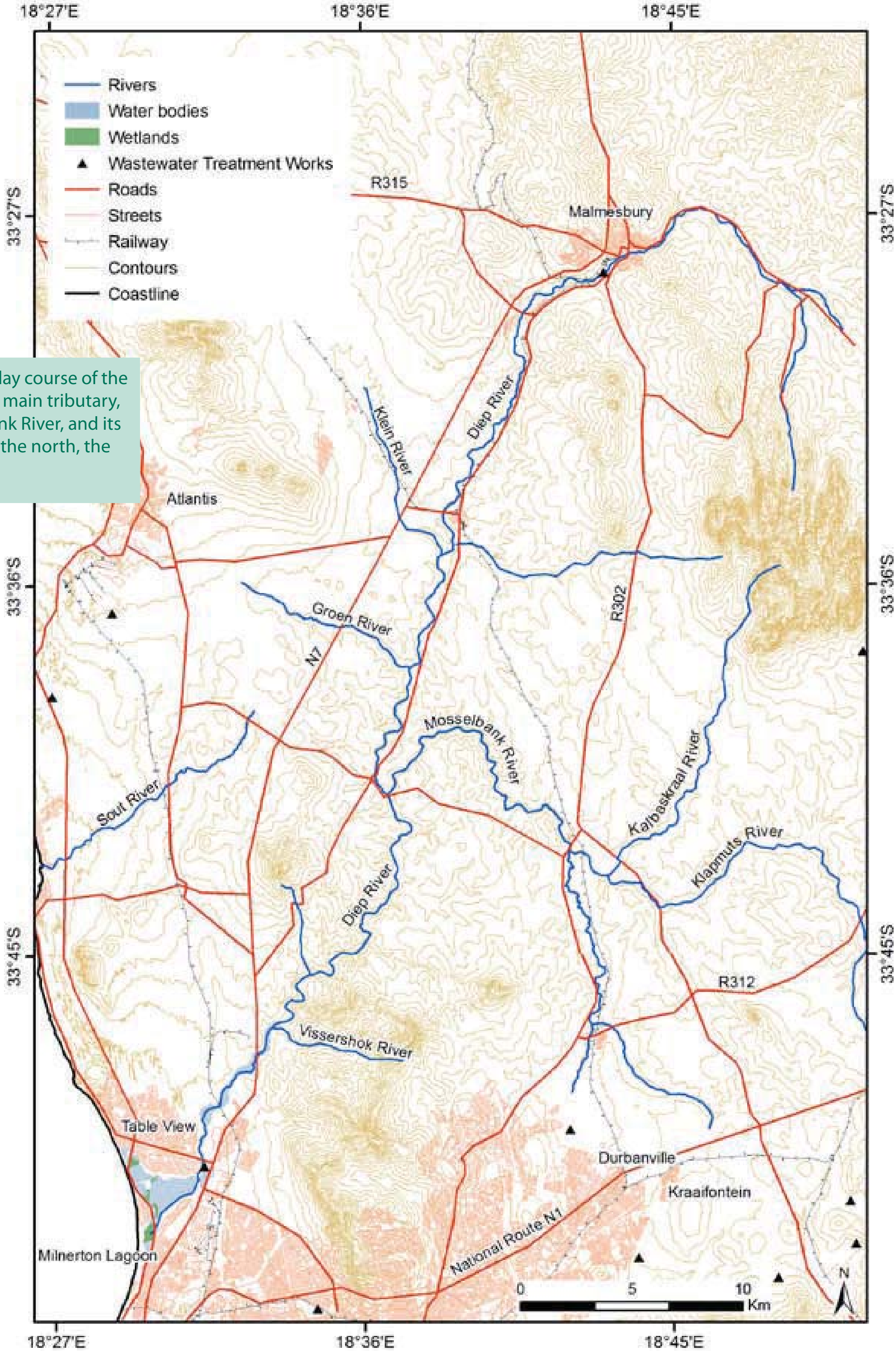
In *circa* 1904, a wooden bridge was constructed across the lagoon at Milnerton, partly to enable the British to gain access to the coastline near Milnerton so that they could defend it against would-be invaders. In 1927, a second bridge was built across the river at Killarney for the use of Durbanville farmers *en route* to Blaauwberg. A new concrete bridge was built over the lagoon in 1985 when the Woodbridge Island Township was developed. Happily, the old bridge has been retained as foot access, and has been declared a Provincial National Monument. The bridge on Otto du Plessis Drive was

Timeline: Diep River, Milnerton	
circa	
1690	Cultivation of Diep River banks
1899	First wooden bridge constructed across the Diep River on the main road to Malmesbury by the Divisional Council
1904	First wooden bridge built over Milnerton Lagoon (now a provincial monument protected by the National Heritage Resources Act)
1905	Sections of Milnerton Lagoon dredged to deepen
1927	Bridge across the Diep River at Killarney constructed for Durbanville
1928	Weir built across the month of the Diep River to increase water levels in the lagoon
1935	The wooden bridge at Vissershok was replaced by the first concrete structure in Cape Town
1942	Weir demolished because it resulted in flooding of parts of Milnerton
1960	Potsdam Wastewater Treatment Works (WWTW) built, and effluent discharged into the Diep River
1961	Otto du Plessis Drive bridge constructed
1970	Concrete bridge replaced with the upgrading of the National Road
1973	Rietvlei dredged to a depth of 9 m to provide fill for the building of the Ben Schoeman container berth in Cape Town Harbour
1974	The lagoon again dredged for the Woodbridge Island development. The mouth remains permanently open
1984	Rietvlei and Milnerton Lagoon declared a Nature Area by Government Notice No. 1632
1985	Milnerton Bridge replaced with a concrete structure. Woodbridge Island township developed and ground level of the coastal peninsula raised using dredged material from the lagoon
1989	The status as a Nature Area is changed to declaration as a Protected Natural Environment in terms of Environment Conservation Act (Act 73 of 1989)
1990	Development in the Kraaifontein area required a detention pond facility and some canalisation along the Mosselbank River
1993	Treated effluent discharged from Potsdam WWTW channeled along the eastern boundary of Rietvlei
1994-6	Milnerton Municipality acquired ownership of the land comprising the Rietvlei Protected Natural Environment
2002	Kraaifontein WWTW located on the Mosselbank River upgraded
2004	Upgrade and expansion of Potsdam WWTW commenced

WOODBRIDGE ISLAND

The Woodbridge Island development involved raising the natural ground level of the coastal peninsula, which was accomplished by filling with material dredged from the lagoon and left the mouth permanently open.

The present-day course of the Diep River, its main tributary, the Mosselbank River, and its neighbour to the north, the Sout River



The wooden bridge across the Diep River in Milnerton (top) and the Milnerton seashore on a typical stormy Cape day (bottom) early 1900s (Western Cape Archives)

constructed in 1961. This narrow span bridge now forms a clear boundary between the upstream floodplain and the downstream channel.

The Woodbridge Island development involved raising the natural ground level of the coastal peninsula, which was accomplished by filling with material dredged from the lagoon and left the mouth permanently open for some time, although presently it closes during the summer.

Several development proposals were investigated for the area during the 1960-1970s but none materialised except for the construction of a road embankment and bridge built across Rietvlei during 1961.

“Reconstruction” of the permanent lake at Rietvlei

Until the 1970s, the Milnerton Lagoon was connected to an extensive saline seasonal pan. Today, this has become Rietvlei (now almost fresh) with some saltmarsh still more or less as it was then.

In the 1960s, there was considerable controversy when proposals were made to convert Rietvlei into a fishing harbour. Several studies and reports were produced about various possibilities in the proposed area until ultimately a decision was made to modify Duncan Dock and build the tanker basin and container berths on the seaward side in Cape Town Harbour. Subsequently, in the early 1970s, a section of Rietvlei was dredged to a depth of nine metres to provide fill for the building of the Ben Schoeman container berth in Cape Town Harbour (see Chapter 3). The fill was transported to the harbour hydraulically by a pipeline laid along the coast (on land). The fishing harbour idea did not, however, ever reach fruition.

The deep-water area known as Flamingovlei (which comprises Northvlei and

Milnerton Lagoon, January 2005, with some of the Woodbridge Island houses on the right and Table Mountain in the distance (Photo: Jenny Day)

The mouth of the Diep River with Cape Town in the background (Photo: Niel van Wyk)

Fish Deaths in Rietvlei – December 2006

Christmas Day 2006 brought an unpleasant surprise to residents of Table View when thousands of dead fish washed up on the shores of Flamingovlei. The deaths of such large quantities of fish led to a massive clean-up operation being undertaken by staff of the City of Cape Town and volunteers from the Milnerton Aquatic Club, Friends of Rietvlei and the general public. Between 25 and 28 December 2006, an estimated 80 tons of dead fish were removed from the vlei and taken to the Vissershok landfill site. The vlei was closed to recreational use and only re-opened on 10 January 2007.

Routine water sampling in the Northvlei on 19 December 2006 showed normal results for the water body. However, during the hot, windless days leading up to Christmas, the water temperature rose by over 8°C and dissolved oxygen levels plummeted. This is assumed to have affected the largely estuarine fish species causing an extensive die-off.

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Fish deaths in Rietvlei – December 2006

Southvlei), became an important water sport recreational area, and the Milnerton Aquatic Club was formed. A series of hallow seasonally-inundated pans to the east of Flamingovlei formed an important biodiversity asset.

In 1989, on the instigation of Mr Kent Durr MP, the Cabinet approved in principle that a defined area of the Rietvlei System be reserved as a Nature Area in terms of Section 4 of the Physical Planning Act (Act 88 of 1967). On 3 August 1984, Rietvlei was proclaimed a Protected Nature Area by Government Notice 1632.

In 2008, the proposal to develop a yacht harbour and marina in the Dolphin Beach ponds (west of the R27) resurfaced. The proposal includes a harbour entrance to the sea just north of the Dolphin Beach development, a yacht harbour in the ponds, and what appears to be marina development in the reedbeds on the northern shore of North Lake.[10]

Thus, in the last 200 years, the Diep Estuary has been significantly modified. Currently, the Rietvlei is shallow and flat with an elevation of 1.0 to 2.0 metres above Mean Sea Level, with the exception Northvlei and Southvlei (Flamingovlei, which was dredged in the mid-1970s), Rietvlei is inundated with rainwater from the river and numerous stormwater channels during winter and gradually dries up during summer. This area is, however, irrigated in summer to prevent the sand from being blown into the nearby houses. The lower estuary, the Milnerton Lagoon, with its confined channel, stabilised by road embankments and bridges, has a maximum width in the estuary of 150 metres and the current channel bed is below Mean Sea Level. Presently, the

10 www.friendsofrietvlei.co.za

The Diep River opposite Potsdam Wastewater Treatment Plant (Photo: Niel van Wyk)

mouth of the Diep Estuary migrates between a gabion (rock basket) structure and concrete wall to the north and a natural high area about 250 metres to the south. The Milnerton Lagoon is once again nearly permanently open due to discharges from Potsdam Wastewater Treatment Works, and there are serious concerns regarding the water quality of the estuary.

The Mosselbank River

The Mosselbank River rises in the low hills of Kraaifontein, flowing in a northerly direction through residential areas and smallholdings. Another branch drains Klapmuts and the farmlands on the western side of Paarl Mountain. The Mosselbank River joins the Diep River at a spot known as "Die Goede Ontmoeting". Extensive development in the Kraaifontein area has required a substantial detention dam system to be installed south of the National Road (N7), and some canalisation has taken place in the urbanised areas. The river also receives effluent from the Kraaifontein Wastewater Treatment Works on the edge of the urban area. Works, and plans are underway for a second works, in the Durbanville area, which wil lalso discharge into the river.

Maasdrift Canal

The Maasdrift Canal is a tributary of the Mosselbank River. A low-profile concrete canal conveys flow through the urban area of Kraaifontein, to a point upstream of the Kraaifontein Wastewater Treatment Works. Thereafter, the river flows in an incised, gently meandering, sand-bed channel to its confluence with the Mosselbank River.

Milnerton Lagoon, with the Milnerton Golf Course, Woodbridge Island and the lighthouse in the background (Photo: Niel van Wyk)

Kalbaskraal River

Kalbaskraal River, a seasonal tributary of the Mosselbank River, flows in a westerly direction predominantly through agricultural lands. It is bordered to the south by a sand-mining operation. Historically, the Kalbaskraal River would probably have comprised a series of linked wetlands – much like many of the rivers on the Cape Flats. Today, although some of the wetlands remain, others have been destroyed and there are now several farm dams on the river, which support an array of waterfowl.

A shallow pool in the Kalbaskraal River, a tributary of the Mosselbank River, in Spring 2006 (Photo: Charles Pemberton)

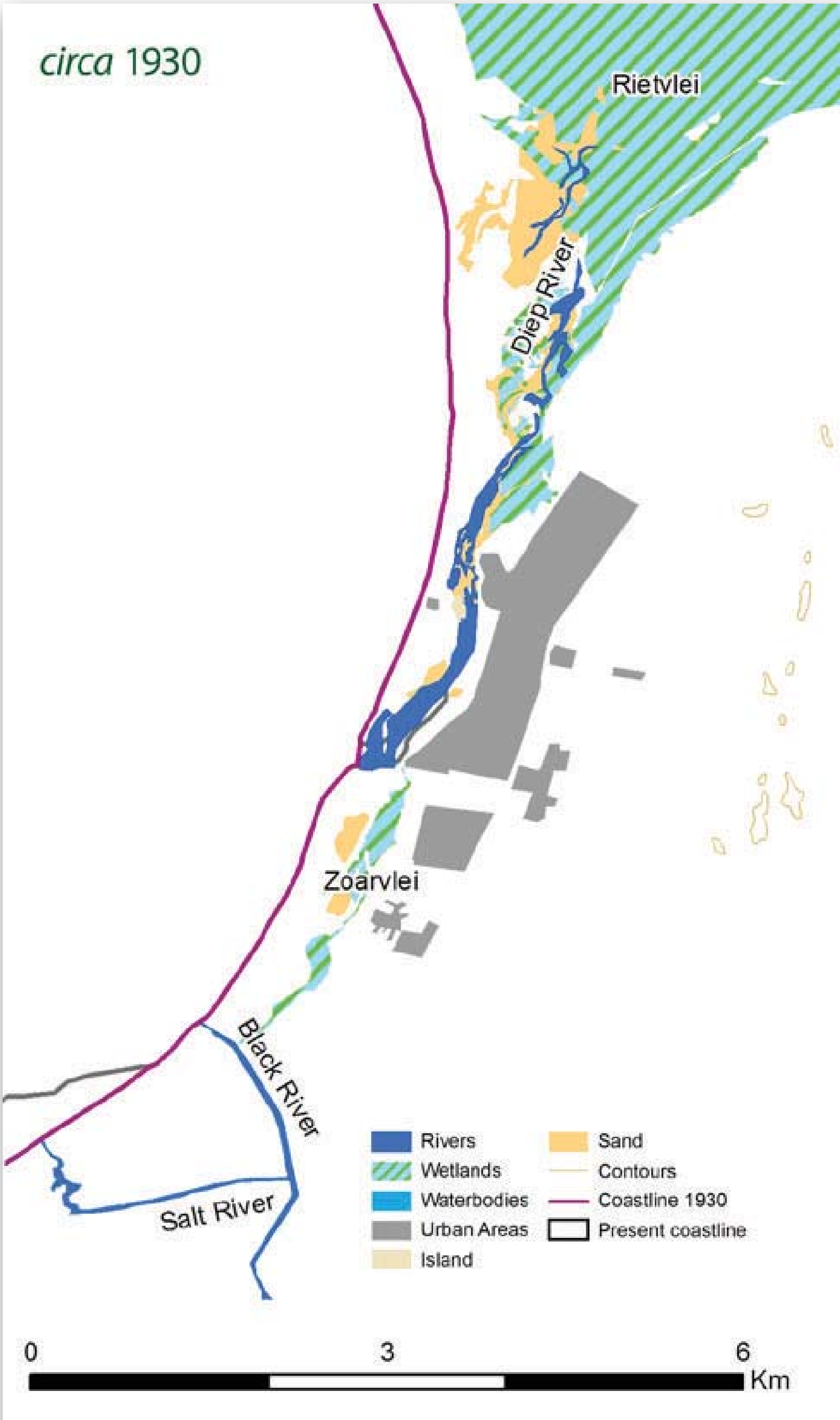
Other City rivers on the west coast (outside of the Diep River catchment)

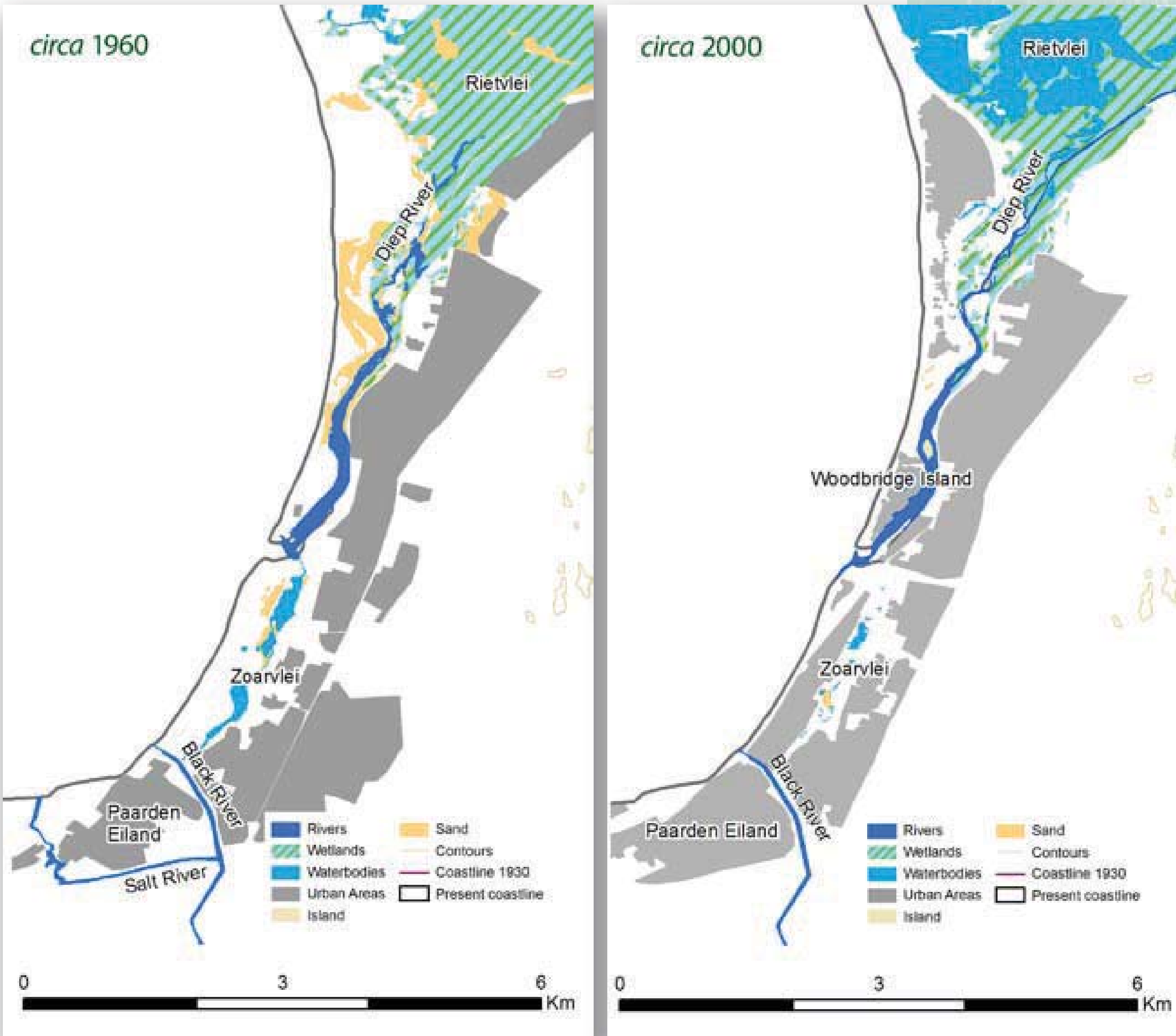
Sout River

As its name suggests, the water flowing in the Sout River is brackish, particularly during summer months, when local farmers report that water is unfit for irrigation or drinking.

The Sout River is a short river that rises in the low-lying hills to the east of Melkbosstrand, on the west coast. Under natural conditions the flow in

These three maps show the changes that occurred along the Table Bay coastline as a result of urbanisation over a seventy-year period. Today, despite its name, Paarden Eiland is no longer an island, and only a remnant of Zoarvlei remains to remind us that the coastline was once characterised by sand dunes, vleis and shifting river mouths.





the river was probably seasonal. Today, however, it is ephemeral in its upper reaches, perennial in its middle reaches and seasonal in its lower reaches. Although a number of small streams and other drainage lines enter the river along its whole length, the only tributary of significance is the Donkergat River, which joins it in the region of the Kleine Zoute Rivier farm.

Downstream of its confluence with the Donkergat River, the Sout River passes the Melkbosstrand Wastewater Treatment Works, from which it periodically receives treated effluent, which has altered the ecological condition of the river considerably, and led to a change in plants from low-growing sedges such as *Juncus kraussii,* to dense high stands of reeds (*Phragmites australis* and *Typha capensis*).

Downstream of the Melkbosstrand Wastewater Treatment Works, the river passes through the Ou Skip Caravan Park on the periphery of Melkbosstrand, before entering

Milnerton salt flats, 2005 (Photo: Jenny Day)

its small estuary, which opens into the Atlantic Ocean on Melkbosstrand Beach. The river is channelised and then canalised in these reaches.

Silwerstroom

Silwerstroom is a seemingly insignificant stream with a troubled past. Despite being located in an arid area, Silwerstroom is naturally perennial because it is fed by the Atlantis Aquifer. The water quality in the river is excellent and, for many years, the City abstracted water from the system and blended it with borehole water to supply the Atlantis area with potable water. The abstraction impacted the ecological health of the stream to the extent that proliferations of algae at the abstraction point frequently blocked the pump. About two or three years ago, the additional maintenance necessitated by the degraded condition lead to the abstraction being halted, and stream flow was reinstated. Since then the ecological health has improved significantly despite other impacts on the system, such as a severely damaged riparian zone, [11] and nutrient enrichment from cattle droppings.[12]

The Silverstroom (Photo: Candice Haskins)

11 The legacy of a misguided 'alien' clearing operation
12 City of Cape Town (2007)

Photo: Rembu Magoba

Chapter 12

Zeekoevlei and its catchment

When van Riebeeck first saw the Cape Flats vleis in 1656, they were much bigger than they are now and many were linked together. They were full of hippos and other creatures, which he called "sea-horses", but which were more likely rhinoceros. Van Riebeeck pointed out that there were apparently no rivers feeding the vleis and the water must have percolated through from the surrounding dunes.[1]

"… and beyond, out onto the plains for about fifty miles, the 'Flakten' or Cape Downs – intersected by straight threads of red road and irregular strips of white sand, and having every vlei and pool and footpath, farmhouse and hut mapped out on its brown and purple heather as vividly as on an ordinance chart – stretched away like an Indian carpet …"

"A Lady" – who arrived in Cape Town from England in 1861*

* A Lady (1961)

1 Thom (1954)

Zeekoevlei, Rondevlei and Princessvlei from Silvermine Nature Reserve, November 2006 (Photo: Cate Brown)

In those days there were numerous water bodies between the dunes of the Cape Flats, and Van Riebeeck was asked for his opinion on whether a canal could be cut across the Cape Flats from False Bay to Table Bay between the Liesbeek River and Salt River,[2] thereby isolating the Peninsula from "marauding tribesmen", and unknowingly replicating the isolation brought about by sea level changes[3] (see Chapters 2 and 3). Van Riebeeck was not in favour of the proposal, for reasons other than engineering difficulty, but the issue was to raise its head again several times in the future.

Zeekoevlei and Rondevlei

Zeekoevlei is the largest of the Cape Flats vleis, with a surface area of about 2.56 square kilometres. It is U-shaped, with a central peninsula dividing the lake into North and South basins. Most of the present-day surface inflow is into the North basin via the Big and Little Lotus "rivers", while the outflow to the sea occurs at the south-western corner of the South basin through the Zeekoe Canal. It has been established that Zeekoevlei is also fed by an aquifer that extends as far as the Royal Cape Golf

2 Interestingly, the approximate route of the proposed canal is still evident today as a series of green areas stretching from the Muizenberg coast, through Zeekoevlei, Rondevlei, the Kenilworth Race Course and the Raapenberg Wetlands, along the Black River and Salt River to the sea.

3 Worden *et al.* (1998)