CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

2019 INLAND WATER QUALITY REPORT

GUIDING THE TRANSITION TO A WATER-SENSITIVE FUTURE.

Making progress possible. Together.

Acknowledgements

The City thanks the consultant team for their scientific comprehensive analysis of the City's inland water quality database and preparation of the technical report which this summary publication is based on. The team comprised Dr Liz Day and Messrs. Dean Ollis, Nick Rivers-Moore and Tumisho Ngobela.

1. FOREWORD

In its new Water Strategy, the City of Cape Town has committed itself to becoming a water-sensitive city by 2040. A water-sensitive city is a city where rivers, canals and streams are accessible, inclusive and safe to use. This summary booklet – *City of Cape Town Inland Water Quality Report* – is being published as a companion to a more comprehensive technical report – *Water Quality of Rivers and Open Waterbodies in the City of Cape Town: Status and historical trends with a focus on the period April 2015 to March 2020*. Both documents are published to promote transparency and as a call to action.

While some of our urban river catchments are in a relatively good or near-natural state, six catchments face serious challenges. Overall, the data show that we have a long way to go to achieve our goal of being a water-sensitive city.

Where the report has revealed areas of concern, the City commits to full transparency as to possible causes that need to be addressed from within the administration. However, we also request that residents keep in mind the part they have to play, and take on their share of responsibility for ensuring that the next report paints a more favourable picture. Ultimately, this will be in the interests of everyone involved.

On the City's side, efforts to address water pollution are being intensified. With the assistance of loan funding, we have drastically stepped up the upgrade of wastewater treatment works and are constantly working to reduce sewer overflows, improve solid waste collection and cleansing, and identify and prosecute offenders. However, we can only achieve our goal in partnership with you, the citizens of Cape Town. All of us, as residents, contribute to the pollution of Cape Town's rivers through our daily activities of keeping clean, as well as through what we buy, throw away, and pour or flush into the sewer or stormwater systems.

The expansion of wastewater treatment capacity and improved technology and design over the past century have made a big impact in preventing ecological degradation. Nevertheless, municipal wastewater treatment processes are often handicapped by chemicals that people in our city illegally pour down the drain or flush down the toilet. Rainfall also washes pollutants from the urban environment into stormwater drains and on to our rivers, including from sewers that have overflowed due to the disposal of foreign objects. Irresponsible agricultural practices contribute nutrients such as phosphorus and nitrogen, which encourage aquatic plant growth and reduce the amount of oxygen available for aquatic organisms. Ongoing land invasions also create challenges such as by blocking the City's access to its infrastructure for maintenance and, where invasions take place in floodplains, contributing to the further degradation of our watercourses and wetlands.

These difficulties are experienced worldwide. Infrastructure upgrade programmes, stricter laws and enforcement, as well as improved incident responses are no doubt part of the solution, but cannot be completely effective on their own against the tidal wave of pollution generated by modern urban society. This is especially true in a developing country. Therefore, to restore our waterways to a state we can all be proud of, it is arguably even more crucial to foster a culture where Cape Town's communities feel a sense of collective ownership of, and responsibility towards, the wetlands, rivers and canals in their urban environment, and are aware of their role in properly managing pollution.

As such, I hope that this report spurs civic organisations, businesses and communities to join the City in revolutionising the way residents think about the urban water cycle (natural surface water, potable water, sewage and stormwater systems), and to help rehabilitate our rivers. We have already formed river health-related working relationships with a number of organisations, who are achieving promising results in their efforts to care for waterways in their neighbourhoods. However, many more of these initiatives are needed before we will be able to turn around water quality. Dumping into sewers, disposal of toxic chemicals into wastewater streams and polluting urban waterways should become taboo in the same way that littering is in most communities.

The City will continue to monitor and publish data on water quality in our waterways so that we can measure progress towards our goal. We are committed to making information regarding the water quality of our urban rivers and vleis more accessible to the public, and data more easily available to researchers.

Michael John Webster

Executive Director: Water and Waste Services
City of Cape Town

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Greater flamingo © C&S Dorse

2. INTRODUCTION

The quality of water in urban watercourses indicates the impact of people on these ecosystems, and reflects contamination from both widespread land use and specific activities generating point-source pollution. The implications of poor water quality can be profound, cutting across a broad range of user sectors, including human health, sewer and stormwater infrastructure, tourism, recreation and biodiversity.

It is against this backdrop that the City of Cape Town (hereinafter "the City") implements its inland water quality monitoring programme. The programme includes a range of rivers and waterbodies of particular concern across the municipal area. It generates large volumes of data, which are collated and analysed to provide City managers and other interested parties with meaningful information about the state of Cape Town's watercourses, and to guide service delivery priorities.

In 2020, the City contracted Liz Day Consulting (Pty) Ltd to prepare the 2019 technical water quality report on inland aquatic ecosystems, including an analysis of all historical water quality data collected up to the end of March 2020. The report serves the dual purpose of raising awareness and tracking the impact of both City and broader society efforts to restore our rivers and wetlands to a state we can be proud of.

This publication presents a summary of some of the main findings of the technical report. Please consult the full technical report for more details.

3. OVERVIEW AND CONTEXT

3.1. Overview of watercourses in Cape Town

There are numerous watercourses in the Cape Town metropolitan city area, many of which originate outside our borders. Together, they drain the major catchment areas shown in figure 1.

Under more natural conditions, before the start of urban development at the Cape, most of the rivers in the city would have been seasonal rivers that flowed only in the wet season. Many of these would have been associated with wetlands, particularly where several watercourses converged. One example is the general region of today's Paarden Eiland, where the Diep, Black, Liesbeek and Salt rivers once converged, forming expansive marshes.

Perennial rivers were those that rose in the mountains such as the Silvermine and Elsies rivers, rivers off the Constantiaberg, and the Liesbeek, Lourens, Sir Lowry's Pass and Eerste rivers. By contrast, most of the rivers that flowed through the vast, sandy Cape Flats were seasonal and often associated with groundwater-fed wetlands, which would have been inundated when the primary aquifer rose above the level of surrounding surface depressions. Today, the hydrology of many of these has been permanently altered by inflows of piped urban stormwater runoff and treated sewage effluent, which have turned rivers such as the Black, Kuils and Mosselbank rivers into perennial, nutrient-enriched systems. In order to drain water from areas with a high water table, formalised channels were created in areas once dominated by seasonal wetlands (and not channelled rivers). The Big and Little Lotus rivers draining into Zeekoevlei and the Soet system at Strand are examples of this.

Note that the Mitchells Plain catchment shown in figure 1 does not in fact (historically) include any natural watercourses. Water in this part of the Cape Flats probably infiltrated through the sand or formed shallow wetlands. Today, the area is largely developed. Runoff from the hardened urban surfaces is collected in large artificial detention ponds and conveyed to the sea through stormwater pipes and drains.

The city bowl and adjacent Sea Point and Camps Bay areas also do not include any remaining natural rivers. This is because most of the streams that drain off Table Mountain and the Twelve Apostles range have been piped underground. This water passes into Table Bay and the coastline along the Atlantic seaboard as stormwater. The City's biodiversity garden and Green Point Park makes use of some of this water resource, which supplies its artificial wetlands and streams.

Figure 1: 'Inland' WWTWs, informal settlements, major catchments, rivers and water bodies in Cape Town.

3.2. Challenges in the management of urban watercourses

Urban watercourses play an important role in a city. Their condition can have a significant impact on human health, property values, security, amenities, flood risk, and maintenance and management costs such as litter and sediment removal.

From an ecological perspective, urban watercourses can be vital corridors of relatively natural habitat in an otherwise sterile urban landscape. In Cape Town's case, they also connect mountainous habitats with the coast. Moreover, urban watercourses provide aquatic habitat and, in some areas, are key for biodiversity.

In Cape Town, which lies in the heart of the Cape fynbos biome, some aquatic ecosystems support plant and/or animal species that occur only in a restricted area in certain watercourse types in parts of town, and nowhere else in the world. Sadly, however, many of these ecosystems are highly threatened.

The sustainable management of any watercourse can be challenging, but is particularly so in urban environments where many of the natural drivers of ecosystem function have changed fundamentally. Factors contributing to reduced ecosystem resilience include canalisation, water abstraction, impoundment, inflows of sewage and wastewater effluent and other pollutants, loss of floodplains, alien plant invasion, and a general loss of natural biodiversity as a result of all of these factors, all of which are compounded by large-scale loss of terrestrial and aquatic natural habitat. These factors also pose problems to human communities and might affect their recreational or aesthetic value, or make them more likely to harbour criminals.

Addressing all of these challenges at the same time is not always possible. For example, the need to manage flood risk (such as by channel lining, diversion, removal of vegetation, or construction and maintenance of attenuation ponds) may require interventions that affect biodiversity (such as loss of riverine habitat or wetland function).

Effective river management and rehabilitation also requires coordinated efforts across a range of departments, which can be challenging to achieve. In the City, these stakeholders include the departments of Water and Sanitation (providing drinking water, sewage management, refuse removal, and catchment, stormwater and river management services), Recreation and Parks (managing parks, sports facilities, tidal and municipal swimming pools, beach amenities and public open spaces), Human Settlements (responsible for formal housing and informal settlements), Environmental Management (responsible for nature reserves, including some with wetlands and sections of rivers, biodiversity nodes and the coastal zone), and Transport (managing roads, road drainage, transit networks and public transport).

Moreover, although legislation in South Africa is generally comprehensive and, in theory, conducive to social and environmental sustainability, any law requires voluntary compliance to be effective. Sadly, this compliance is lacking in some sectors. Implementation of local government policies that seek to achieve effective integration across departments may also be constrained by funding limitations. This hampers the management of domestic and industrial waste streams and runoff, which directly affects urban watercourses.

In trying to overcome these challenges, the City's Catchment, Stormwater and River Management Branch works closely with other line departments who have an interest in, and influence on, urban catchments to achieve more holistic catchment management. Partnerships with external parties and public interest groups are also recognised as an important tool, and it is hoped that the publication of reports such as these will stimulate more collaboration in this regard.

Western leopard toad © C&S Dorse

The western leopard toad *(Sclerophrys pantherina)* is an endangered frog species restricted to the southwestern Cape region. Although it inhabits terrestrial areas for most of the year, it breeds in standing water ponds, wetlands and vleis. Here, its eggs hatch into tadpoles, which remain in the ponds for a few months until they emerge as tiny toadlets.

A number of important breeding sites for this species are located in Cape Town.

Whorled heath © D Gibbs

Whorled heath or Cape Flats Erica *(Erica verticillata)*, which is endemic to Cape Town, was once abundant in seasonal wetlands with acid soils in parts of the Cape Flats. However, large-scale loss of wetlands as a result of agricultural and urban development led to its extinction in the wild by the mid-20th century.

A few specimens were, however, located in various botanical gardens, and were cloned for reintroduction to the few remaining areas of suitable habitat in Cape Town.

3.3. Consideration of land use and major point-source inputs of pollution

One of the most profound impacts on water quality in Cape Town, as in many other cities, is that of waste. Treated and untreated sewage has a particularly harmful effect on our watercourses.

Under ideal conditions, domestic and industrial liquid waste is conveyed to wastewater treatment works (WWTWs), where it is treated to an acceptable (licensed) standard. It is then either released back into the environment (usually into rivers or the sea), reused in industry, construction or as an irrigation supply, or, in some areas, treated further for human consumption. In practice, the management and treatment of human waste is often fraught with problems, particularly in developing countries, including the following:

- The unlawful establishment of informal settlements on land considered unsuitable for housing (such as in low-lying flood-prone areas, or in or near seasonally inundated wetlands). This impedes service delivery, which means that residents tend to dispose of their household waste, greywater and sewage directly into the environment, resulting in rapid pollution and degradation of sometimes important seasonal wetlands.
- Repeated sewer leaks and overflows from sewage infrastructure, largely due to by-law contraventions and, to a lesser extent, factors affecting sewer condition. (For more on this, read the "Comment on sewage spill frequency" on page 13.)
- Overflows from sewage pump stations which may be caused by mechanical, electrical or instrumentation failures, foreign objects, generator failures and load-shedding.
- Inadequately treated wastewater discharged from WWTWs into rivers. This water contributes to significant nutrient enrichment, low levels of oxygen and high ammonia, which affect river habitat quality and downstream systems such as vleis and other wetlands. Note that, without dilution by the receiving waterbody, even effluent that is treated to legal standards (in other words, the General Effluent Limits specified by the national Department of Human Settlements, Water and Sanitation (DHSWS)) is likely to contain high levels of nutrients, as well as ammonia, and could also lead to poorly oxygenated waters due to high levels of organic decomposition.
- Illegal connections in industrial or residential areas. These allow waste that should be discharged into sewers to be passed into stormwater systems instead. A common source of pollution in some residential areas is the passage of water backwashed from swimming pools into streets or the stormwater system, where it can cause persistent toxins (such as chloramines) to form.
- High levels of illegal waste dumping and inconsistent use of the City's refuse management services. As a result, waste accumulates along roads and open spaces, from where plastics and organic waste often wash into the stormwater system.

Stormwater discharged into a river, Hout Bay

Backyard dwellings and water quality

The living conditions of many backyard dwellers not only affect human health and impair dignity, but often also serve as a source of significant water pollution due to inadequate servicing. Although usually located in areas with formal water and sanitation, many backyard dwellers do not have access to formal sanitation. As a result, domestic waste (both sewage and water used for washing, cooking, etc.) is disposed of either into the streets or directly into the stormwater system, from where it passes into detention ponds or rivers.

Even where backyard dwellers have toilets available, bulk service design seldom caters for the sometimes three or four-fold increase in actual resident numbers as backyard dwellings multiply. This means that sewers and pump stations often cannot cope with the additional volume of waste produced.

Water pollution along backyard dwellings © L Day

Comment on sewage spill frequency in Cape Town

Overflows or spills from the sewage reticulation network of pipes and pump stations, and from wastewater treatment works, can affect the aquatic environment either directly (when located close to receiving waterways) or in a more indirect manner (as sewage spills onto roads often enter the stormwater system via roadside kerb inlets). As the built stormwater network is linked to the river network, contamination entering the stormwater system often inevitably finds its way into rivers and wetlands.

Causes of sewage overflows specifically from the conveyance network include by-law contraventions (illegal dumping of building material and other foreign objects, and the build-up of fats) and factors relating to the condition of sewage reticulation infrastructure (accumulation of sand, root growth and pipe collapses). In 2019, by-law contraventions accounted for 76% of sewage spills, while only 24% resulted from infrastructure condition constraints (see figure 2 below).

Figure 2: Number of, and reasons for, sewage spills in Cape Town, 2019

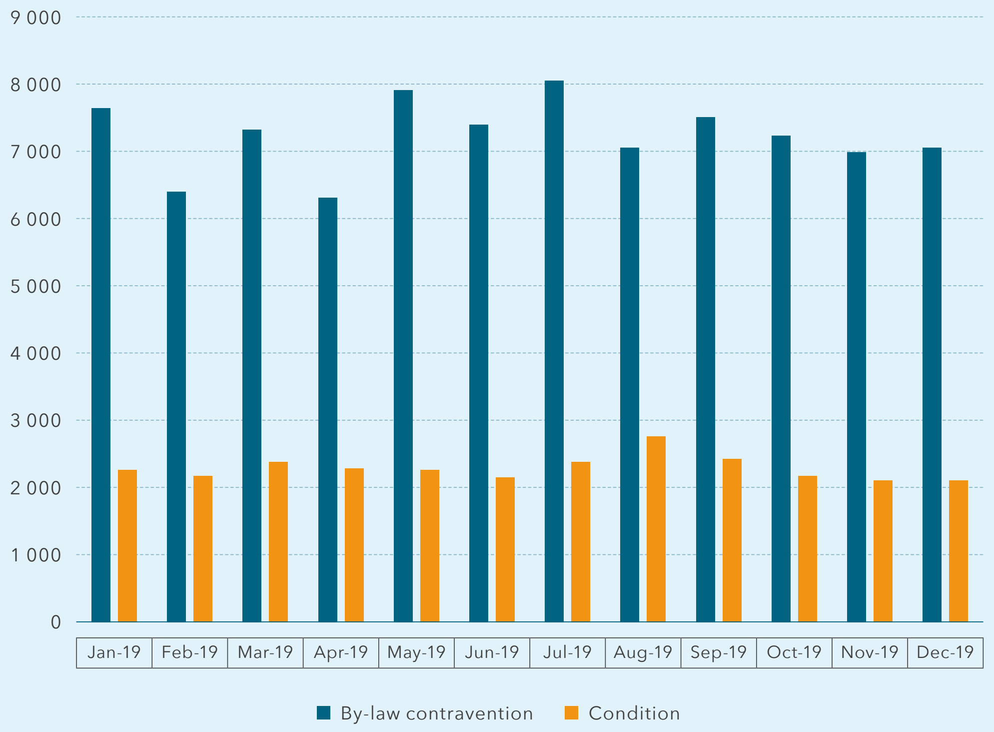
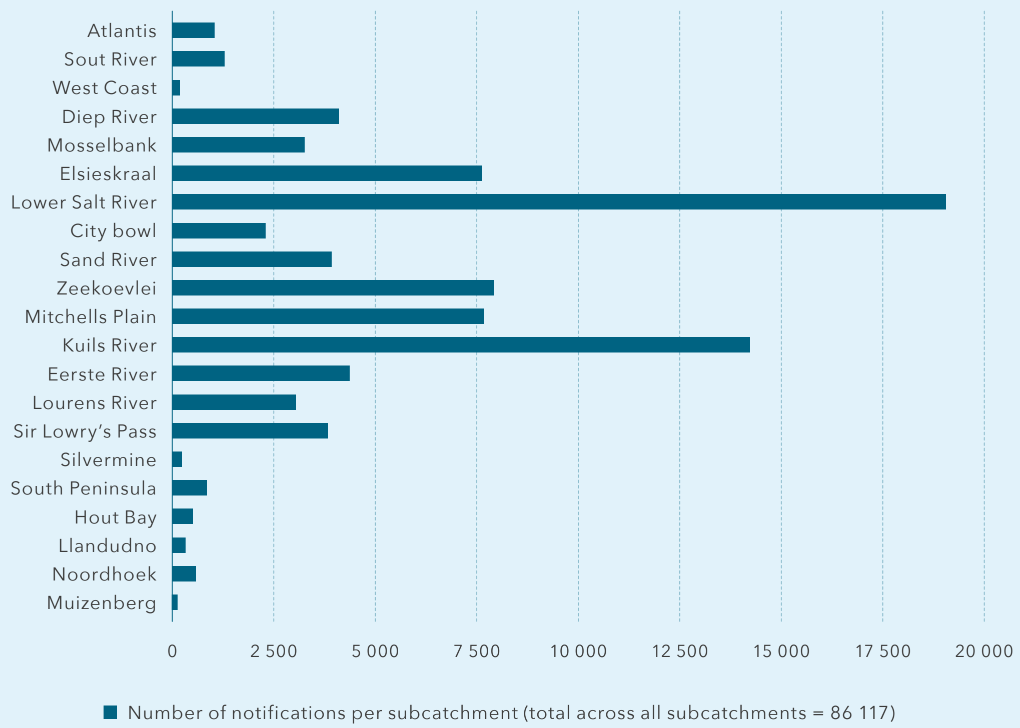


Figure 3 below shows the frequency of sewage spills in Cape Town in terms of the catchments around which the rest of this booklet (and particularly section 7) revolves. The data suggest that the Lower Salt and Kuils catchments had by far the greatest frequency of reported sewage spills, followed by the Elsieskraal, Zeekoe and Mitchells Plain catchments. The report demonstrates that catchments that exhibit poor water quality also tend to be those with higher incidents of sewer spills.

Catchments with the lowest number of reported spills or overflows were the Silvermine, South Peninsula, Hout Bay, Noordhoek, Atlantis, Sout, West Coast, Llandudno and Muizenberg catchments. Of these, the West Coast, Llandudno and Muizenberg catchments drain directly into the sea and do not affect river systems.

Figure 3: Sewage spills by subcatchment, 2019



Note that the data referenced in figure 3 do not indicate volumes of sewage spilled or overflowing, or the time over which the spill occurred before being addressed. In addition, the data reflect only areas in which sewage spills were reported through the City's C3 notification system. In some areas, residents might be more vigilant in reporting problems than in others, and some reports might reflect relatively short-lived incidents versus major spills. In addition, repeat reports of the same incident are likely to cloud the data somewhat.

The catchments referred to in figure 3 also feature strongly in the discussion of ambient water quality in the full technical report. It is clear to see that there is a link between areas experiencing high numbers of sewage spills and catchments experiencing water quality challenges.

Grootboschkloof stream, Constantia

Ambient water quality

Ambient water quality refers to the quality of water in natural watercourses as opposed to treated or piped-water quality. It is determined based on the holistic monitoring of systems in their entirety. By contrast, the current report on the water quality of Cape Town's waterways focused on data collected from specific points, usually those identified as problem areas. Therefore, it does not provide an overall idea of "ambient" water quality in Cape Town. In fact, because the monitoring focuses mainly on poorly performing systems, the water quality data assessed in this report arguably exaggerate the level of watercourse pollution in the city to some extent.

3.4. What is water quality?

The concept of "water quality" considers the combined effects of the physical, chemical and biological attributes of a water sample on a particular user. As such, it serves as a measure of its "fitness for use" for an intended purpose.

Water quality samples analysed in a laboratory are usually interpreted according to standards or guidelines relating to a particular user group or purpose. These may include guidelines for human drinking water, domestic animal drinking water, irrigation, recreational water use (e.g. swimming or water sports), as well as guidelines relating to the effect of varying water quality on aquatic plants and animals.

To consider water quality from a human health and/or ecological perspective, one needs to evaluate a range of physical, chemical and biological attributes of the water. This often requires an integrated understanding of how these constituents interact. Therefore, water quality data should ideally be interpreted by people with expertise in the fields of freshwater ecology, microbiology and water chemistry in the context of urban catchment landscapes and associated land uses. Cape Town's residents and environmental interest groups can also assist the City with environmental monitoring by becoming involved with citizen science initiatives such as mini-SASS (Southern African Scoring System) surveys.

3.5. Natural water quality

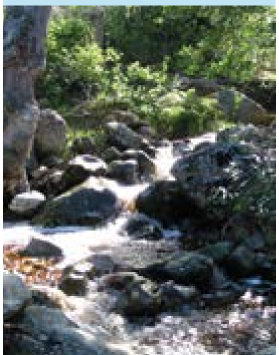
Under "natural" or un-impacted conditions, different watercourse types often have different water quality characteristics. For instance, many wetlands or vleis are naturally more nutrient-enriched and possibly have a higher salt content than rivers as a result of nutrient imports from animals such as birds, as well as the accumulation of plants over long periods of time.

Even different river types exhibit different water quality. Ecologists usually classify rivers into distinct types, largely based on geomorphology and gradient. On the basis of this, the following broad river types occur in the City, namely:

- Mountain stream reaches, which flow off steep mountain gradients and tend to occur on the outskirts of the city and outside the urban edge
- Upper (or cobble) foothill reaches, which occur on the steep mountain foothills, and (where they pass through the City's jurisdictional boundaries) tend to run mainly through farms, smallholdings or low-density residential areas and nature reserves
- Lower (or gravel) foothills, which, with a few exceptions, run through highly developed urban areas, including residential suburbs, commercial and industrial zones
- River reaches that are sometimes called "transitional", but are more accurately classified as valley bottom wetlands, mostly dominating the naturally seasonal, flat, low-lying Cape Flats area
- Lowland rivers, which meander across broad floodplains, and generally pass into the estuarine zone of the river

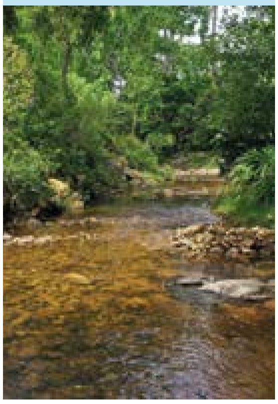
Examples of watercourse types in Cape Town

Mountain stream: Window stream above Kirstenbosch

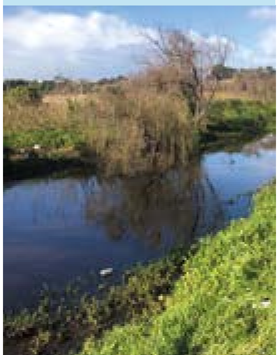


© J Day

Foothills river: Liesbeek River, Newlands

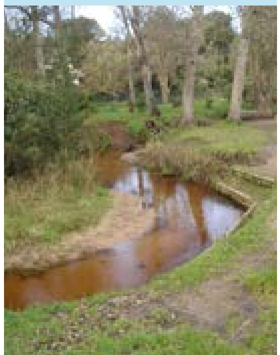


Lowland river: Liesbeek River, Mowbray



© L Day

Incised valley bottom wetland/'transitional' river: Diep River, Plumstead



© L Day

In the many decades before Cape Town developed into the major city it is today, its rivers would have culminated in estuaries or lagoons under natural conditions. Ten such estuaries occur within the city's boundaries, namely Rietvlei/the Diep River, Hout Bay, Wildevoëlvlei, Bokramspruit, Schuster, Silvermine, Zandvlei, Eerste, Lourens and Sir Lowry's estuaries. The Sout and Salt systems would have also formed estuaries or coastal lagoons under natural conditions.

Many of these estuaries have lost their natural function. Their river outlets have been converted into concrete canals (such as the Salt and Sir Lowry's Pass rivers), with no salt flux and tidal exchange left so as to meet the criteria for an estuary. Zandvlei and the Diep River estuary are the only remaining systems that retain some estuarine functionality, despite significant levels of impact, particularly in terms of natural salinity. The Eerste River estuary has been severely affected by large volumes of low-salinity wastewater discharges, and the Lourens River and Silvermine River estuaries have been affected by urban development and (in the case of the former) significant upstream abstraction.

At the same time, many naturally seasonal wetland pans or coastal lakes that would have rarely, if ever, opened into the sea under natural circumstances (such as Wildevoëlvlei and Zeekoevlei) have today been connected to the sea via artificial channels and canals. As a result, they have been classified as estuaries in some studies.

Today, the City's stormwater management system, which manages surface runoff across Cape Town, includes (approximately):

- 16 630 km of stormwater pipes and culverts;
- 890 stormwater detention ponds and dams;
- 236 stormwater treatment wetlands;
- 1 910 km of rivers and streams; and
- 4 164 "natural and seminatural" wetlands, including vleis and estuaries.[1]

All these changes represent significant changes to natural watercourse patterns and function as a result of urbanisation. Ultimately, this is reflected in water quality.

Therefore, the discussion of water quality in the following sections should be seen as a measure of ecosystem condition, the suitability of urban waterways for recreation, and the City's approach to monitoring it.

[1] *Visit www.capetown.gov.za and search for 'our stormwater system'.*

4. THE CITY OF CAPE TOWN'S INLAND WATER QUALITY MONITORING PROGRAMME

The City's inland water quality monitoring programme is structured around the collection of data about watercourses where water quality is a likely cause for concern.

Therefore, many of the monitoring points are downstream of WWTW effluent discharge points, and in river reaches in catchments where runoff is likely to be contaminated. Some sampling points are located in watercourses that are used for recreational purposes, which serve to measure these systems' fitness for use.

"Recreational water" is any body of water used for open-water swimming or water sports such as kayaking, waterskiing or sailing. It usually refers to an inland body of fresh water, such as a river, reservoir, lake or pond, but could also refer to coastal waters, including estuaries and the open sea.

Source: https://watertreatmentservices.co.uk/water-treatment/recreational-water-quality-standards.

Over the years, the City has collected various kinds of water quality data on its watercourses (main rivers and wetlands/vleis) – in some cases, going back to the late 1970s. This has generated an extensive database of sites that represent water quality in main rivers, stormwater or effluent outflows into watercourses, as well as key wetlands, dams and detention ponds.

Figure 1 shows the main catchment areas in Cape Town. Note that although most of these have been included in this study, sites for which only a few data points were available or which were monitored for ad hoc or project purposes, were excluded.

A total of 242 water quality sampling sites were included in the report. These comprise 13 canal sites, seven artificial dam or impoundment sites, two detention ponds, two effluent outlet channels, two estuary sites, 158 river sites, five stormwater outlets and 53 vlei, standing water or wetland sites.

Of this historical dataset, some 174 sites are currently monitored through monthly collection of water samples for analysis by the City's Scientific Services Branch at their water quality testing laboratories in Athlone. A range of chemical, algal and bacterial constituents are measured.

The extensive Mitchells Plain area, which is drained by stormwater pipes that discharge into the sea from coastal outlets, has no natural or artificial open channel system. However, this important catchment generates large volumes of runoff from hardened urban areas. For this reason, two stormwater attenuation pond sample sites were included in this study to provide an indication of surface water quality in this catchment.

Also note that not every catchment in the city is represented in the monitoring programme. Some catchments do not have any monitoring sites. These are catchments that are not necessarily considered problematic from a water quality perspective (such as minor rivers along the Atlantic seaboard), do not have significant river systems (such as the Atlantis catchment), or where natural rivers have been almost entirely piped into the stormwater system (such as the city bowl).[2]

[2] *Note, therefore, that this may result in an unintended bias in the water quality database, suggesting that water quality in Cape Town rivers may be universally poor, which is not necessarily the case.*

4.1. Purpose of water quality monitoring in urban watercourses

If carefully structured and rigorously performed, water quality monitoring can provide valuable insights into the long-term trajectory of water quality in waterbodies, including rivers and lakes/vleis. These insights, in turn, inform decisions about the risk that water quality may pose to different user groups. For example, are vleis generally fit for recreational use such as swimming, rowing, sailing or canoeing? Water quality monitoring also provides information about the ecological health and, thus, ecological sustainability of these systems.

Water quality data can help identify which watercourses are prone to ongoing pollution, which would point to a need for further investigation to identify the causes of, and possible solutions to, pollution. Moreover, the data can "red-flag" sudden onsets of pollution that may, for instance, be caused by sewage leaks or illegal discharges, provide evidence for compliance with licensing or permit conditions, and inform water quality remediation efforts.

In cities such as Cape Town, where the urban watercourses discharge directly into the sea, urban water quality also has a very direct effect on the quality of coastal waters,[3] which affects the recreational value of Cape Town beaches, as well as the viability of the city's near-shore fishing industry, among others.

Water quality samples being collected from Zandvlei

What water quality monitoring can't do

Analysis of water quality samples collected from a river only shows the state of water quality at the time of sampling, and at the specific location where the sample was collected. It does not tell us anything about water quality immediately before or after sampling, or in other areas around the sampling point. This means that pollution plugs may be missed or accidentally targeted by the timing of sampling. Therefore, a long-term monitoring programme undertaken at, for instance, monthly or fortnightly intervals provides a general overview of water quality patterns and trends in the monitoring network.

It also only provides information about the constituents that were actually measured by the laboratory. There may be other kinds of pollutants in a waterbody as well.

[3] *The City has a comprehensive coastal water quality monitoring programme. The recently published 2019 Know Your Coast report provides an overview of water quality around Cape Town's coastline. Access it at http://www.capetown.gov.za/Explore%20and%20enjoy/nature-and-outdoors/our-precious-biodiversity/coastal-water-quality.*

5. THRESHOLDS USED TO GUIDE WATER QUALITY INTERPRETATION

Water quality data for the report were interpreted based on certain categorical ranges appropriate for assessment of water from both a recreational (public health) and an ecological health perspective. This categorical approach is in line with established national procedures commonly used in the assessment and reporting of inland water quality.

Public health risk assessment thresholds for *Escherichia coli* (*E. coli*) were based on those used in various guidelines,[4] as well as studies such as the Resource Quality Objectives Study for the Berg Water Management Area. These thresholds were further adapted for use in the urban context to identify examples of extreme exceedance. Therefore, the thresholds in table 1 include the *E. coli* target level for full-contact recreation (swimming)[5], acceptable and tolerable levels for intermediate-contact recreation (canoeing, sailing), and a further breakdown of the unacceptable category to allow for a more detailed assessment of *E. coli* contamination often found in urban environments.

For ecological health, the categories range from target (incorporating "good" and "fair" conditions) to "poor", and then "unacceptable" (see table 2). The desired minimum water quality category considered appropriate for Cape Town's urban waterways is at the "fair" lower-threshold breakpoint.

Each of the physico-chemical water quality constituents (such as nitrogen, phosphorus, oxygen, ammonia, etc.) analysed in the technical report was assessed in terms of individual thresholds relevant to that particular constituent. These thresholds were then assigned to the water quality categories below. **For a more detailed explanation, kindly consult the technical report.**

Different rates for different states

The rating of water quality risk to human recreational users is very different from the rating of water quality with regard to ecological condition, which considers the degree to which water quality has changed from the natural state. For example, a salt pan frequented by numerous wading birds might rate very poorly from a human health perspective as a result of high levels of salt and bacteria. At the same time, however, it could rate in a near-natural condition ecologically, being a relatively un-impacted example of the "salt pan wetland" type.

Water quality assessments from a human health perspective typically include measures or, in some cases, indicators of pollutants that could be harmful to humans if they are ingested or come into contact with human skin or body parts (eyes, ears, etc.). By contrast, water quality assessments from an ecological perspective focus on variables that could contribute to toxicity to aquatic organisms, or could influence habitat quality or availability (such as excessive plant growth that alters habitat type).

The Lesser flamingo © C&S Dorse

Table 1: Public health/recreational use categories used to guide the assessment of microbial data

PUBLIC HEALTH/RECREATIONAL USE CATEGORIES	FAECAL COLIFORM COUNT (INCLUDING *E. COLI*)*
Maximum acceptable risk for full-contact recreation	≤400 cfu/100 ml
Acceptable risk for intermediate-contact recreation	≤2 500 cfu/100 ml
Tolerable risk for intermediate-contact recreation	2 501–4 000 cfu/100 ml
Unacceptable risk – level 1	4 001–10 000 cfu/100 ml
Unacceptable risk – level 2	10 001–100 000 cfu/100 ml
Unacceptable risk – level 3	>100 000 cfu/100 ml

** Bacterial concentrations in water are usually expressed as numbers of colony-forming units (cfu) per 100 ml.*

Table 2: Relationship between categories used to assess water quality from an ecological perspective and Present Ecological State categories (consult technical report for a more detailed explanation)

WATER QUALITY CATEGORIES	INTERPRETATION OF CATEGORIES	PRESENT ECOLOGICAL STATE CATEGORIES*
GOOD	TARGET	A: Natural/no change
GOOD	TARGET	B: Largely natural, with few modifications/small change
FAIR	TARGET	C: Moderately modified/moderate change
POOR	BELOW TARGET	D: Largely modified/large change
UNACCEPTABLE	UNACCEPTABLE	E: Seriously modified/serious change
UNACCEPTABLE	UNACCEPTABLE	F: Critically modified/extreme change

** The Present Ecological State (PES) of aquatic ecosystems is determined by integrating a number of metrics, including instream and riparian habitat quality, geomorphology, flow regime, water quality and biota. In this report, the City has undertaken an assessment of specifically the water quality component of a PES assessment.*

[4] *For example the Department of Human Settlements, Water and Sanitation (DHSWS), previously known as 'Water Affairs' or the national Department of Water and Sanitation.*

[5] *Note, however, that the City does not generally recommend full-contact use in any of its inland waterbodies.*

6. STATUS OF WATER QUALITY IN THE CITY'S RIVERS AND VLEIS/DAMS

The technical report provides a comprehensive analysis of historical and current water quality of Cape Town's major rivers and vleis/dams. For the assessment of current (2019) water quality, data for the April 2019 to March 2020 period were used, which were compared to the historic dataset, in particular the previous four years' data. This summary booklet highlights some aspects of the technical report. Kindly consult the full report for further details.

6.1. Public health/recreational assessment based on *E. coli* levels

E. coli measurements in inland waters are used primarily as an indicator of risk to human health, particularly when a waterbody is used for recreational purposes. Therefore, this parameter is generally considered for all urban rivers and waterbodies where informal, intermediate contact may take place (such as walking through, or wading in, the water).

More specifically, however, it is also considered in vlei systems with established recreational water sports and/or other water-based activities that may be associated with both intermediate and, at times, full-contact recreation. In Cape Town, these are **Zandvlei**, **Zeekoevlei**, **Rietvlei**, **Milnerton Lagoon** and **Princess Vlei**.

Escherichia coli (E. coli) is a species of faecal coliform bacteria that are commonly found in the lower intestine of warm-blooded organisms (birds and mammals).

Most *E. coli* strains are harmless, but some can cause severe food poisoning in humans. Their presence in water is used as an "indicator" of faecal contamination by birds or mammals and, therefore, of other pathogens that may be present in faeces.

Defining recreational user groups

Guidelines for inland waters are scaled according to the different levels of risk associated with different types of recreational activity. The South African guidelines identify three recreational user groups with different risk profiles, namely **full-contact**, **intermediate-contact** and **non-contact recreation**.

- **Full-contact recreation** is defined as full-body water contact and includes full-immersion activities such as swimming and diving. Distinguishing features of this user group include:
  - the extent of water contact (repeated and/or lengthy immersion is common, which means the probability of ingesting water is high);
  - users' age group (swimmers often include children, who are more susceptible to a number of health effects, particularly infectious diseases); and
  - users' health status (people are inclined to swim even when they are not completely healthy, making them more susceptible to health effects).
- **Intermediate-contact recreation** includes all forms of contact recreation not listed under full-contact recreation. Therefore, this category includes some activities that involve a high degree of water contact (such as waterskiing, wading and windsurfing), and others that involve relatively little water contact (such as canoeing and angling). The major distinguishing features of the high-contact activities in this class are:
  - the degree of water contact (full immersion is likely to occur only occasionally and among novices of the particular water sport);
  - users' age (water sports such as waterskiing and windsurfing are usually practised by adults rather than young children); and
  - users' health status (strenuous water sports are generally practised by water users in a fairly good state of health).
- **Non-contact recreation** includes all forms of recreation that do not involve direct contact with water such as picnicking and hiking along waterbodies. It also refers to the scenic and aesthetic appreciation of water by those residing or holidaying on the shores of a waterbody. No water contact occurs, so public health effects associated with water quality are of little relevance to this user group.

The technical report includes a general assessment of *E. coli* data from all the river and vlei systems monitored by the City. This is followed by a more focused assessment of the implications of contamination of the five main recreational waterbodies listed above.

6.1.1. Informal recreational use: All river and vlei/dam systems

Figure 4 on page 26 indicates the long-term trend in *E. coli* levels measured at all rivers and vleis/dams over approximately 30 years (1990 to 2020). At both rivers and vleis, the general assessment reveals a decline in the percentage of samples that were at acceptable or tolerable levels for intermediate-recreational contact over the 30-year period.

E. coli contamination patterns in vleis and dams are slightly different from those in rivers, reflecting the capacity of these open, "standing" water systems for bacterial reduction because of an increased residence time, with prolonged exposure to sunlight assisting with bacterial die-off.

Figures 5a and 5b on pages 28 and 29, in turn, indicate the current state of rivers and vleis/dams for 2019 (i.e. April 2019 to March 2020) compared to the preceding four-year period (2015 to 2018).[6]

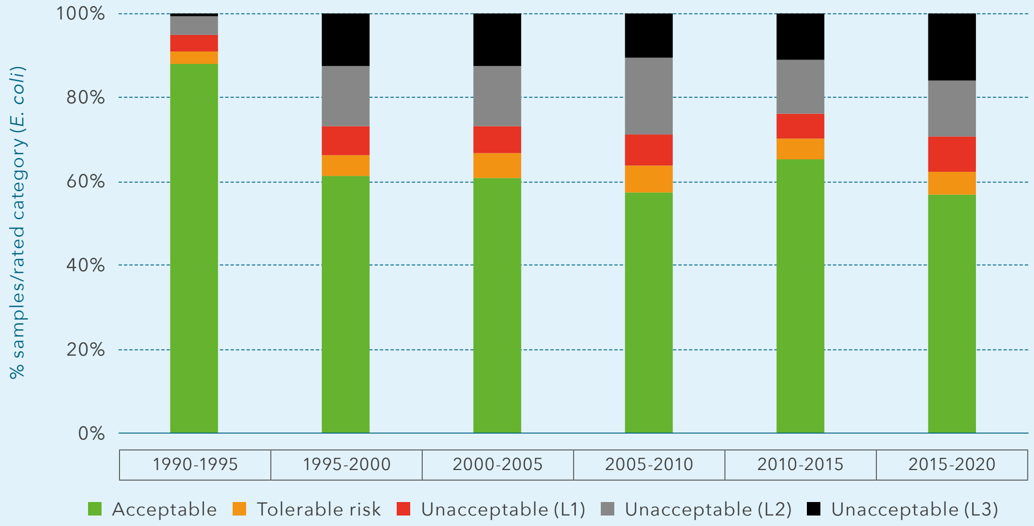
For more detailed information on the trends observed in specific catchment areas, please consult section 7 in this summary booklet, as well as the full technical report.

Water quality monitoring being undertaken by City Biodiversity Management staff © K Wright

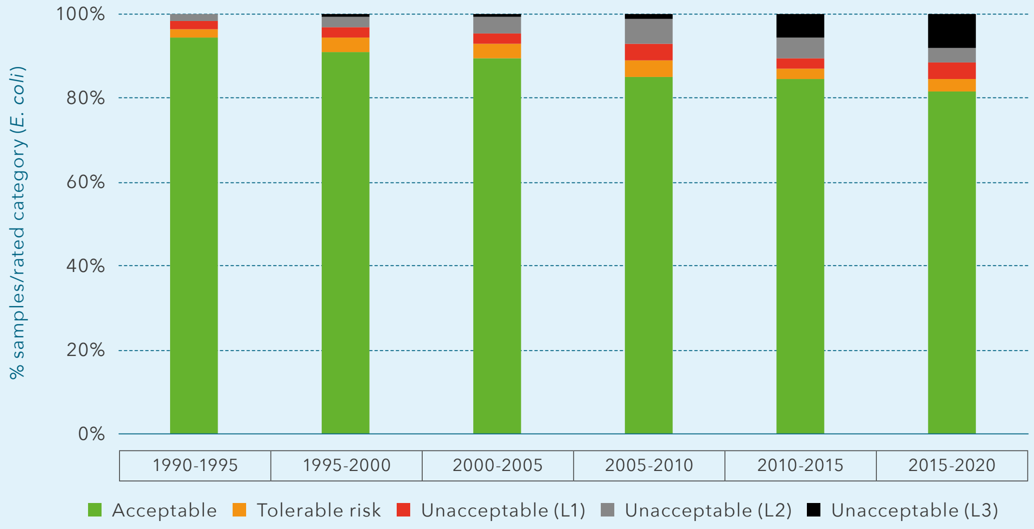
[6] *For those unfamiliar with the box-and-whisker plots used in the technical report and this summary booklet, a text box is provided on page 27 to aid with interpretation.*

Figure 4: Long-term trend in *E. coli* levels at rivers and vleis/dams, 1990–2020

All rivers



All vleis, dams and detention ponds



Guide to the interpretation of box-and-whisker plots

The figure below illustrates how the box-and-whisker plots used in this report should be interpreted. Each plot is generated using the full set of data for a specific river or vlei system over the specified time period.

The yellow line in this figure indicates the median value (also known as the 50th percentile), while the shading inside the "box" represents the interquartile range (i.e. the range between the Q1: 25th and Q3: 75th percentiles).

The "whiskers" of the box indicate maximum and minimum values within 1,5 times the interquartile range, added to the 75th percentile and subtracted from the 25th percentile respectively.

Outliers are shown as individual dots on either side of this range. In statistics, an outlier is a datum point that differs significantly from others. An outlier may be due to variability in the measurement, or may point to an experimental error. For this reason, it is sometimes excluded from the data set, as it can cause serious problems in statistical analyses.

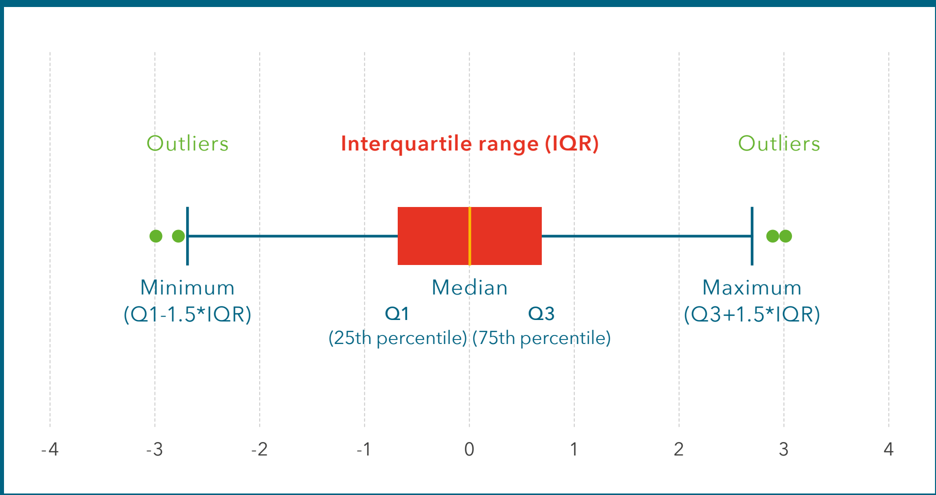


Figure 5a: Comparison of *E. coli* data for 2019 and 2015-2018 (rivers)

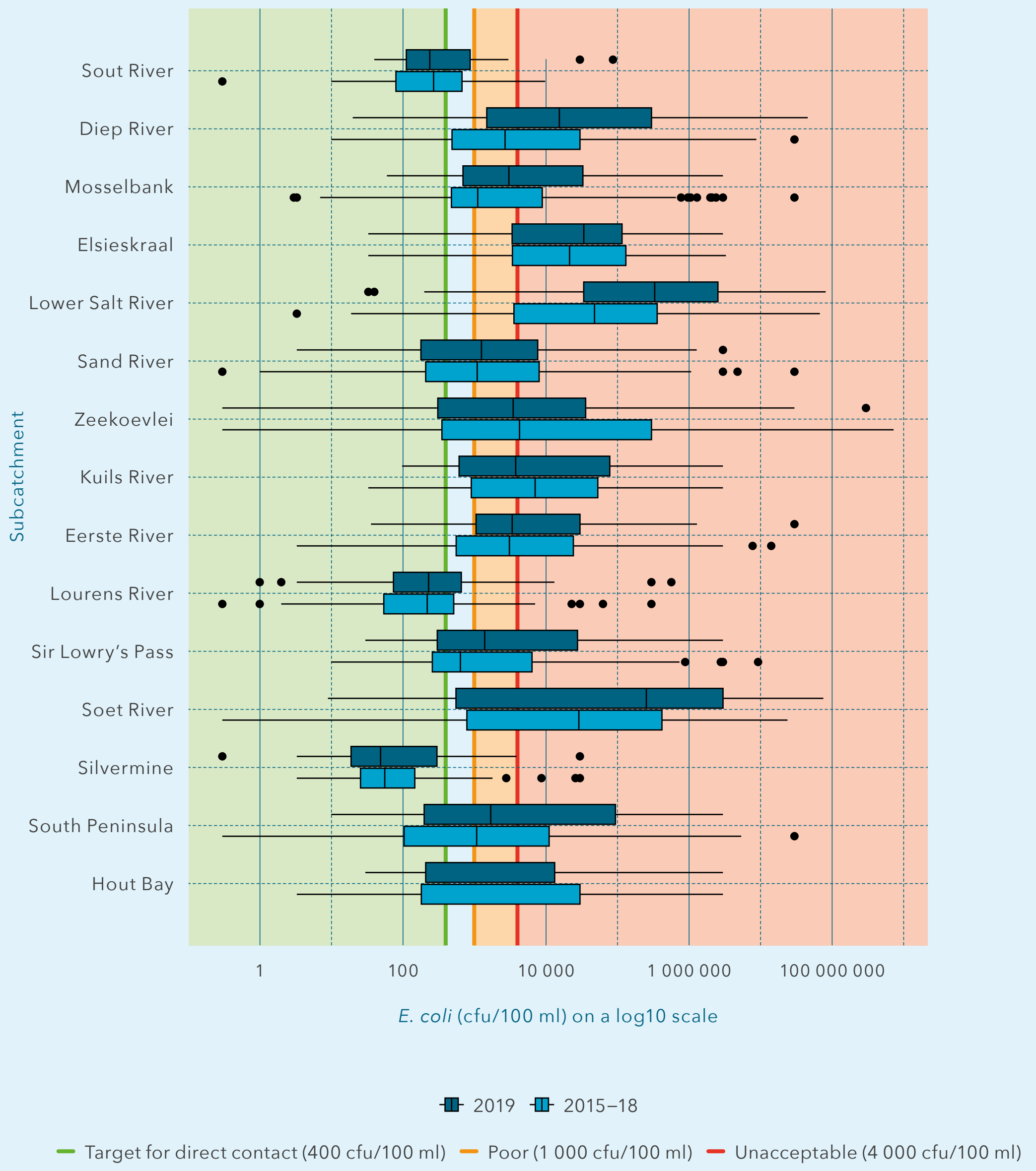


Figure 5b: Comparison of *E. coli* data for 2019 and 2015–2018 (vleis and dams)

6.1.2. Formal recreational activities: Specified recreational vleis

In terms of formal recreational activities, the report goes on to provide a more detailed analysis of human health risks and concerns at the following five main recreational waterbodies in Cape Town:

- Rietvlei, which is used for sailing, windsurfing, waterskiing and fishing
- Milnerton Lagoon, which is used for canoeing, wading and swimming (the latter generally from the beach)
- Princess Vlei, which is used for baptisms and canoeing
- Zeekoevlei, which is used for sailing, windsurfing, waterskiing, canoeing and fishing
- Zandvlei, which is used for sailing, windsurfing, canoeing and fishing

Users of these recreational waters could potentially be exposed to human health risks associated with faecal contamination, as well as potential toxicity from certain types of algal blooms.

Based on an analysis of *E. coli* and algal microcystin toxin data for the past five years, the technical report concludes that most of these five waterbodies have generally been in a condition conducive to at least intermediate-contact recreation. However, Milnerton Lagoon has been subject to periodic and, at times, prolonged contamination by *E. coli*, which suggests exposure to untreated sewage. Rietvlei, in turn, is vulnerable to periodic blue-green algal blooms, some of which have resulted in the production of microcystin toxins at concentrations likely to pose extreme risks to recreational users who come into contact with the waterbody.

Most of the assessed urban vleis are found to be hypertrophic with regard to phosphate. Therefore, the report strongly recommends a focus on measures to reduce sources of nutrient enrichment in all of the recreational waterbodies. Addressing upstream sources of untreated sewage at Milnerton Lagoon in particular is also strongly recommended for this waterbody to remain safe for recreational use. In addition, the report raises concerns that standing waterbodies in other areas of Cape Town may also be used for recreation by the public, even though no regular monitoring of human health risk is being undertaken there (such as the Kuils River in the Khayelitsha Wetland Park area, where local communities participate in kayak polo games and training). Although this site has been subject to ad hoc assessment, the report recommends that it (and any other, similarly used sites) be monitored routinely in future.

For more detailed information on the trends observed in specific catchment areas, consult section 7 in this summary booklet, as well as the full technical report.

6.2. Ecological water quality assessment based on nutrient enrichment levels

6.2.1. Major nutrients (phosphorus and nitrogen)

Plants require various nutrients for healthy growth. These include phosphorus, nitrogen, sulphur, magnesium, potassium and many others, although they are often only required in extremely small amounts. Of these, nitrogen and phosphorus play a particularly important part in determining the rate of plant growth, and are often referred to as "growth-limiting" nutrients because of this. In freshwater ecosystems, phosphorus is in fact the actual "growth-limiting" nutrient, as plants such as blue-green algae (cyanophyte algae) can access nitrogen directly from the air.

Most nutrients are not toxic to aquatic environments, even in high concentrations. Some exceptions include ammonia (NH_3), nitrite and nitrate. However, in high concentrations, nutrients (particularly phosphorus) do trigger excessive plant growth. This changes aquatic ecosystem function and structure. It also causes many management problems – from the need for invasive plant clearing, to the risk of toxic algal blooms, and fish kills due to the low oxygen levels caused by decomposing aquatic plants.

Today, most, if not all, of the aquatic ecosystems in Cape Town have been affected by additional nutrient inflows, particularly phosphorus, mainly due to man-made causes such as:

- inputs of treated sewage effluent;
- runoff from catchment areas with many backyarder or informal settlements, which are subject to poor levels of sewage, solid waste and stormwater servicing;
- illegal discharges into the stormwater system in industrial and commercial areas (fertiliser factories, carwashes, markets, informal butcheries and meat markets);
- runoff from fertilised gardens and parks; and
- runoff from agricultural areas in (and in some cases beyond) Cape Town borders.

Water hyacinth plants at Rondevlei © S Khan

6.2.2. Trophic state

The nutrient (trophic) state of a freshwater ecosystem allows it to be broadly classified into one of four trophic categories – oligotrophic, mesotrophic, eutrophic and hypertrophic. These are respectively associated with low, moderate, high and extremely high levels of nutrients (mainly phosphorus and nitrogen).

In standing waterbodies such as vleis, these conditions are associated with the following broad habitat types:

- **Oligotrophic** waterbodies typically have clear water and a rocky or sandy shoreline. Both planktonic and rooted plant growth are sparse.
- **Mesotrophic** waterbodies are in between oligotrophic and eutrophic, and often share characteristics with both these trophic states.
- **Eutrophic** waterbodies are typically shallow with a soft, silty bottom. Rooted plant growth is abundant along the shores and out into the lake, and algal blooms are not unusual. Water clarity is usually poor. If deep enough to thermally stratify (separate into a top and bottom layer of different temperatures), the bottom waters are often devoid of, or low in, oxygen.
- **Hypertrophic** waterbodies may have similar habitat types to eutrophic systems, but a lack of oxygen in bottom waters is more common. These systems are also prone to blooms of blue-green and green algae.

The link between nutrients and fish kills

Periodically, some of Cape Town's vleis or dams experience so-called "fish kills", when large numbers of dead fish occur in parts of the waterbody. This is sometimes accompanied by other fish gulping at the water surface.

These events are usually linked to excessive nutrients, which result in rapid algal growth. Algae have a short lifecycle and high rates of turnover. Therefore, in bloom conditions, dead algae sink to the base of the vlei, where they decompose. Decomposition requires oxygen, so if large volumes of algae (and other plant material) are decomposing, it can cause the bottom layer of the waterbody to be anoxic (without oxygen), killing fish and other aquatic organisms that rely on dissolved oxygen. Such events often follow warm, calm conditions, when decomposition is faster, and when warm water contains less dissolved oxygen anyway. Other, less common causes of fish kills include outbreaks of diseases such as the koi herpes virus, which affects carp, or toxic pollutants.

Indigenous Galaxia sp. © C&S Dorse

6.2.3. Phosphorus enrichment

The technical report includes a comprehensive analysis of phosphorus enrichment levels in Cape Town's rivers and vlei/dam systems. In summary, the data analysis shows that phosphorus enrichment is a pervasive issue in most of our catchments, with only the Lourens River and Silvermine River systems remaining largely in their target range for this variable. Watercourses that receive treated effluent from WWTWs and runoff from poorly serviced settlements appear to be most affected. Figure 6 illustrates the levels of phosphorus measured in Cape Town's rivers and waterbodies over the long-term monitoring record.

The knock-on effects of this enrichment, which the data suggest is progressively increasing, are apparent in the high concentrations of phosphates in all of the standing waterbodies assessed. Most samples fell well within the unacceptable range, indicative of hypertrophic systems. In fact, many samples were more than two orders of magnitude beyond the unacceptable threshold. The waterbodies where phosphorus enrichment is least problematic, albeit still often in the hypertrophic range, are Princess Vlei, Little Princess Vlei, Die Oog, Glencairn Vlei and the Elsieskraal dams. These waterbodies represent catchments that neither receive treated sewage effluent nor are characterised by substantial informal or poorly serviced settlements.

Reedbed wetland in the Noordhoek valley bordered by formal and informal housing areas

Figure 6: Long-term trend in phosphorus enrichment at rivers and vleis/dams, 1978–2020

6.2.4. Nitrogen enrichment

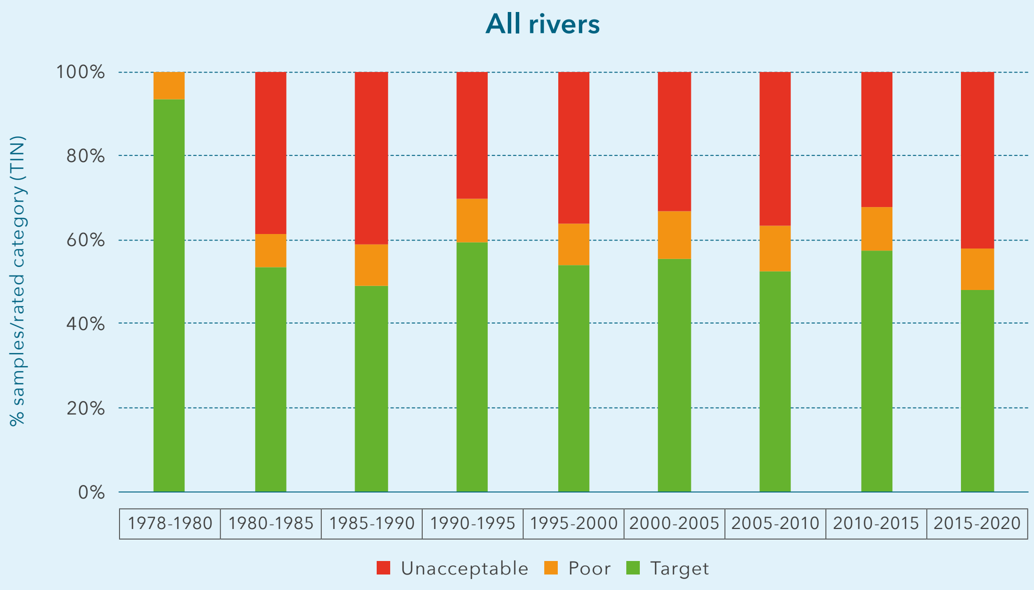
Analyses of total inorganic nitrogen (TIN) data suggest that nitrogen enrichment, although problematic, is a less prevailing concern than phosphorus enrichment in Cape Town's catchments (figure 7).

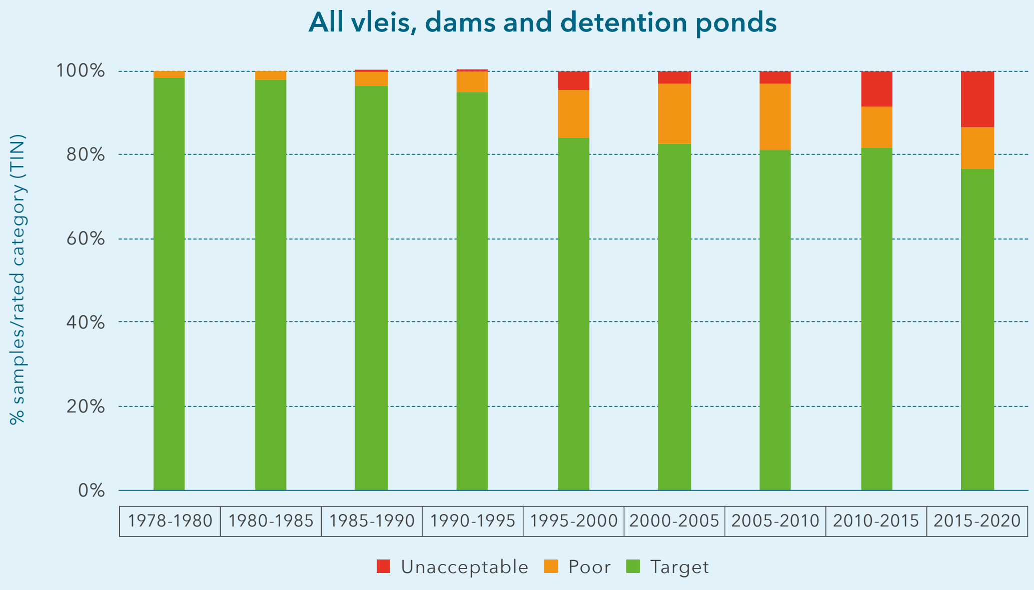
Of the standing waterbodies assessed, nitrogen enrichment is considered problematic only in Wildevoëlvlei and the Mew Way, Edith Stephens and Mitchells Plain detention ponds. TIN concentrations elsewhere generally fall in acceptable limits.

Nevertheless, the data also show that standing waterbodies (along with the rivers or stormwater systems that feed them) are characterised by low nitrogen:phosphorus ratios, which are likely to promote blue-green algal dominance in many of these systems. The least affected systems are Zandvlei, Little Princess Vlei and Princess Vlei, and the trend in all systems is one of increasing phosphorus relative to nitrogen. This is considered likely to increase the possibility of blue-green algae dominating standing water systems and, under certain conditions, to give rise to blue-green algal blooms.

Canalised Liesbeek River

Figure 7: Long-term trend in nitrogen enrichment at rivers and vleis/dams, 1978–2020





6.2.5. Consequences of nutrient enrichment: Algal blooms

Chlorophyll a is a pigment that occurs in green plants and is one of the primary pigments used in photosynthesis. In water quality assessments, it is used as a measure of algal growth – more specifically of phytoplankton abundance.

What is phytoplankton?

Phytoplankton are microscopic single-celled algae, including diatoms, that occur in the water column.

Under conditions of nutrient enrichment, particularly phosphorus enrichment, chlorophyll a often increases. This normally coincides with an increase in algal growth rates in response to increased nutrients. Interestingly, nutrient-enriched systems with a significant volume of macrophytes (more complex plants than single-celled or filamentous algae, such as pondweed or other plants) are less likely to be dominated by algae or give rise to algal blooms.

The City monitors chlorophyll a in many of its standing water systems (vleis and dams). The technical report considers this data from an ecosystem health perspective. The report notes that severely elevated chlorophyll a concentrations, which are indicative of bloom conditions, can have a range of implications for waterbody management. They contribute to the accumulation of nutrients at the bottom of the waterbody when the bloom dies, where decomposition can cause anoxic layers to form, and from where nutrients can periodically be released into the water column. Moreover, high concentrations of chlorophyll a can be associated with odour and aesthetic problems. Microcystis, for example, which is the dominant cyanophyte species in some of Cape Town's waterbodies, produces a distinctive foul smell under bloom conditions. Some of these blooms may also produce algal toxins (e.g. microcystins), which can temporarily make a waterbody unsuitable for recreation. The visible presence of green algal scums is also unpleasant, and persistent bloom conditions in waterbodies can affect property values and suitability of the waterbody for different kinds of recreational uses.

For a more detailed discussion of this aspect of Cape Town's vlei and dam systems, consult the full technical report.

6.2.6. Microcystin toxicity risk

Cyanobacteria (or blue-green algae) are a common and naturally occurring component of most recreational water environments. However, they are of potential public health concern, as some types may, under certain circumstances, produce toxins that can be harmful to recreational water users.

Since microcystin toxin testing is expensive, it is not routinely included in the City's water quality tests. Instead, it is undertaken after specific sample screening for elevated blue-green algal cell counts.

Figure 8 summarises the results of all microcystin tests carried out on Cape Town's main recreational vleis. For interest's sake, it also includes Wildevoëlvlei, since this non-recreational vlei has a history of excessive nutrient enrichment and has seen major interventions to address persistent blue-green algal blooms.

The data show that, despite many of the vleis being prone to high levels of chlorophyll a and possible bloom conditions at times, the frequency at which microcystin toxins were identified in these waterbodies was relatively low. Since 2010, when microcystin toxin testing became a regular response to blue-green algal blooms, only samples from Rietvlei and Wildevoëlvlei have shown concerning microcystin toxin concentrations. This suggests a significant improvement in Zeekoevlei's water quality over time, considering that it suffered frequent blue-green algal blooms and periods of microcystin toxicity in the early 2000s.

Microcystin toxin effects on humans

Many cyanobacteria species produce a group of toxins known as microcystins. When ingested, toxic microcystins are actively absorbed by fish, birds and mammals.

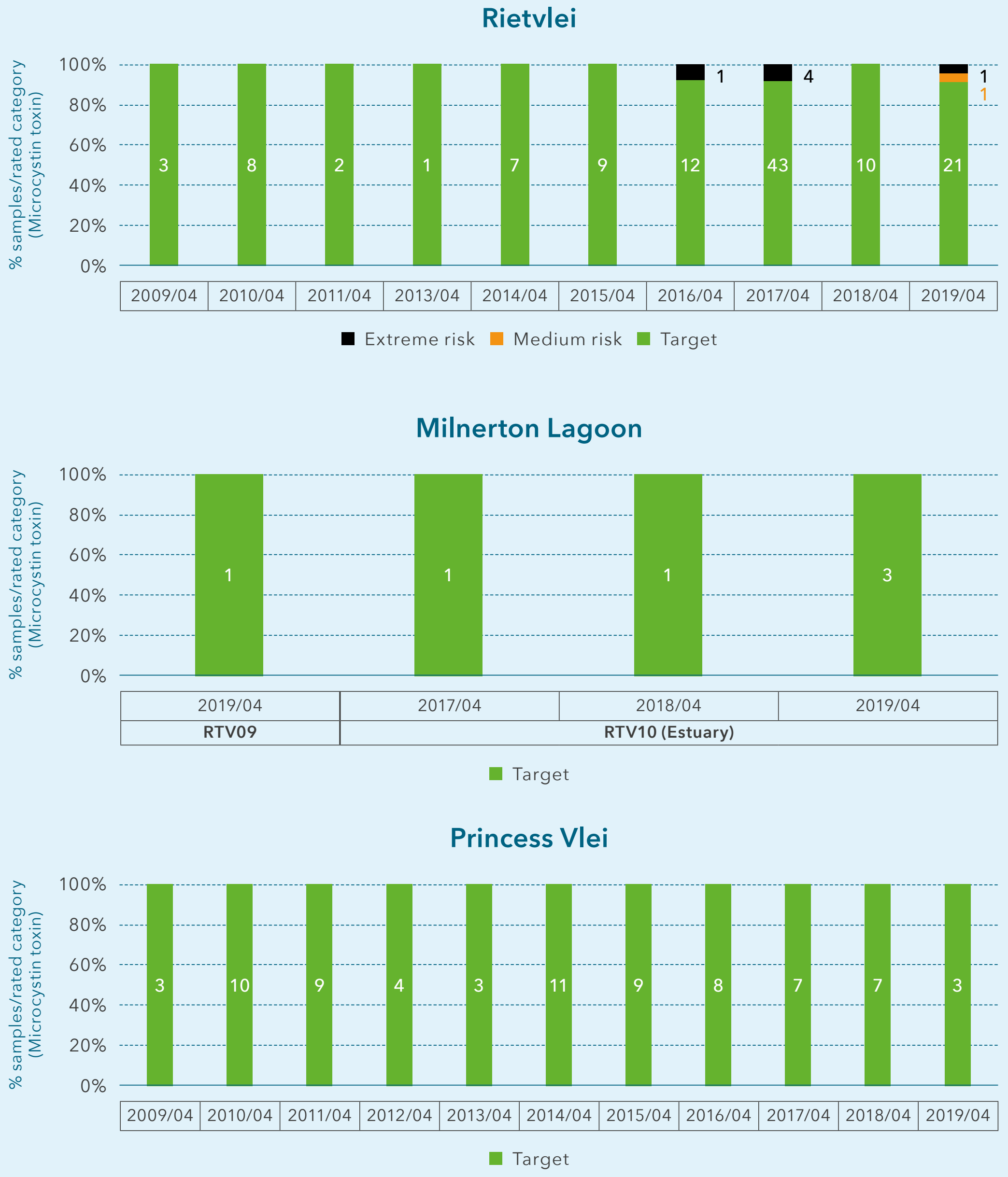
Depending on the level of exposure, cyanobacterial blooms and their cyanotoxins can cause a wide range of symptoms in humans. These include fever, headaches, muscle and joint pain, blisters, stomach cramps, diarrhoea, vomiting, mouth ulcers and allergic reactions. Symptoms can occur within minutes to days after exposure. In severe cases, seizures, liver failure, respiratory arrest and (rarely) death may occur.

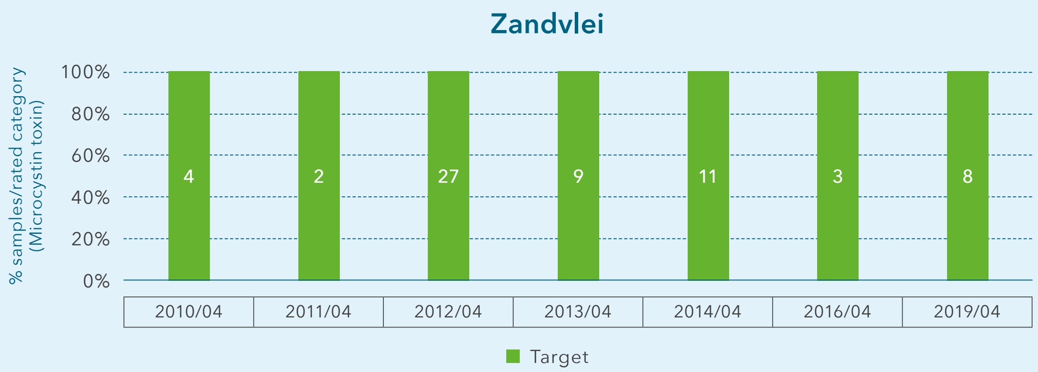
Several types of cyanobacteria have gas-filled cavities that allow them to float to the surface or to different levels below the surface, depending on light conditions and nutrient levels. This can cause the cyanobacteria to concentrate on the water surface, which results in a pea-soup appearance.

Samples from Rietvlei were in the range associated with extreme risk in 2016, 2017 and 2019, with an additional episode of elevated toxins at medium risk in 2019. Since this vlei is a popular recreational waterbody, such episodes would have been of significant health risk to recreational users exposed to the water. The City implemented measures to limit risk, such as temporarily restricting access to the Rietvlei waterbody, but was often met with opposition from certain user groups who disagreed that the water quality posed a potential health risk.

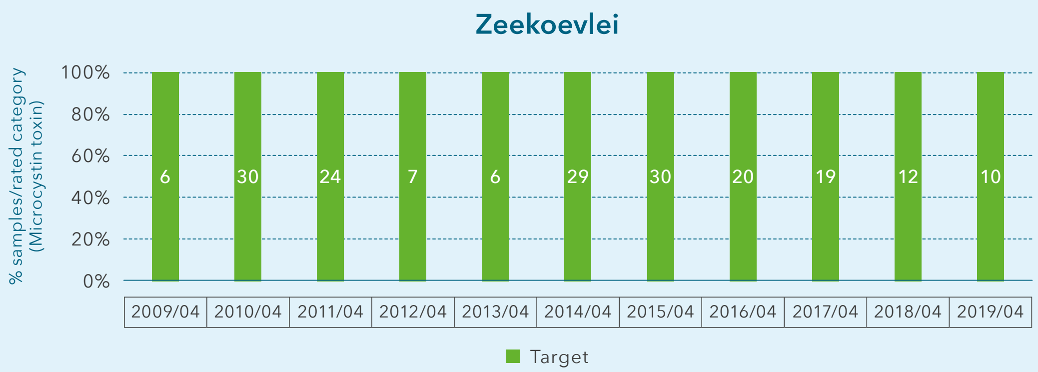
In 2009, 2010 and 2017, Wildevoëlvlei periodically showed microcystin levels that were high enough to be of concern in the event that this system was used recreationally. As this vlei receives treated effluent from the adjacent WWTW, recreational-use contact with the waterbody is not advised, and residents of the shoreline residential estate partake in non-contact activities only, such as walking and birdwatching.

Figure 8: Threshold levels in vleis tested for microcystin toxins
(numbers represent test numbers)

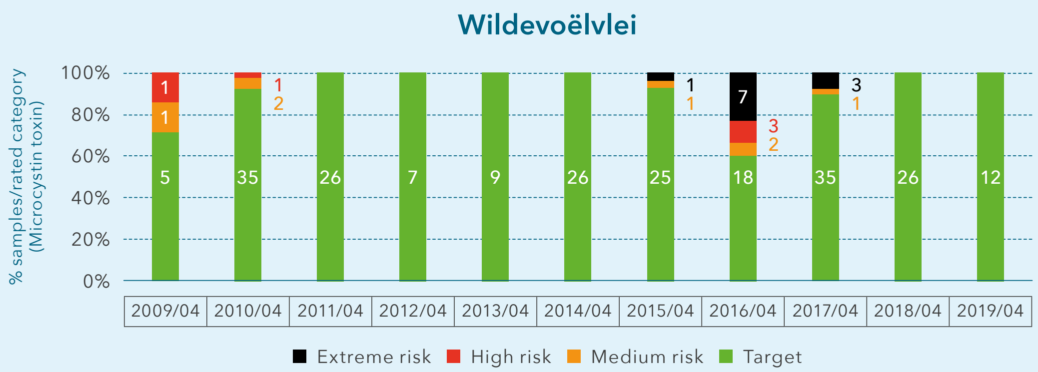




Zandvlei
% samples/rated category (Microcystin toxin)
100%
80%
60%
40%
20%
0%
4
2
27
9
11
3
8
2010/04
2011/04
2012/04
2013/04
2014/04
2016/04
2019/04
Target



Zeekoevlei
% samples/rated category (Microcystin toxin)
100%
80%
60%
40%
20%
0%
6
30
24
7
6
29
30
20
19
12
10
2009/04
2010/04
2011/04
2012/04
2013/04
2014/04
2015/04
2016/04
2017/04
2018/04
2019/04
Target



Wildevoëlvlei
% samples/rated category (Microcystin toxin)
100%
80%
60%
40%
20%
0%
1
1
5
1
2
35
26
7
9
26
1
1
25
7
3
2
18
3
1
35
26
12
2009/04
2010/04
2011/04
2012/04
2013/04
2014/04
2015/04
2016/04
2017/04
2018/04
2019/04
Extreme risk
High risk
Medium risk
Target

6.2.7. Summary

Of the five main recreational vleis/waterbodies, most have generally been in a condition conducive to intermediate-contact recreation over the past five years. However, Milnerton Lagoon has been subject to periodic and, at times, prolonged *E. coli* contamination, which suggests exposure to untreated sewage. Rietvlei is vulnerable to periodic blue-green algal blooms. Some of these blooms have produced microcystin toxins at concentrations likely to pose extreme risks to recreational users who come into contact with this waterbody.

Since most of the assessed urban vleis are hypertrophic with regard to phosphate, a focus on measures to reduce sources of nutrient enrichment in all of the recreational waterbodies is strongly recommended. Addressing upstream sources of untreated sewage at Milnerton Lagoon in particular is also strongly recommended for this waterbody to remain safe for recreational use.

The Rietvlei waterbody lies in the Table Bay Nature Reserve © P Glanville

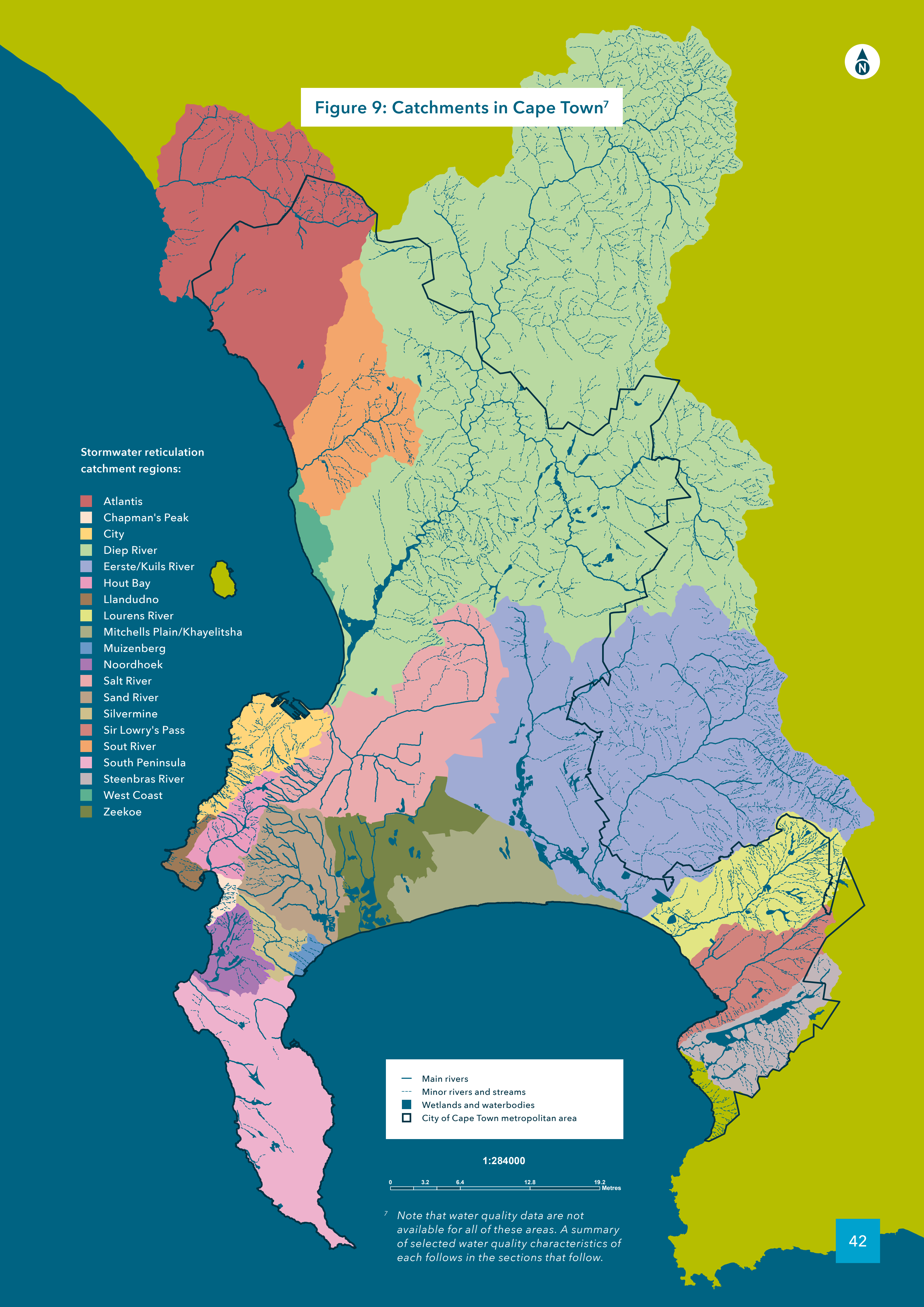


Figure 9: Catchments in Cape Town[7]

[7] *Note that water quality data are not available for all of these areas. A summary of selected water quality characteristics of each follows in the sections that follow.*

7. SUMMARY OF WATER QUALITY IN EACH MAJOR CATCHMENT MONITORED BY THE CITY

The following information is a summary which focuses on nutrient enrichment (phosphorus) and *E. coli* levels in various rivers, vleis, dams and detention ponds in the inland water quality monitoring programme.

For a more detailed discussion of these and other water quality constituents, along with their applicable graphs and maps, kindly consult the full technical report.

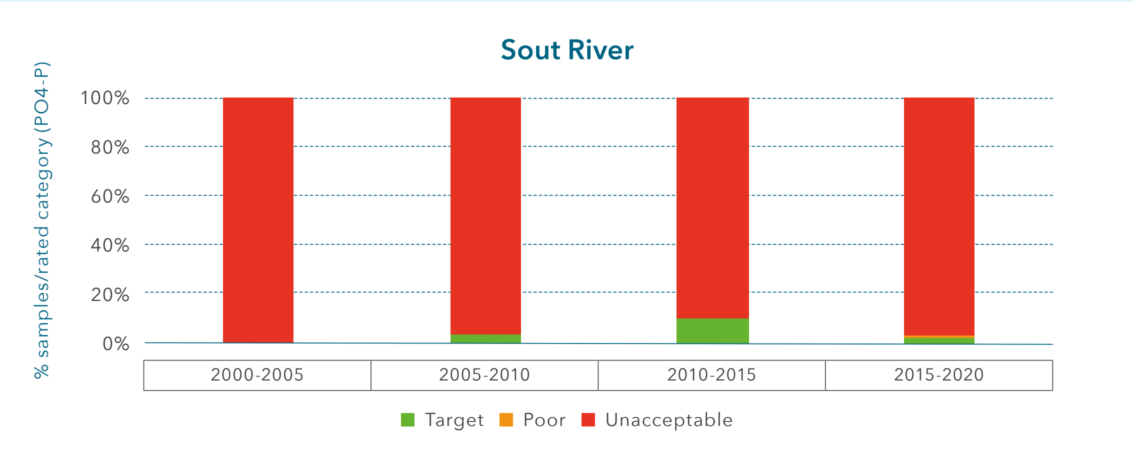
Formal recreational waterbodies are indicated in **bold underlined text**.

Zandvlei, Muizenberg

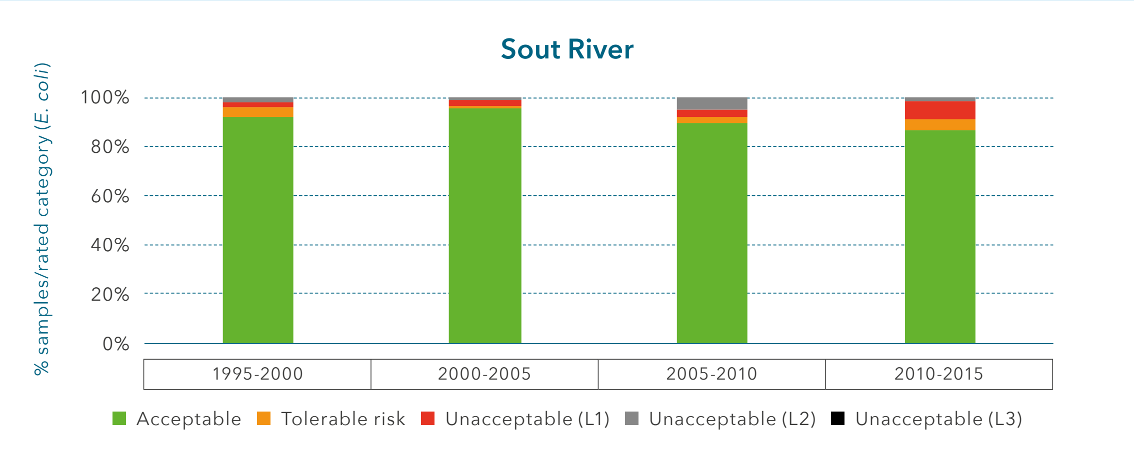
7.1. Sout catchment

Rivers: Sout, Donkergat

Phosphorus enrichment: The Sout catchment has a history of significant phosphate enrichment and is currently among the worst-performing catchments in this regard.



Faecal contamination: *E. coli* levels in the small Sout River system have generally been acceptable for informal recreational activities over the monitoring period 2000–2020.



Possible source(s) of water quality issues experienced:

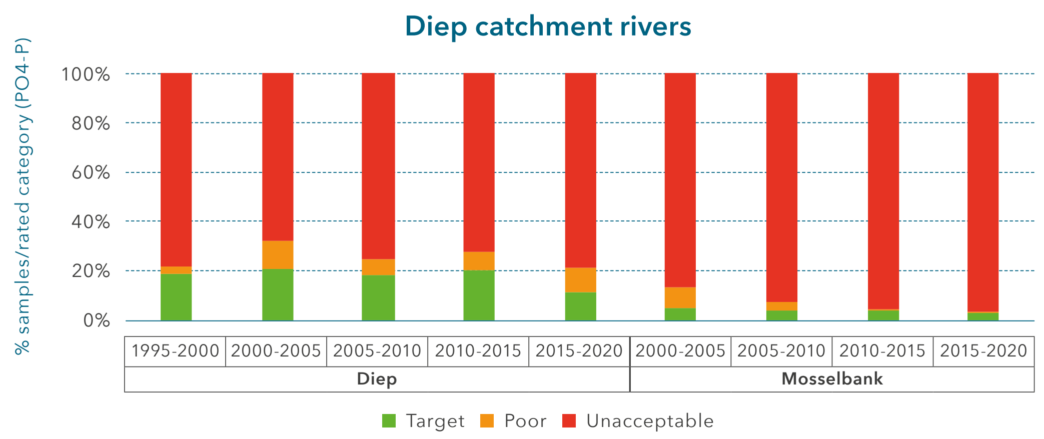
- Irrigation return flows from upstream farm lands
- Melkbosstrand WWTW discharge into lower Sout River (note that some effluent is re-used for irrigation in residential estates)

7.2. Diep catchment

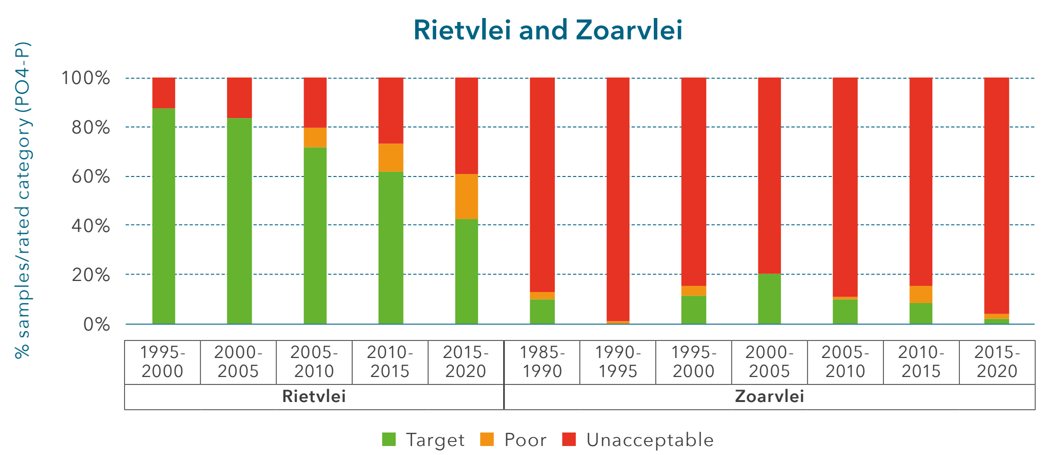
Rivers: Mosselbank, Maastricht Canal, Klapmuts, Kalbaskraal, Groenfontein, Diep and **Milnerton Lagoon**, Sout, Swart, Platklip, Riebeeks

Waterbodies: Zoarvlei, **Rietvlei**

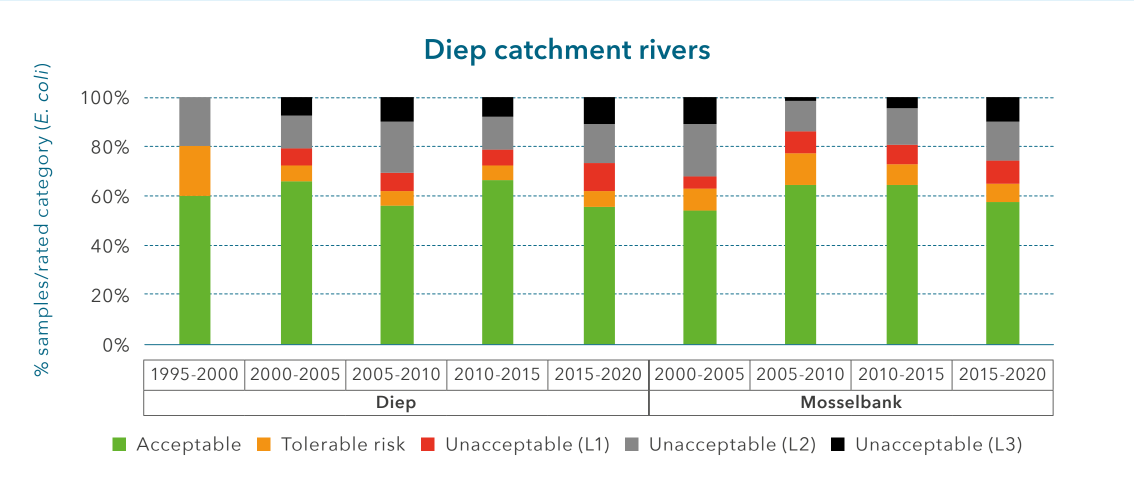
Phosphorus enrichment: The Diep catchment rivers have a history of phosphorus enrichment, which has further deteriorated in the lower reaches of the Diep River (including the Milnerton Lagoon sites) and the Mosselbank River over the past five years. It is currently among the worst-performing catchments in this regard.



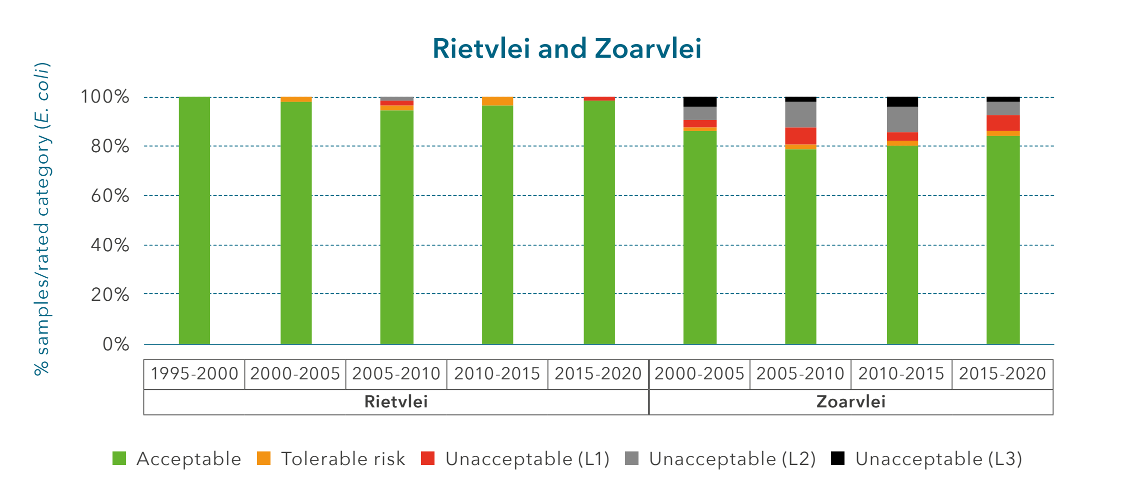
In terms of phosphate levels in Rietvlei and Zoarvlei, these were well in the hypertrophic range (i.e. unacceptable). In Rietvlei, this is likely to drive the development of algal blooms, while nutrient enrichment of Zoarvlei tends to result in prolific growth of reeds and other plants such as water hyacinth.



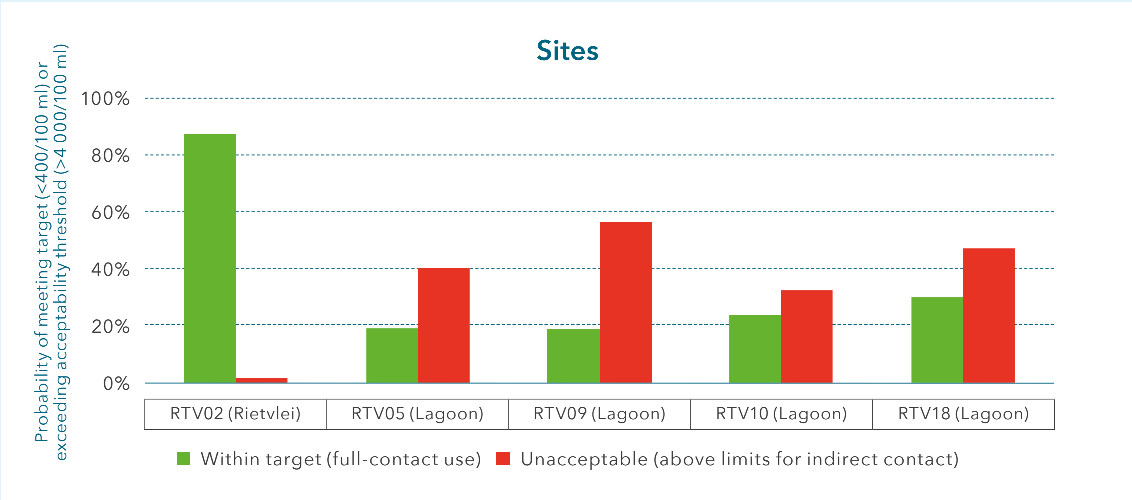
Faecal contamination: *E. coli* levels are often problematic in rivers forming part of both the Diep catchment (including the **Milnerton Lagoon** section of the Diep River, which is used for canoeing and sometimes swimming) and the Mosselbank catchment. This would make them generally unsuitable for both formal and informal recreational activities.



E. coli levels in **Rietvlei**, which is a formal recreational area, were generally acceptable over the monitoring period 1995–2020, and would therefore be suitable for most forms of both full and intermediate-contact recreation. In Zoarvlei, in turn, *E. coli* levels were moderately higher, although it is less likely that informal recreation would be undertaken in this heavily reeded waterbody.



The probability of water quality in **Rietvlei** meeting the acceptability threshold for recreation is significantly higher than at **Milnerton Lagoon**. This indicates that contact-recreational activities in the lagoon should be avoided until the water quality challenges experienced in the catchment have been addressed.



Possible source(s) of water quality issues experienced:

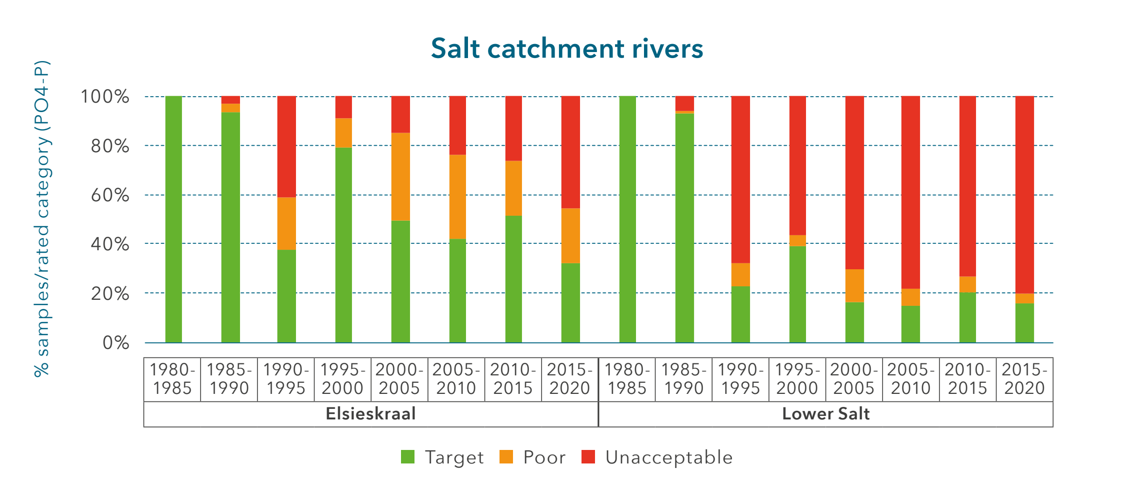
- Agricultural and urban developments in areas of the catchment situated beyond the City's municipal borders (i.e. Swartland)
- Various WWTW discharges into Mosselbank River (note that some treated effluent from WWTWs in the catchment is re-used for farm irrigation)
- Presence of poorly serviced informal settlements in the catchment (e.g. Dunoon and Joe Slovo), as well as backyard dwellings in formal settlements such as Fisantekraal
- Runoff from agricultural areas (livestock feedlots and fertilised fields)
- Potsdam WWTW discharge into Lower Diep River/Milnerton Lagoon system
- Runoff from the industrial area of Paarden Eiland (affecting Zoarvlei)
- Long-term inflows from the nutrient-enriched Bayside Canal and, presumably, runoff from the surrounding catchment area, which is periodically contaminated by sewage overflows

7.3. Salt catchment

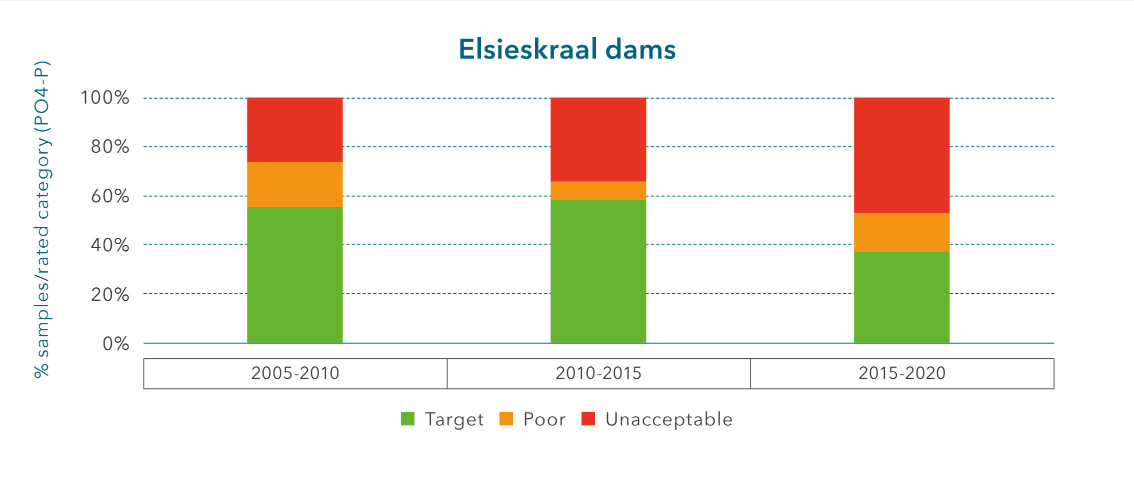
Elsieskraal catchment rivers: Elsieskraal, Van Riebeeckshof
Elsieskraal catchment waterbodies (dams): Fynbos, lower Angelier Park, Welgemoed, Kanonberg, Plattekloof, Doordekraal

Lower Salt catchment rivers: Salt River canal, Black, Liesbeek, streams of eastern slopes of Table Mountain, Vygekraal, and the canals of Kromboom, Blomvlei, Jakkalsvlei, Bokmakierie, Langa, Kalksteenfontein and Nyanga

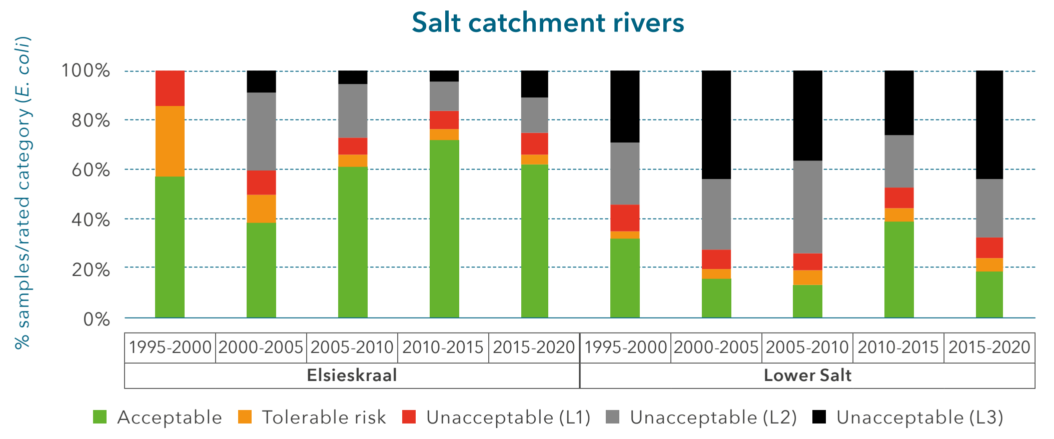
Phosphorus enrichment: The Salt catchment has a history of significant phosphate enrichment and is currently among the worst-performing catchments in this regard.

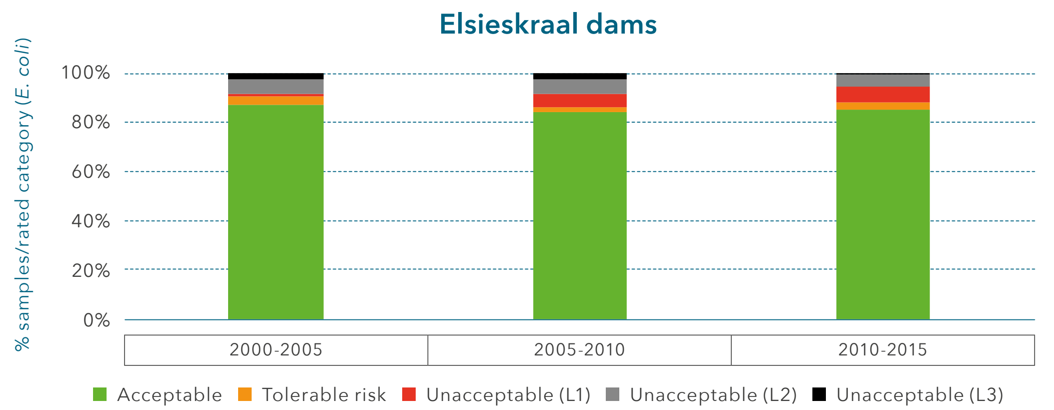


The Elsieskraal dams are among the least concerning Cape Town monitored waterbodies in terms of orthophosphate enrichment, although they are still in the hypertrophic range.



Faecal contamination: Faecal contamination is a pervasive problem in particularly the Lower Salt catchment. The majority of *E. coli* values recorded in the past five years have been well within the unacceptable range for intermediate-contact recreation. This indicates that the rivers and canals in this region of the catchment are not suitable for informal recreation. *E. coli* levels in the dams located in the upper Elsieskraal catchment tend to be less problematic. Note, however, that no known forms of formal water sport activities are taking place in these systems.





Possible source(s) of water quality issues experienced:

- Elsieskraal: Increasingly urbanised catchment. The river reaches through Bellville are affected by areas of inner-city homelessness. In general, however, Elsieskraal is neither subject to inflows of treated sewage effluent nor characterised by substantial areas of informal or poorly serviced settlements.
- Lower Salt: Borcherd's Quarry and Athlone WWTW discharges
- Presence of poorly serviced informal settlements and backyard dwellers in the Salt catchment (e.g. Joe Slovo, Valhalla Park, Kanana, Vygieskraal informal settlements)
- General habitat transformation and associated water quality challenges, which are possibly due to the transformation of natural vegetation, agricultural runoff and the canalisation of rivers (such as the lower reaches of Elsieskraal River and parts of Lower Salt catchment)
- High-density residential, commercial and industrial precincts

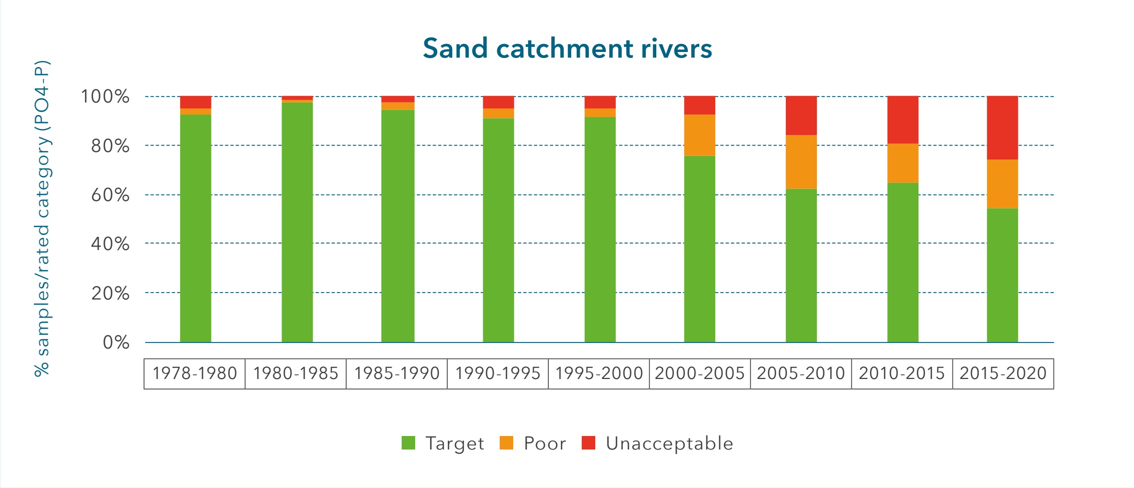
Black River in the lower Salt catchment which can be seen from the N2/M5 interchange

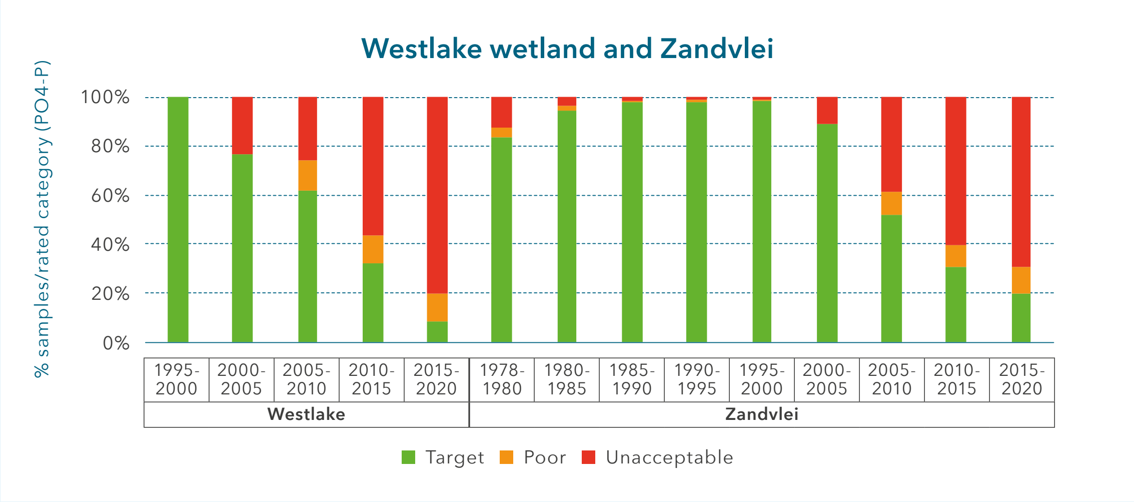
7.4. Sand catchment

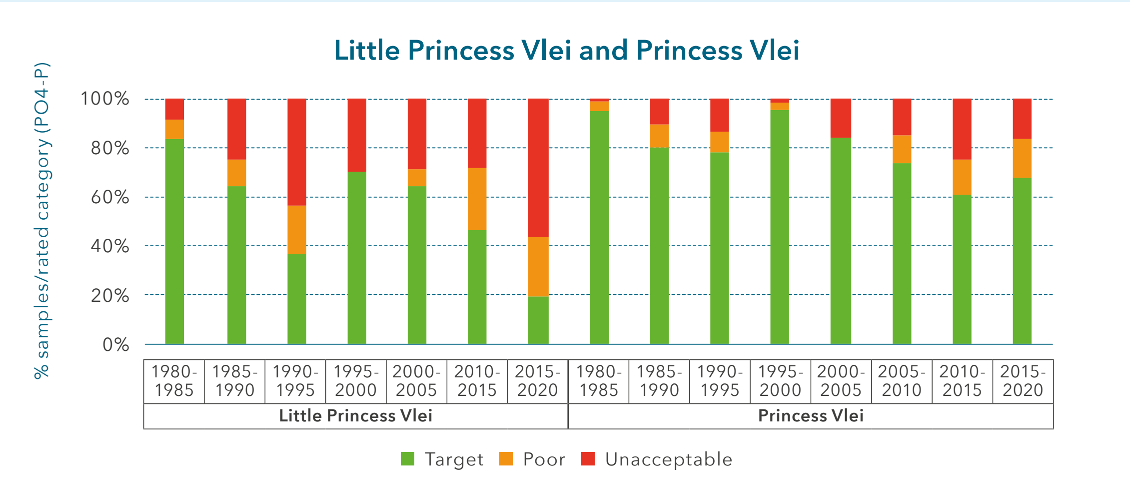
Rivers: Sand, Keysers, Westlake, Prinskasteel, Prinseskasteel stream, Spaanschemat, Grootboschkloof, Pagasvlei stream, Mocke, Diep, Brommersvlei stream, Burgersboskloof stream, Wynberg stream, Southfield canal, Zandvlei outlet channel

Waterbodies: Langevlei, **Princess Vlei**, Little Princess Vlei, Die Oog, **Zandvlei**, Westlake wetland, Psoralea Park wetland

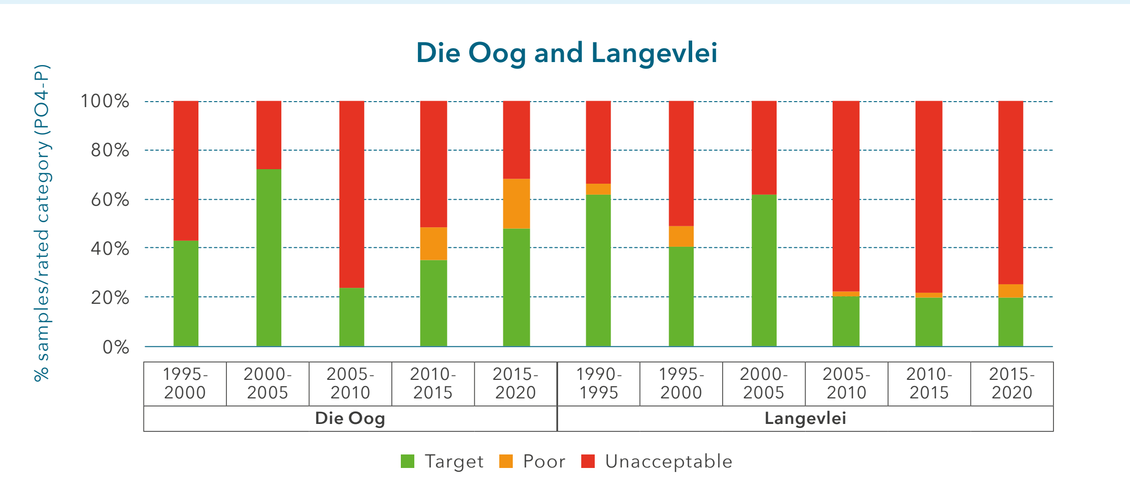
Phosphorus enrichment: Over time, a gradually increasing proportion of samples from rivers in the Sand catchment have been in poor and unacceptable ranges for phosphate concentration. A number of vleis in the catchment are similarly affected by gradually increasing phosphorus enrichment, which tends to encourage aquatic plant and algal growth.





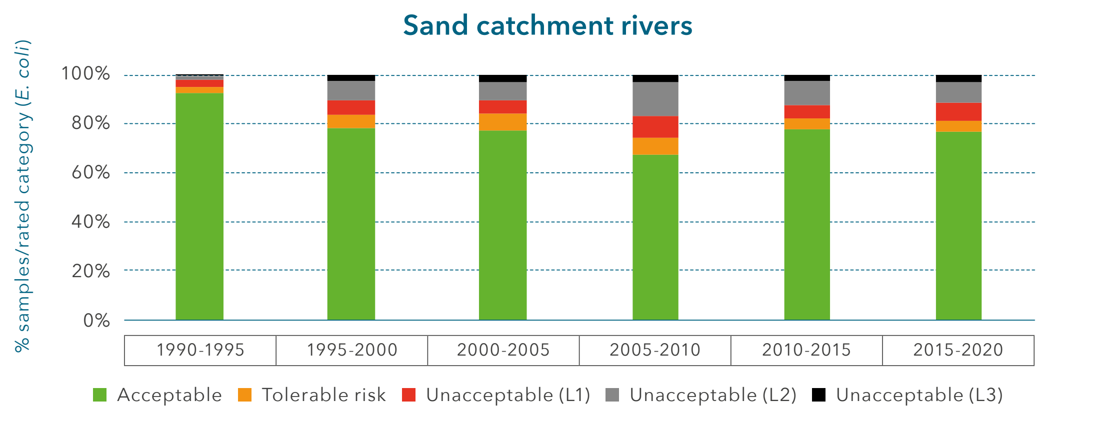


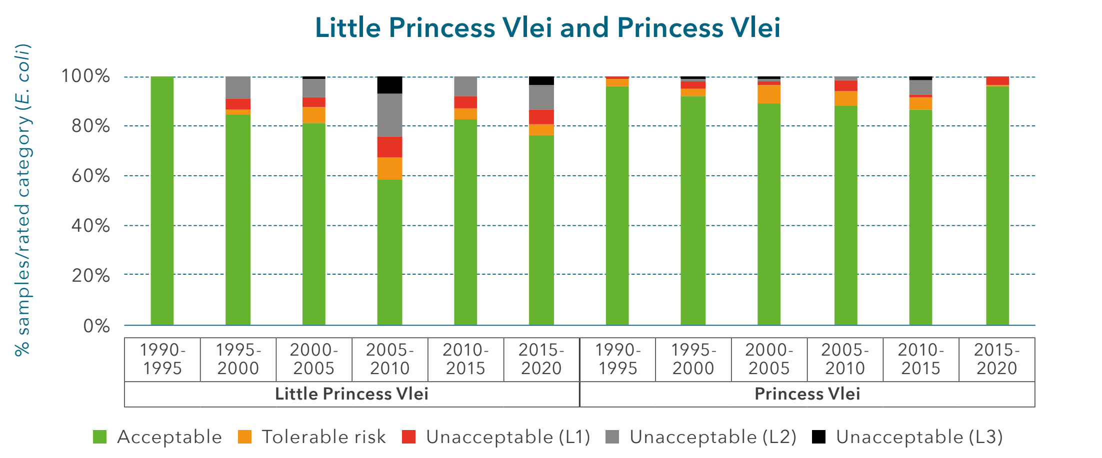
Little Princess Vlei and Princess Vlei
% samples/rated category (PO4-P)
100%
80%
60%
40%
20%
0%
1980-1985
1985-1990
1990-1995
1995-2000
2000-2005
2010-2015
2015-2020
1980-1985
1985-1990
1990-1995
1995-2000
2000-2005
2005-2010
2010-2015
2015-2020
Little Princess Vlei
Princess Vlei
Target
Poor
Unacceptable

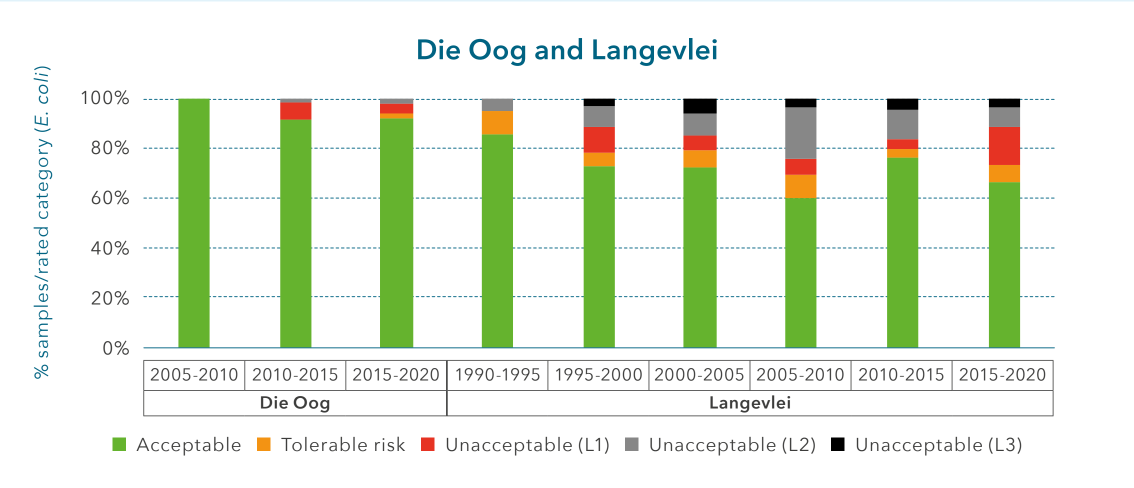


Die Oog and Langevlei
% samples/rated category (PO4-P)
100%
80%
60%
40%
20%
0%
1995-2000
2000-2005
2005-2010
2010-2015
2015-2020
1990-1995
1995-2000
2000-2005
2005-2010
2010-2015
2015-2020
Die Oog
Langevlei
Target
Poor
Unacceptable

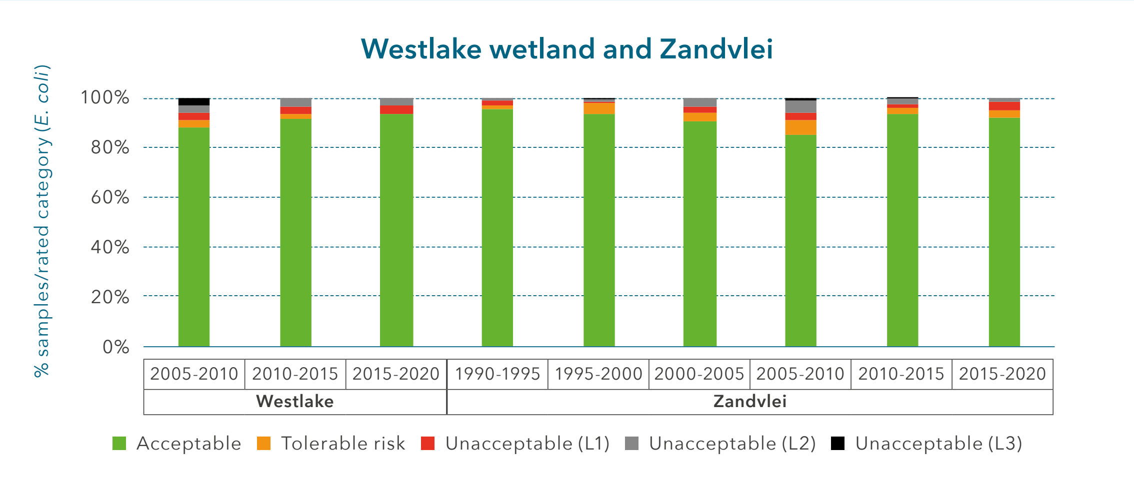
Faecal contamination: *E. coli* measurements recorded at river sites in the Sand catchment have deteriorated moderately over the monitoring period, indicating that conditions are not entirely suitable for informal recreational activities.



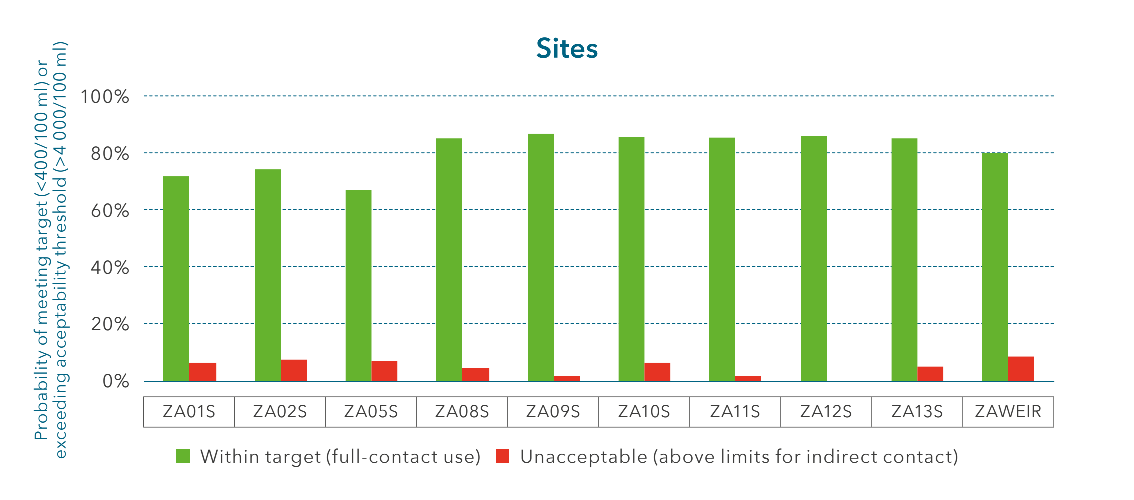




E. coli levels in **Zandvlei**, which is a formal recreational area, were generally acceptable over the indicated monitoring period. The area is therefore suitable for most forms of full and intermediate-contact recreation.



This is confirmed in the graph below, which points to a high probability of water quality at **Zandvlei** meeting the acceptability threshold for recreation.



Possible source(s) of water quality issues experienced:

- Agriculture in upper catchment (wine farms)
- Moderately to highly urbanised catchment, with high levels of street waste and dumping in certain parts, but neither subject to inflows of treated sewage effluent nor characterised by substantial areas of informal settlements

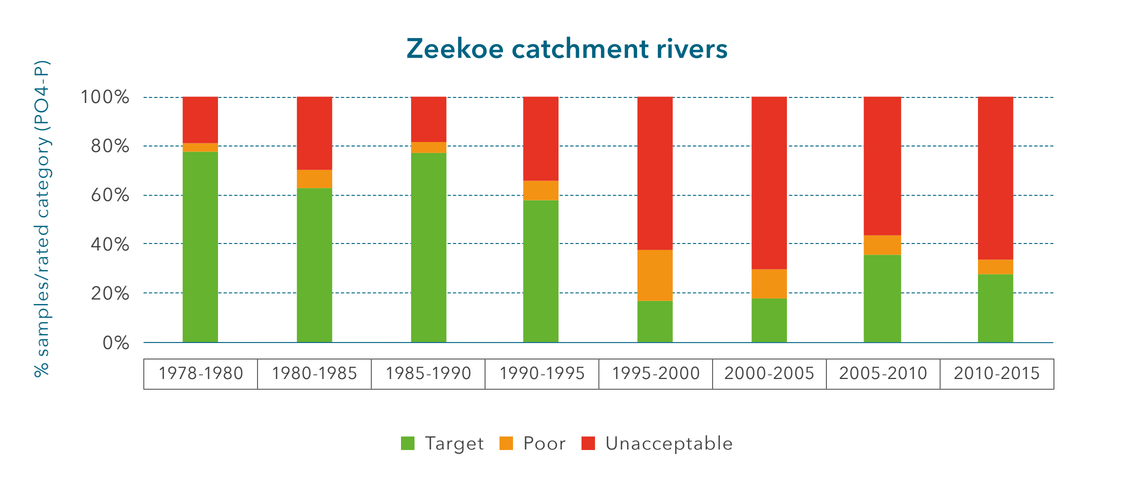
Zandvlei © S Dorse

7.5. Zeekoe catchment

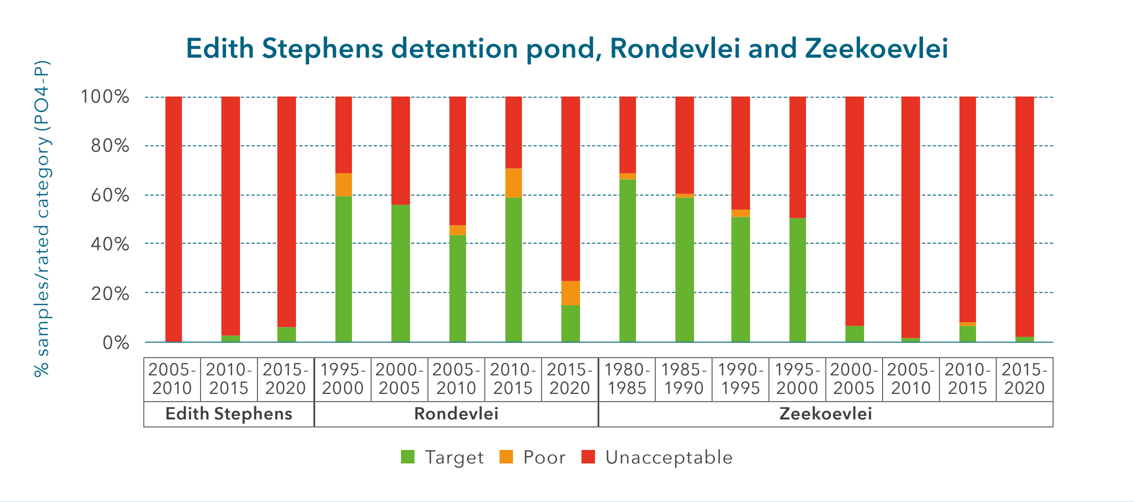
Rivers: Big Lotus River canal, Little Lotus River canal, Zeekoe outlet channel

Waterbodies: Edith Stephens detention pond, **Zeekoevlei**, Rondevlei, Moddervlei, Costa da Gama wetland

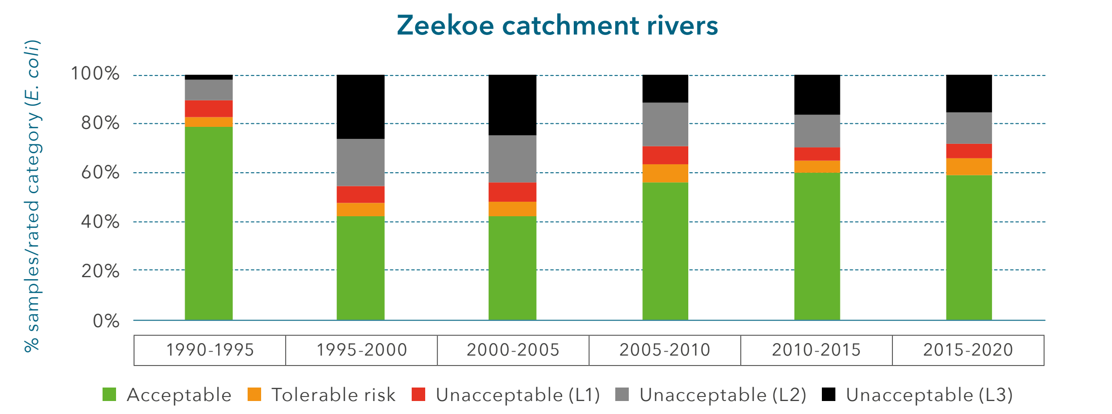
Phosphorus enrichment: While some improvement has been noted over the past decade, there has been a marked increase in the proportion of Zeekoe catchment river sites (i.e. the Big and Little Lotus rivers) in the poor and unacceptable category for phosphate over the monitoring period. This is currently among the worst-performing catchments with regard to phosphorus enrichment.



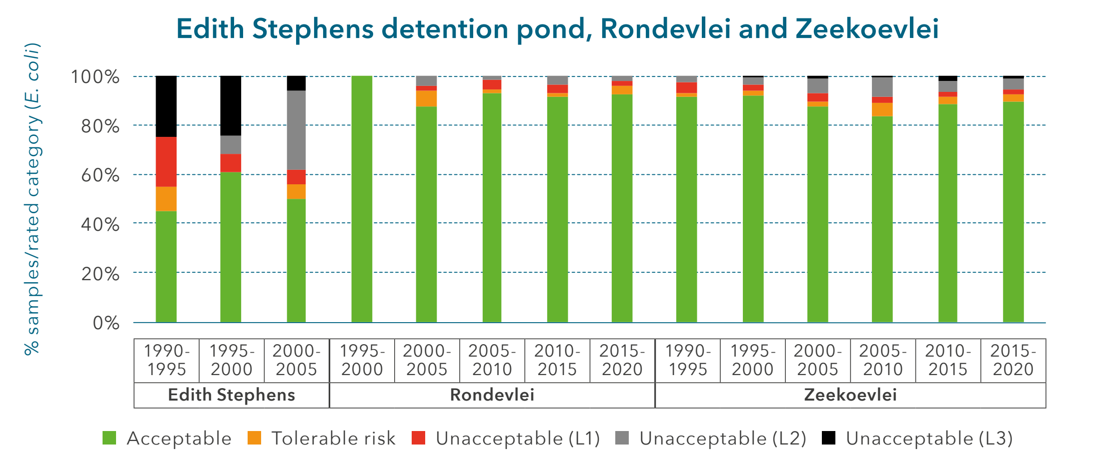
Phosphate levels in Zeekoevlei and Edith Stephens detention pond are well within the hypertrophic range (i.e. unacceptable). The smaller waterbody of Rondevlei, which has a relatively smaller catchment area, shows lower levels of phosphate enrichment.

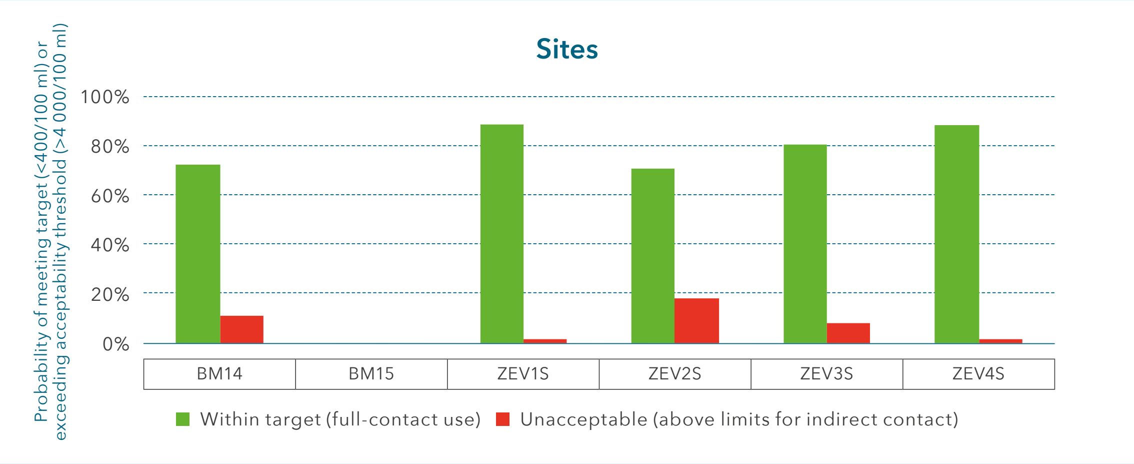


Faecal contamination: Most *E. coli* measurements recorded at the Big and Little Lotus canal sites in the Zeekoe catchment in the past five years fell in the poor and unacceptable categories for intermediate-contact recreation. Although these rivers are not used for formal recreational activities, water quality does affect particularly the northern section of Zeekoevlei itself, where the rivers enter this waterbody.



Most *E. coli* measurements from Edith Stephens for the period 2015–2018 were within the poor and unacceptable ranges for intermediate-contact recreation. At **Zeekoevlei**, the pattern seems to be strongly seasonal, with *E. coli* counts being worse in winter than in summer. The probability of meeting the target for full-contact recreation is calculated to approach 100% in summer, decreasing to 50–80% at most sampling points in winter. In winter, the estimated probability of exceeding the unacceptable threshold for intermediate-contact recreation approaches 35% in the northern section of the vlei, which is located near the more polluted inflowing rivers, and 15% near the southern shoreline. (At other sampling points, the calculated probabilities of exceeding the threshold remain below 5%.)





Possible source(s) of water quality issues experienced:

- Presence of relatively large areas of poorly serviced informal and backyard settlements in the Gugulethu, Philippi and Grassy Park areas
- Runoff from highly urbanised areas with high levels of street waste and dumping
- Edith Stephens: Polluted runoff from the surrounding catchment which enters the pond via the Big Lotus canal during high flows
- Agricultural runoff from the Philippi Horticultural Area
- Cape Flats WWTW discharge into Zeekoe outlet canal
- Zeekoevlei: Polluted inflowing rivers in the northern portion of the vlei. Improvements in Zeekoevlei water quality over the past decade presumably reflect management interventions such as the construction of a cut-off drain to divert subsurface flows from the nearby WWTW into the downstream Zeekoe channel, annual drawdowns and efforts to address contamination in the broader catchment.

Rondevlei is part of the False Bay Nature Reserve, a declared Ramsar site

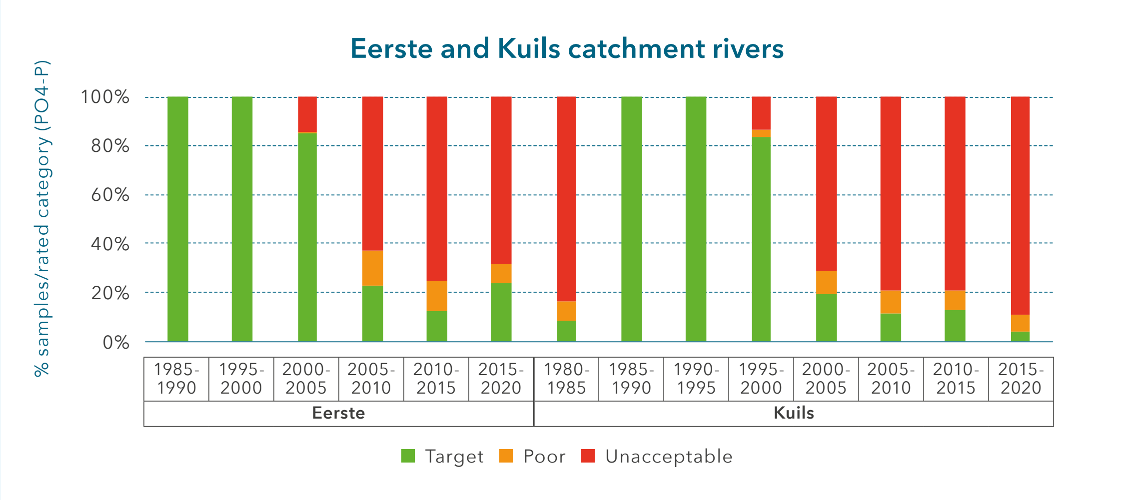
7.6. Eerste/Kuils catchment

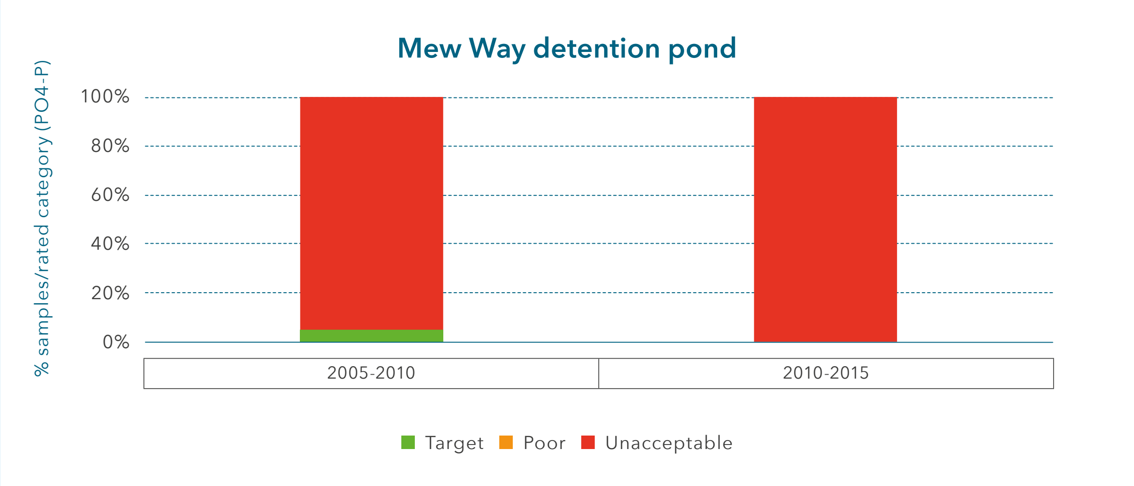
Kuils catchment rivers: Kuils, Bottelary

Eerste catchment rivers: Eerste, Lower Kuils (sites EK08 and EK11), Kleinvlei canal, Moddergatspruit

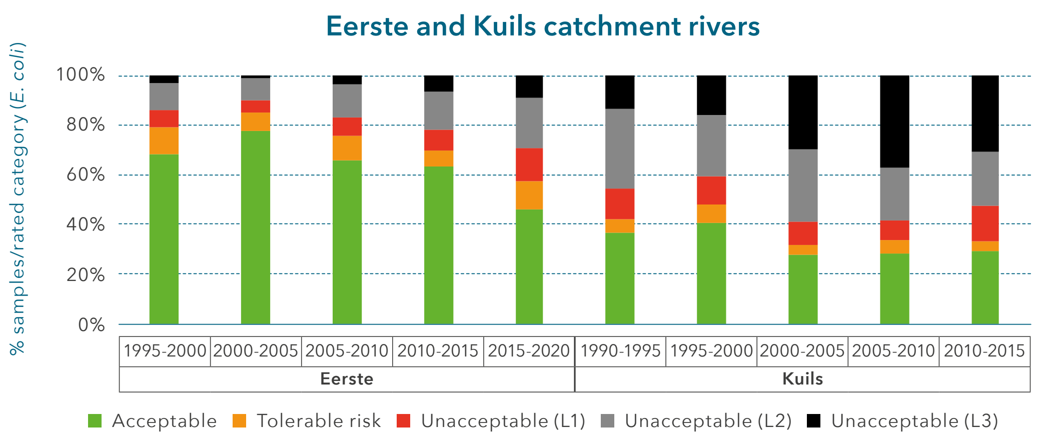
Waterbodies: Khayelitsha wetland, Mew Way detention pond

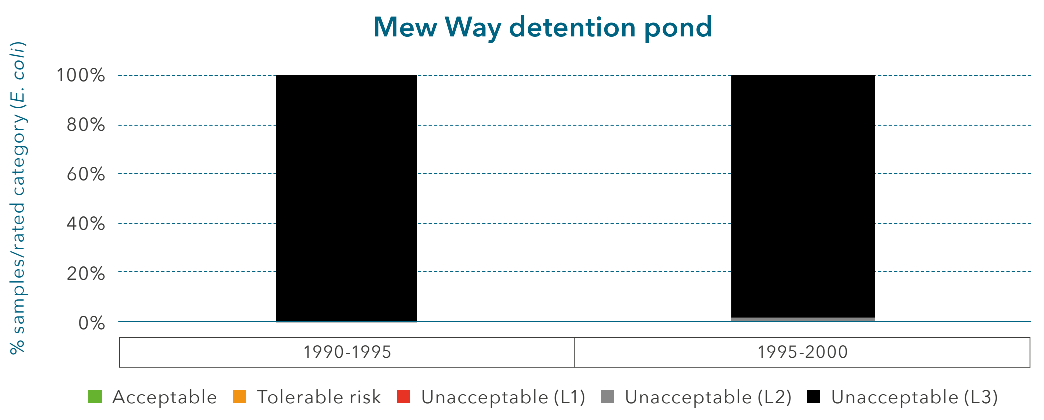
Phosphorus enrichment: The proportion of river sites in both the Eerste and Kuils catchments, as well as the Mew Way detention pond, where water rates poor or unacceptable in terms of phosphorus enrichment have significantly increased over time. This makes it one of the worst-performing catchments in this regard at present.





Faecal contamination: *E. coli* contamination has been a significant and increasing concern in the rivers of this catchment over the full monitoring period. A relatively high proportion of river and stormwater channel samples have consistently been within the unacceptable range. Faecal contamination levels in the Mew Way detention pond are extremely high.





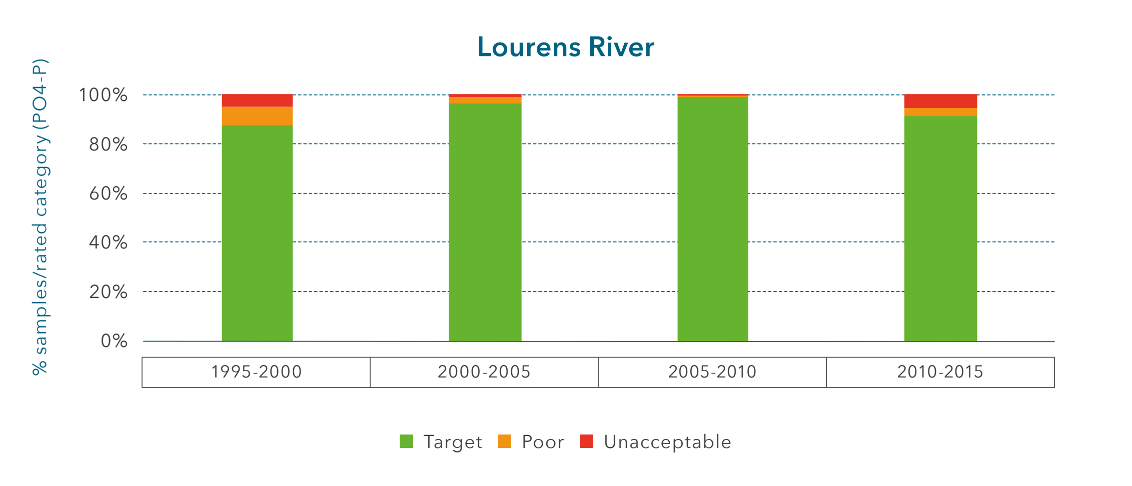
Possible source(s) of water quality issues experienced:

- Agricultural and urban developments in areas of the catchment situated beyond the City's municipal borders (i.e. greater Stellenbosch)
- Scottsdene, Bellville, Zandvliet and Macassar WWTWs discharge into Bottelary River, Upper and Lower Kuils River and Eerste River respectively
- Presence of large areas of poorly serviced informal settlements in the Kuils and Eerste catchments

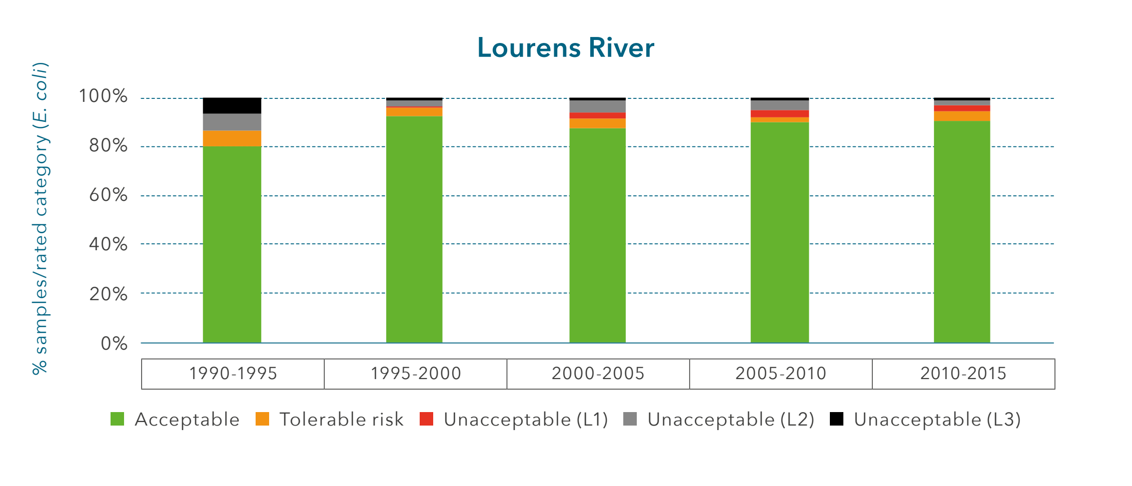
7.7. Lourens catchment

Rivers: Lourens, Melksloot

Phosphorus enrichment: Over time, the proportion of samples from the lower end of the Lourens catchment have been in poor and unacceptable ranges for phosphate, even though the upper reaches of Lourens River are among the least-impacted sections of river monitored by the City.



Faecal contamination: *E. coli* levels in the Lourens River tend to be reasonably low.



Possible source(s) of water quality issues experienced:

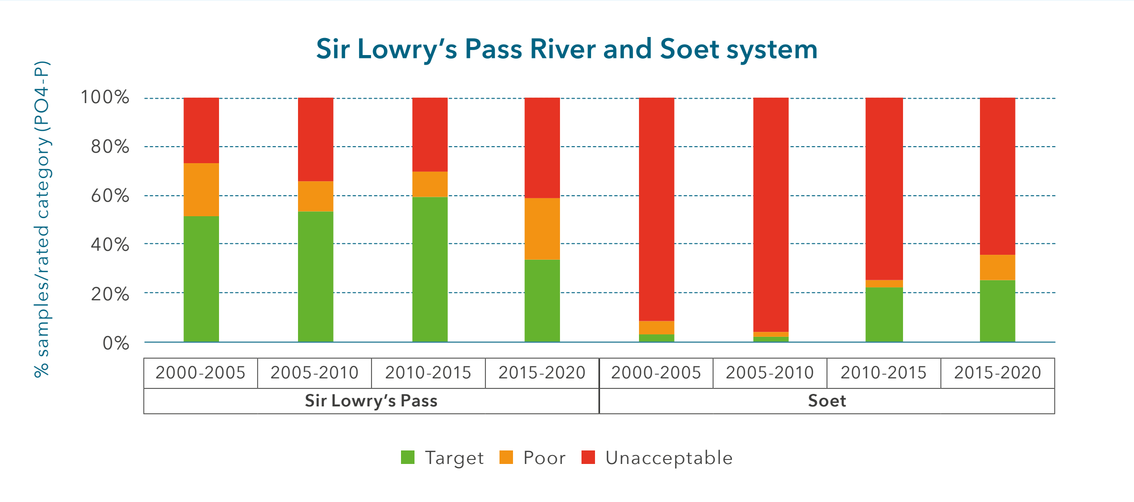
- Runoff from agricultural and urban residential areas
- Densely populated and hardened lower reaches of the catchment

7.8. Sir Lowry's Pass catchment

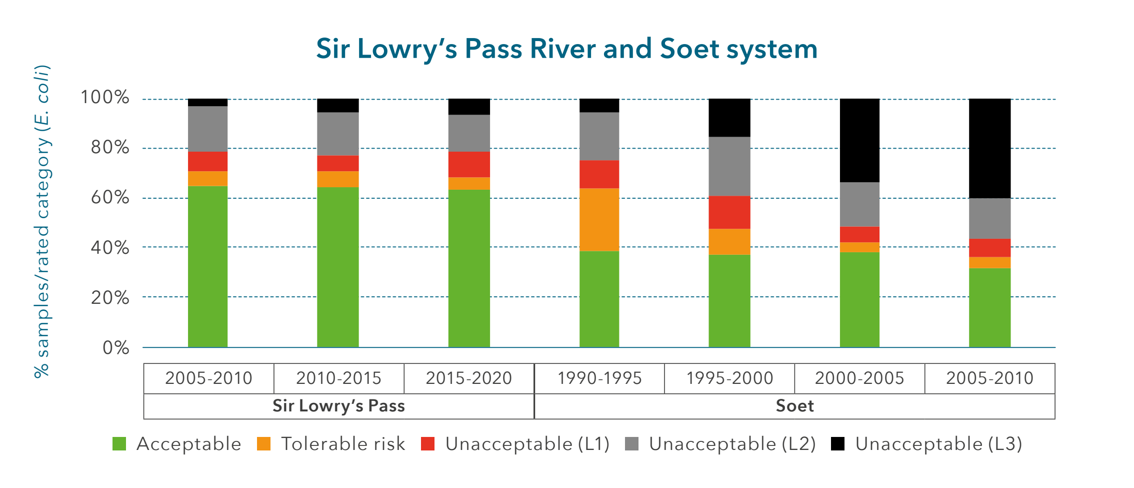
Sir Lowry's Pass catchment rivers: Sir Lowry's Pass

Soet subcatchment rivers: Soet (predominantly a constructed stormwater network)

Phosphorus enrichment: The Sir Lowry's Pass River shows elevated phosphorus levels, and the proportion of results at target level are declining. Although generally at an unacceptable level, phosphorus enrichment in the Soet catchment has improved marginally over the past 10 years.



Faecal contamination: *E. coli* levels in the Sir Lowry's Pass River are moderately high, with signs that the proportion of acceptable results are declining. *E. coli* levels in the Soet catchment largely fall within the unacceptable range.



Possible source(s) of water quality issues experienced:

- Presence of poorly serviced informal settlements in both the Sir Lowry's Pass and Soet catchments
- Gordon's Bay WWTW discharge to lower portion of Sir Lowry's Pass River, which is canalised
- The Soet is a small system that does not have a natural river channel. It is almost entirely comprised of a constructed network of stormwater channels, which are subject to ongoing inflows of polluted greywater and sewage water discharged from informal and poorly serviced settlements in its catchment, as well as flows from the upstream Heritage Park area and its catchment.

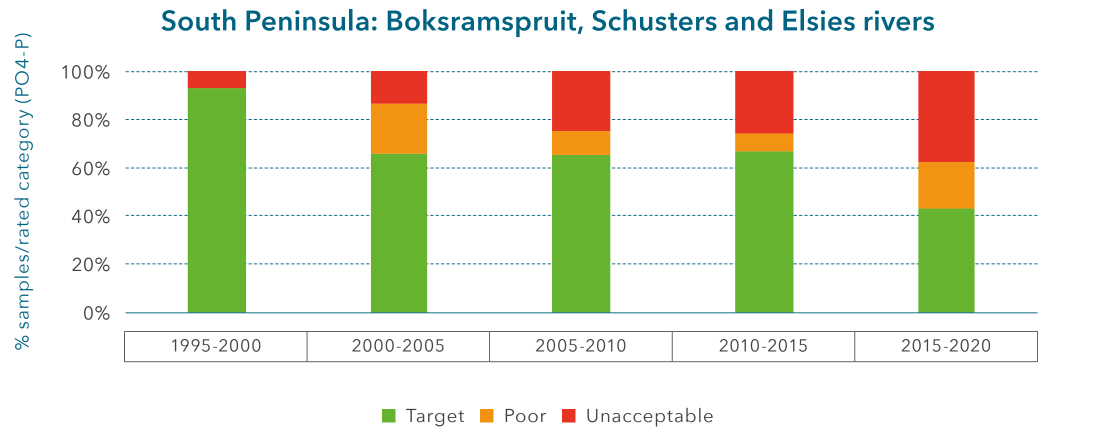
7.9. South Peninsula catchment cluster

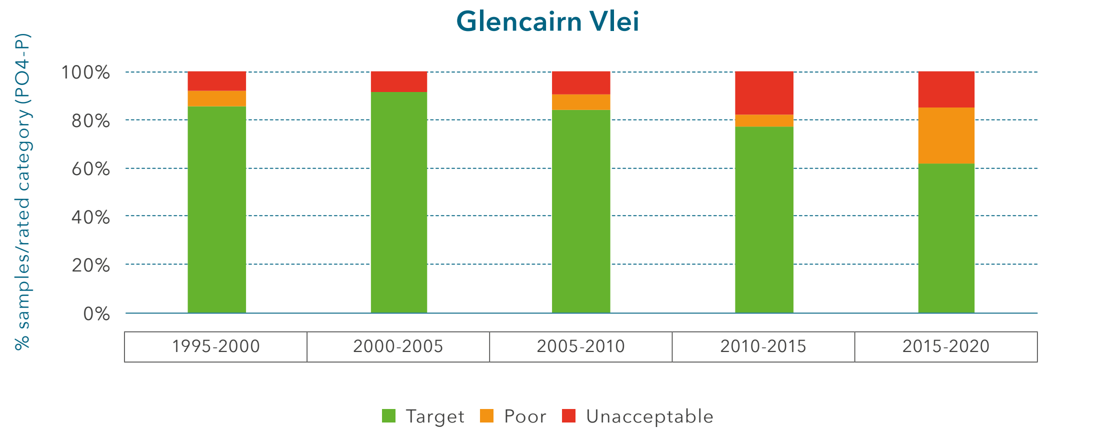
Rivers: Bokramspruit, Schusters, Elsies

Waterbodies: Glencairn Vlei, Schusters wetland

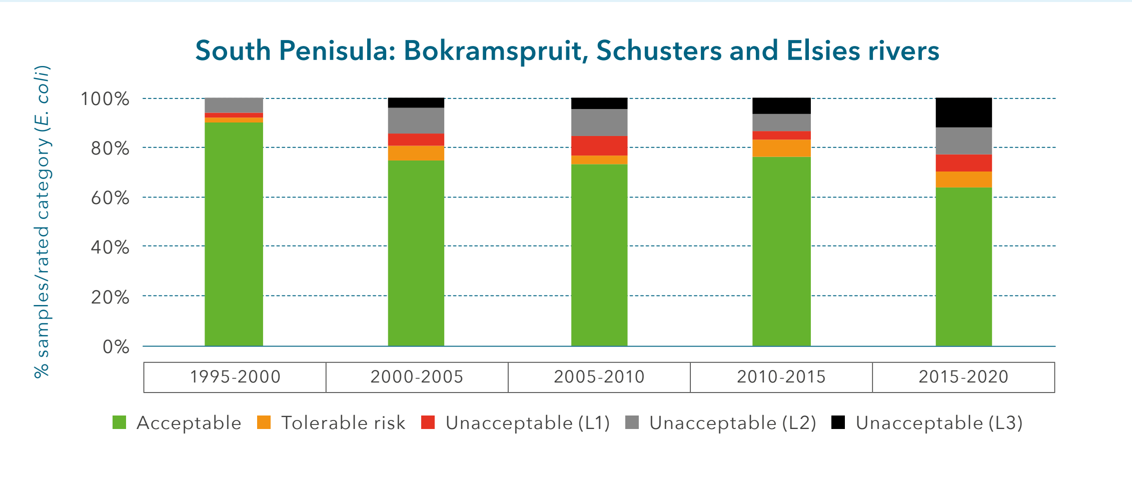
Phosphorus enrichment: Phosphate enrichment levels in the rivers of this catchment cluster (in particular the Bokramspruit River) have increased gradually over the monitoring period.

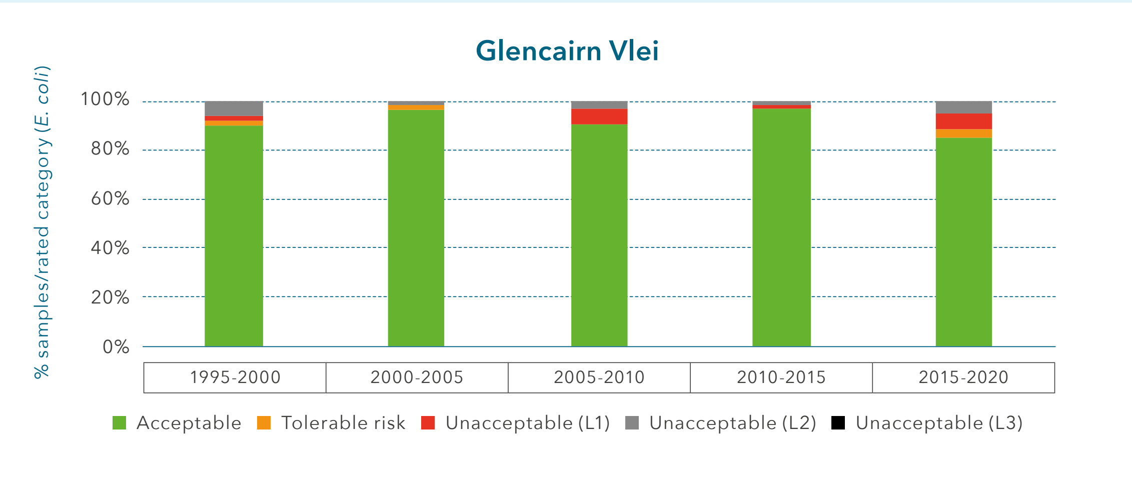
Glencairn Vlei is among the waterbodies in Cape Town where orthophosphate enrichment has been least problematic in recent years, albeit still in the hypertrophic range.





Faecal contamination: Faecal contamination levels in the rivers of this catchment cluster have gradually increased over the years. Those in the Bokramspruit have frequently been at an unacceptable level. Mean annual *E. coli* concentrations for the Schusters and Elsies rivers in 2019 were target and poor respectively, and unacceptable in the Bokrampsruit.





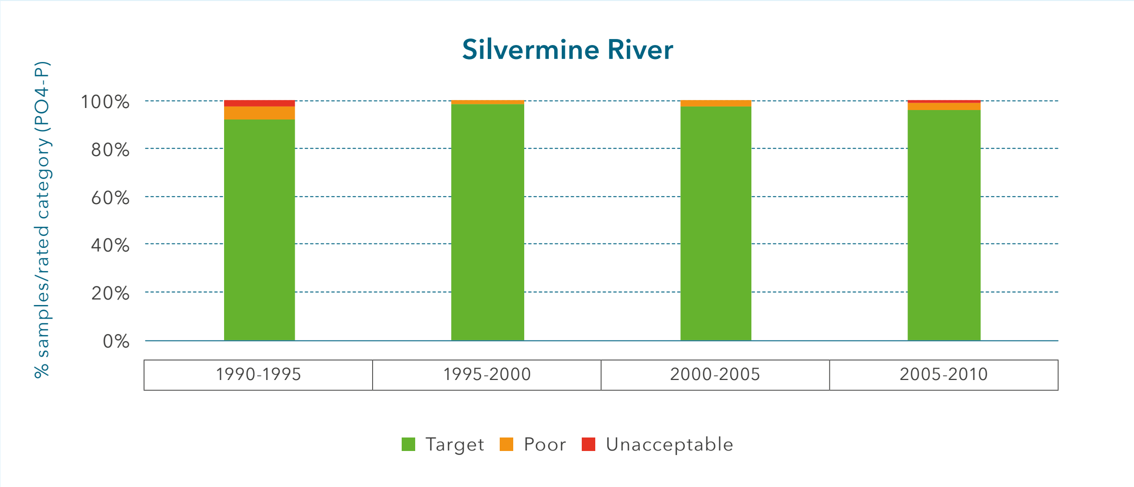
Possible source(s) of water quality issues experienced:

- Increasingly urbanised catchments, although neither subject to inflows of treated sewage effluent nor characterised by substantial areas of informal or poorly serviced settlements (except for parts of Ocean View)
- Bokramspruit sites located downstream of Ocean View, which is characterised by backyard dwellers and poor servicing

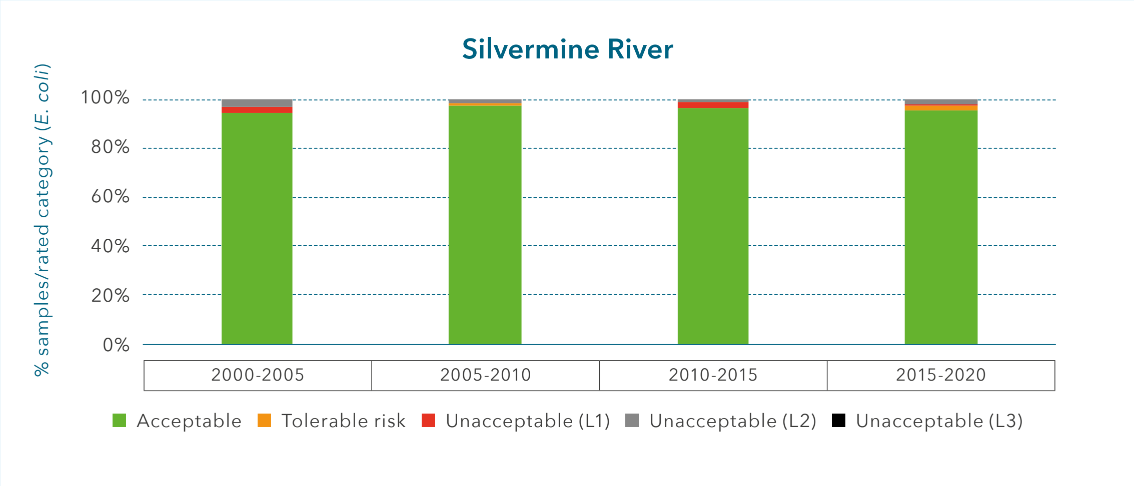
7.10. Silvermine catchment

Rivers: Silvermine

Phosphorus enrichment: Overall, the Silvermine River has relatively low levels of phosphorus enrichment, although an increasing proportion of samples from the lower catchment have occasionally yielded poor and unacceptable results. This is despite the fact that the upper and middle reaches of the Silvermine River are among the least impacted sections of river monitored by the City.



Faecal contamination: *E. coli* levels in the Silvermine River are low and generally fall within the acceptable range for informal recreation.



Possible source(s) of water quality issues experienced:

- Moderate levels of runoff from urban residential areas and Westlake golf course in the lower reaches of the Silvermine River

7.11. Noordhoek catchment

Rivers: Brookwood stream, De Goede Hoop stream
Waterbodies: Noordhoek reedbeds, Wildevoëlvlei

Phosphorus enrichment: Wildevoëlvlei has by far the highest levels of phosphate enrichment of all open waterbodies in Cape Town, making this system highly prone to algal blooms.

Faecal contamination: Although Wildevoëlvlei receives treated effluent from a WWTW and is therefore nutrient enriched, *E. coli* levels in the vlei are relatively low. However, the waterbody should not be used for recreational activities due to the presence of the WWTW.

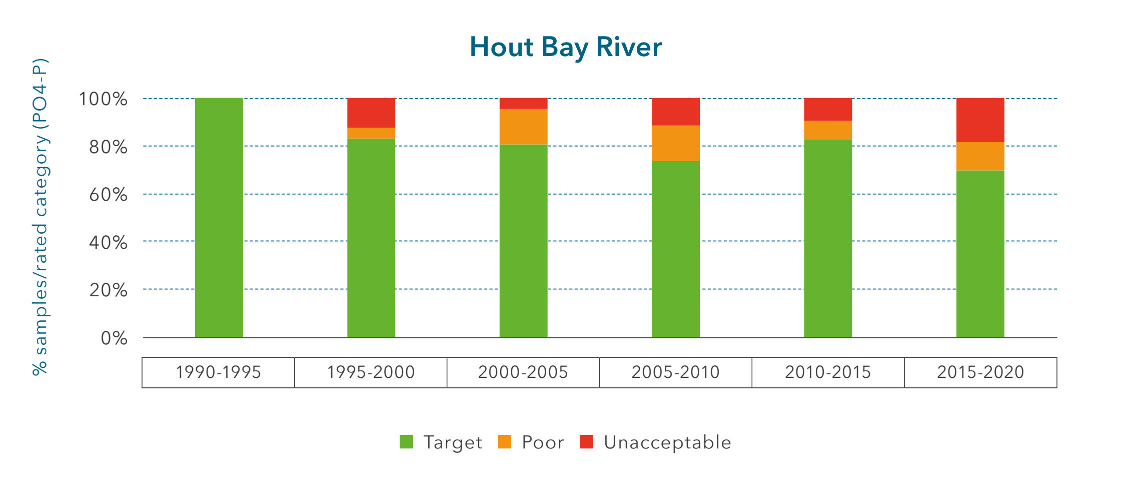
Possible source(s) of water quality issues experienced:

- Inflows into Wildevoëlvlei from both the Wildevoëlvlei WWTW and, sporadically, an extensive area of poorly serviced informal settlements located to the east of the site

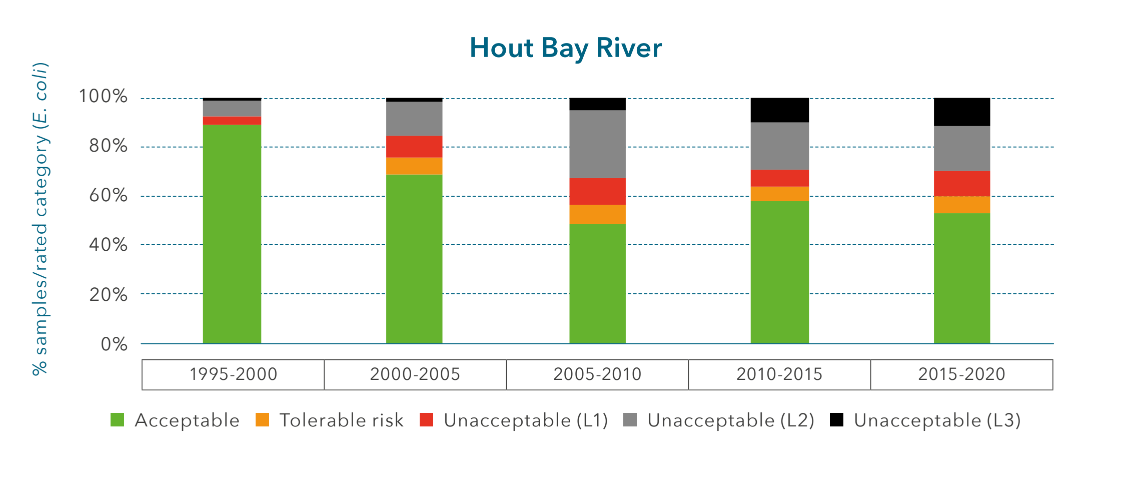
7.12. Hout Bay catchment

Rivers: Hout Bay, Baviaanskloof stream, Bokkemanskloof stream

Phosphorus enrichment: An increasing proportion of samples from river sites have rated poor and unacceptable for phosphate concentration over time, even though the upper reaches of the Hout Bay River are among the least-impacted sections of river monitored by the City.



Faecal contamination: *E. coli* levels in the Hout Bay River have increased over time, particularly in the reach downstream of the Imizamo Yethu informal settlement. In this region, water quality fell within the unacceptable range for intermediate-contact recreation in 2019 based on mean *E. coli* concentrations. By contrast, upstream sites in this catchment fell within the target range.



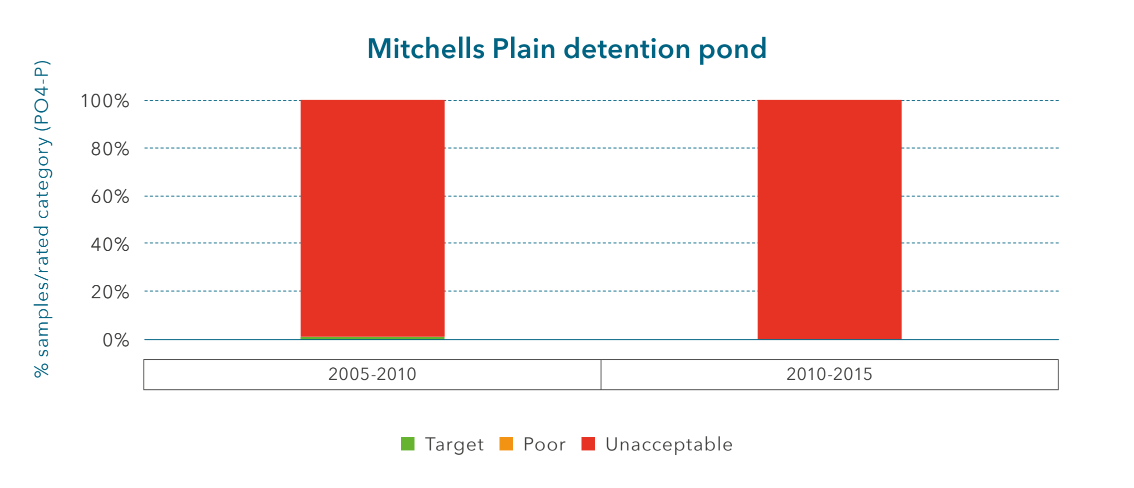
Possible source(s) of water quality issues experienced:

- Upper reaches of river relatively pristine
- Water storage dams in mountain catchment area
- Presence of Imizamo Yethu informal settlement in the middle to lower reaches of the catchment
- Contaminated runoff from settlements enter the river

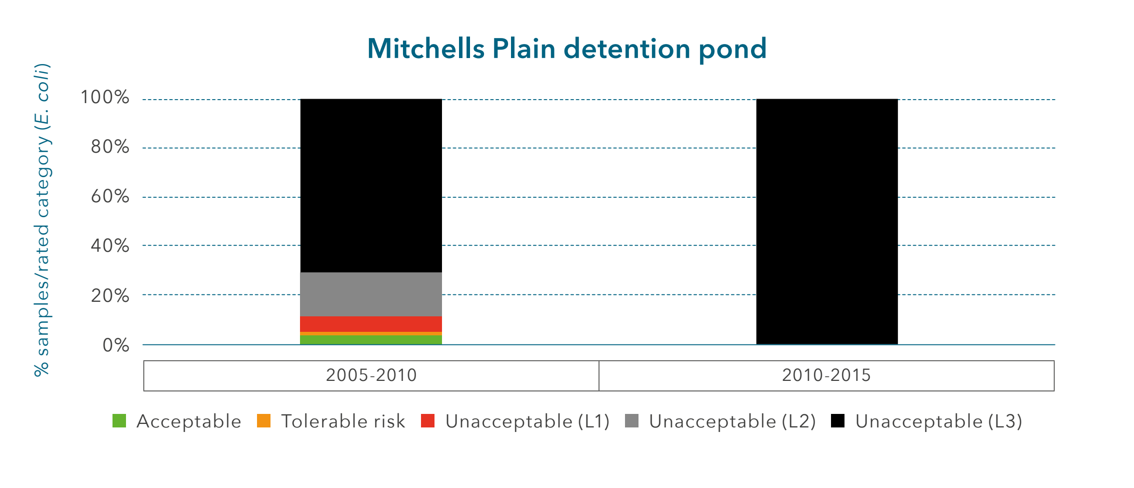
7.13. Mitchells Plain catchment

Waterbodies: Mitchells Plain detention pond (artificial)

Phosphorus enrichment: Extreme nutrient enrichment is evident in Mitchells Plain detention pond. Consistently unacceptable levels of phosphorus have been recorded both historically and in recent years.



Faecal contamination: Some 95–100% of samples from the Mitchells Plain detention pond have been in the unacceptable category for *E. coli* across all sampling years.



Possible source(s) of water quality issues experienced:

- Mitchells Plain WWTW treated effluent used for irrigation and discharged to coast (however, this does not affect the detention pond)
- Contaminated stormwater runoff from the catchment, which has no rivers and is characterised by dense residential and business precincts, and high levels of poorly serviced informal settlements

7.14. Other catchments where no routine inland water quality monitoring is undertaken

Atlantis catchment

Silwerstroom spring

West Coast catchment

No major rivers or waterbodies

City bowl catchment

Platteklip stream. Most other rivers are piped. No major open waterbodies.

Muizenberg catchment

No major rivers or waterbodies

Steenbras catchment

Steenbras River, Steenbras Dam. Used for potable water supply. No recreation.

Chapman's Peak catchment

No major rivers or waterbodies. Seasonal streams are largely piped before entering Atlantic seaboard coastal areas.

Llandudno catchment

No major rivers apart from largely seasonal streams or seeps, and no waterbodies

Zandvlei is an estuary, which has a tidal cyclic and seasonal balance of sea to fresh water mix

8. CONCLUSIONS

8.1. Overview of findings

The technical report and this summary booklet have considered Cape Town's watercourses from the perspective of a number of water quality variables that are critical indicators of aquatic ecosystem condition, particularly in urban areas. The data reveal that the biggest water quality issue experienced in most of the routinely monitored systems is elevated phosphorus, which drives eutrophic and hypertrophic conditions. Phosphorus enrichment makes receiving waterbodies such as vleis vulnerable to excessive plant growth, which requires ongoing maintenance and, at times, poses human health risks due to the presence or risk of microcystin toxins.

While the report names likely causal factors and source areas for phosphorus enrichment, these are identified by way of correlation rather than systematic pollution tracking. Nevertheless, the most likely sources of phosphorus loading in the city's inner catchments are:

- inflows of treated effluent from the City's numerous WWTWs, which discharge into several rivers (while WWTWs may comply with license limits set for phosphorus by the regulator, nutrient enrichment of receiving waterways and associated algal and aquatic plant growth may still occur);
- discharges of raw sewage from leaking or overflowing infrastructure, sometimes as a result of pump failure during load-shedding; and
- the passage of water contaminated with sewage and other domestic waste (such as water from cooking, washing, etc.) from informal settlements and other poorly serviced areas.

These are also associated with significant bacterial contamination, which poses a risk to people encountering this water, whether in the form of puddles and ditches in settlements, in stormwater channels, or in the receiving rivers and (to a lesser extent) vleis and dams.

Over time, WWTW effluent volumes discharged into the receiving aquatic environment may decrease as a result of the City's efforts to encourage effluent reuse. Yet the problem of water contamination as a result of inadequate servicing in some areas will remain an issue until sewage management, solid waste removal, as well as stormwater treatment and conveyance services in informal settlements have been scaled up. The cost of not providing such services at an appropriate scale is high – in terms of human health and dignity in the affected areas, compromised ecosystems and, of course, monetary expenditure. There are significant costs involved in the reactive and symptomatic management of:

- invasive aquatic plants;
- the emergency closure of recreational waterbodies in response to algal blooms or sewage spills;
- litter and solid waste removal;
- invasive reeds, water hyacinth and other plants that encroach into nutrient-enriched and often shallowing waterbodies;
- organic sludges; and
- interventions such as cut-off drains and low-flow diversions to redirect proportions of contaminated stormwater into sewers.

That said, however, it is noted that not all of Cape Town's watercourses are highly contaminated. The monitoring data do point to a few rivers where water quality is impacted to a much lesser degree. These include the Silvermine River and Lourens River systems. Other rivers, such as the Sand catchment rivers and Hout Bay River, are moderately to highly contaminated in their lower reaches only, and usually as a result of the issues outlined on page 71.

As mentioned earlier, it must also be stressed that the City's monitoring programme itself, while extensive and covering all the major catchments in Cape Town, focuses mainly on areas known to face water quality challenges. This generates an unintended bias in the water quality database towards degraded sites exhibiting signs of pollution. Cape Town undoubtedly also has a number of aquatic ecosystems (including river reaches, open waterbodies and wetlands) with relatively good water quality, particularly for a major urban area, which are not currently monitored on a routine basis. This may be due to budgetary constraints, as well as the need to prioritise monitoring and pollution abatement initiatives in problematic areas instead.

From a human health perspective, as represented by *E. coli* data, the analyses suggest that Cape Town's five main recreational waterbodies have generally been in a condition conducive to, at least, intermediate-contact recreational activities over the past five years, despite often high levels of *E. coli* in the rivers and channels that feed them. In summer, the probability of Zeekoevlei, Zandvlei and Princess Vlei meeting even full-contact standards is high (approaching 100% for Zeekoevlei and 80% for the other two systems). In winter, water quality near the major point-source river inflows deteriorates somewhat in Zandvlei and Zeekoevlei, the latter largely due to inflows of polluted water from informal settlements upstream.

The risk of unacceptable levels of *E. coli* is highest in Milnerton Lagoon, which has been subject to periodic and, at times, prolonged contamination. This indicates exposure to untreated sewage, assumed to derive mainly from the large informal and backyard-dominated settlements in the catchment upstream (such as Dunoon and Joe Slovo). Occasionally, compromised final effluent discharged from the Potsdam WWTW may also affect water quality in the system, but operational and capital improvements are addressing this.

By contrast, data for Rietvlei, which are currently obtained from a single routinely monitored site and occasional ad hoc samples, suggest that the probability of *E. coli* measurements within the target for direct-contact recreation is high (>80%) throughout the year. Moreover, the probability of measurements posing an unacceptable risk for indirect-contact recreation remains very low.

Like most of the other assessed urban vleis, Rietvlei is hypertrophic (extremely enriched) with regard to phosphate, and vulnerable to periodic blue-green algal blooms. These blooms may produce microcystin toxins (usually in summer to late autumn), which can pose a risk to recreational users who come into contact with the waterbodies. Rietvlei experienced such conditions in 2016, 2017 and 2019. These transient episodes could have been of significant health risk to recreational users exposed to the water, which is why the City imposed precautionary measures such as temporarily restricting access to the Rietvlei waterbody. Interestingly, however, Rietvlei has been the only waterbody displaying concerning concentrations of microcystin toxins since 2010, when microcystin toxin testing became a regular response to blue-green algal blooms. At the very least, this suggests a significant improvement in water quality at Zeekoevlei over time, considering that it suffered frequent blue-green algal blooms and periods of microcystin toxicity in the early 2000s. Blue-green algal blooms and associated toxicity are less pervasive in Princess Vlei and Zandvlei.

It is of some concern that there are areas in Cape Town where residents (including children) use rivers, vleis and other wetlands other than those considered in this report, for informal playing, swimming, paddling and possibly even washing, cooking and water drinking, without knowing whether the water is fit for use. Some of these waterbodies are highly contaminated. This issue can only be addressed by improving the condition of the catchments draining into these systems, through the provision of basic sanitation and servicing.

Roads near wetlands

The colour of the Silvermine River is due to tannins that leach from fynbos vegetation and stain the water brown/black

9. CITY RESPONSES – MEASURES BEING TAKEN TO ADDRESS WATER QUALITY CHALLENGES

Water Quality Improvement Programme

This report has highlighted that the current state of many of Cape Town's waterways is generally poor. Of particular concern is the ambient water quality of the Diep (Milnerton Lagoon), Salt, Soet, Hout Bay, Big and Little Lotus, and the Kuils/Eerste rivers.

Specific events, including community concerns about water quality in the lower Kuils River, and the algal bloom in the Milnerton Lagoon in December 2019 and into 2020, have raised public awareness of the issue. This has resulted in increased government support and intervention to improve water quality in Cape Town's urban waterways. The City's response is to rehabilitate and restore Cape Town's waterbodies to meet the administration's commitment of turning the Mother City into a water-sensitive city by 2040, as stated in commitment 5 of its Water Strategy.

To this end, the City has established the Water Quality Improvement Programme (WQIP). This strategic intervention seeks to improve "ambient water quality", which the United Nations defines as natural, untreated water that is affected by a combination of natural influences, anthropogenic activities and other causes of pollution (depicted in figure 10).

Figure 10: Causes of inland water pollution

Human behaviour: What we put into the sewer and stormwater systems, and what we throw away.

Sewer collection and wastewater treatment system: Capacity and operations.

Informality: Settlement patterns, urbanisation and poverty.

The primary objective of the WQIP is to address pollution and incrementally improve the water quality of the rivers and waterbodies in Cape Town. This will be achieved in accordance with various laws, guidelines and water quality objectives/targets, as well as being sustainable into the future.

The WQIP is designed to:

- demonstrate the City's ability to respond effectively, and substantially improve ambient water quality in priority catchments by employing a transversal (cross-cutting) project management approach;
- institutionalise and mainstream this transversal approach by establishing appropriate governance arrangements;
- build capacity in the City to deliver on the overall objective, targeting people, resources and partnerships; and
- partner with key stakeholders that influence ambient water quality in the City's rivers and waterbodies.

The WQIP consists of pollution abatement strategies and action plans (PASAPs) that set out how the City aims to address pollution and poor water quality at a river catchment (or subcatchment) scale. The PASAPs, in turn, cascade down into detailed transversal action plans (TAPs), which contain short to long-term interventions and projects across various directorates. TAPs are compiled by task teams comprising key role players in catchments or subcatchments, and are coordinated by the City's Catchment Stormwater and River Management Branch.

Each action/task identified in the TAPs fall into one of five work streams, namely (i) capital projects, (ii) maintenance and operations, (iii) specialist tasks, (iv) communications, and (v) compliance and enforcement. Examples of actions/tasks include:

- capital improvements at WWTWs (such as Potsdam);
- repairs and maintenance of sewage pump stations;
- informal settlements servicing;
- river maintenance programme implementation;
- litter-boom project partnerships;
- river warden partnerships;
- engagement with catchment forums and other interest groups;
- water quality reporting;
- by-law enforcement blitzes; and
- awareness campaigns such as "Bin It, Don't Block It".

Some tasks will be easy to undertake in the short term. Many others, however, will require significant capital and are to be undertaken over longer timeframes. Therefore, incremental improvement in ambient water quality of our urban waterways will be a long journey for the City and its partners.

The WQIP will initially focus on the following priority catchments, which the City has identified as facing significant water quality challenges. The technical report has confirmed that these catchments are indeed among the most challenged from a water quality perspective.

- Diep River (Milnerton Lagoon)
- Soet River
- Salt River
- Kuils/Eerste rivers
- Hout Bay River
- Big and Little Lotus rivers (Zeekoevlei)

10. HEALTHY URBAN WATERWAYS – OUR SHARED RESPONSIBILITY

Everyone living and working in Cape Town has a shared responsibility to keep our water resources and infrastructure clean and well-maintained.

The City manages municipal water and sanitation infrastructure – such as stormwater pipes, canals, ponds and urban waterways, and sewage conveyance pipes and pump stations – but needs residents and businesses to do their part to ensure a healthy, safe and working city for all.

The sewer system is designed to transport only wastewater from kitchen sinks, bathroom basins, baths, showers and toilets to WWTWs. Here, the water is treated and cleaned so that it is safe enough to be discharged back into inland waterways (such as rivers, vleis, canals and aquifers) and the ocean. This wastewater may also include industrial liquid waste, especially if draining from the city's industrial areas. The City's WWTWs are licensed by the national Department of Human Settlements, Water and Sanitation (previously called Water and Sanitation).

Municipal WWTWs are not designed to treat fats, oils and other harmful chemicals, or to remove disposed sanitary products (such as earbuds, tampons, sanitary pads, nappies, rags, condoms, cosmetics or pharmaceuticals) from the wastewater stream, so these should never be flushed down toilets or poured down household drains. When incorrectly disposed, these harmful substances find their way into our urban rivers, vleis and ocean, harming the various species of fish, plants and animals that rely on clean waterbodies to survive.

The main causes of sewer and stormwater system blockages are the careless and illegal dumping of material such as rubble, household appliances, domestic rubbish, rags and garden refuse, as well as littering. These can be prevented by ensuring that this infrastructure is used appropriately and only for their intended purposes. All residents and businesses should make use of the City's refuse collection services, drop-off sites and landfill sites for appropriate disposal of solid waste. Remember to "Bin It, Don't Block It"!

Bin It. Don't Block It.

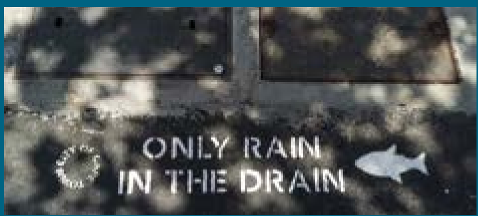
This sewer blockage prevention campaign is aimed at informing residents and businesses about the importance of keeping the sewer system clean and free from litter and pollution. It also explains how human behaviour is crucial to the well-being of City infrastructure and the natural environment.

What you can do to help

By following the pointers below, you can play your part in protecting our sewers, stormwater system and inland water sources from pollution, contamination and obstructions. For more information, visit **www.capetown.gov.za** and search for *'prevent blocked sewers'* and *'our stormwater system'*.

Remember that any polluted water that runs off your business or residential property into the street will pass into the stormwater system, flow down to our rivers or wetlands, and ultimately end up in the ocean.

Understand the difference between the City's sewage and stormwater networks. Did you know that a stormwater manhole may have holes in the lid, while a sewer manhole cover is always solid?



Bin It, Don't Block It! Household waste should be binned, recycled or composted, depending on the type. Do not throw it down the stormwater drain or into the sewer network, as it either blocks the system and causes localised flooding or sewer overflows, or ends up in and pollutes our waterways.

Don't flush nappies, sanitary products, wipes, earbuds, condoms, hair, rags or newspapers down the drain. These block the sewer network, which result in overflows of raw sewage into the environment.

Unwanted food belongs in the bin, not down the sink or drain. Fruit and vegetable waste and egg shells can be used to make compost.

Dirty household wastewater should be disposed of in the sink or toilet so that it enters the sewer network and travels to WWTWs for treatment (rather than the stormwater system which is connected to waterways and the sea). This includes wastewater from hair products and treatments, pool backwash and bin-washing water. If this wastewater reaches the stormwater system, it is destined for our waterways and, ultimately, the ocean, where it will harm the ecosystem, contaminate seafood and threaten marine life.

Should you notice a sewage spill, log a call on the City's "Report a fault" (C3 notification) system. Include a basic description of the problem plus an accurate location (street address or map pin) so that the City can easily locate and deal with the cause of the spill. Report illegal dumping, sewer overflows, vandalism and burst pipes in one of these ways: SMS **31373**, email **water@capetown.gov.za**, call **0860 103 089**, visit a walk-in centre or go to **www.capetown.gov.za/servicerequests**

Do not allow water from bin washing to flow into the street. This highly contaminated water is harmful to the environment.

Wipe cooking fat off pans and pots with newspaper or paper towels – do not pour it down the sink or stormwater drain.

Join local river clean-up groups and help prevent waste from getting into waterways in the first place.

Recycle your waste! Locate your nearest drop-off site by visiting **www.capetown.gov.za** and searching for *'Drop-off facilities'* or *'Waste recyclers map'*.

Restaurants should regularly clean out grease traps. The build-up of fats in the sewer system is a major cause of blockages and sewer overflows.

Pick up any litter on and around your property and put it in a nearby bin. This will prevent Cape Town's infamous winds from blowing the litter into our stormwater system.

Clean up pet waste. If not, the rain will wash this pollution into the stormwater system, which is likely to cause increased *E. coli* levels and nutrient enrichment of our waterways.

Wash your vehicle on a soft surface, where the greywater gets absorbed into the soil. Do not wash it on hard surfaces near a drain, as the chemicals in the greywater will run directly into the stormwater system. Make sure that your local car wash facility also takes steps to prevent runoff of dirty detergent laden wastewater.

Use eco-friendly products for your garden and for cleaning vehicles. When it rains, chemicals in fertilisers, pest control and cleaning products end up in the stormwater system, harming our rivers, streams, wetlands and the ocean.

Used motor oil and paint products that contain harmful chemicals should be disposed of at a City-approved drop-off facility.

Disposal of factory effluent (liquid waste) into the stormwater or sewer system is illegal. Factories should contact the City to check whether their wastewater may be disposed of into the sewer and treated at the WWTWs, or should be disposed of at a hazardous landfill site instead (if the factory waste could be harmful to the municipal wastewater treatment process).

Do not let wash water, silt or cement-laden runoff from factories, industrial premises or building sites flow into the street, as this will enter the stormwater system and ultimately pollute our urban waterways and ocean.

Clean your gutters regularly and sweep away leaves and sandy sediment that could end up in the stormwater system, causing blockages and flooding. Let the rainwater from your roof and paved areas soak into the ground or a flower bed so that groundwater can be replenished and any possible pollutants are absorbed by the soil and plants. This diverts pollutants away from our stormwater system and reduces system load. Do not direct rainwater from your gutters into the sewer system, as it causes sewer overflows.

Join citizen science initiatives to help monitor the environment: **http://www.minisass.org** for river monitoring and **https://ispot.org.za/** to contribute to biodiversity record keeping.

This report can be found online by visiting **www.capetown.gov.za** and searching for *'Inland water quality'*.

Information on Cape Town's coastline, beaches and coastal amenities can also be found online by visiting **www.capetown.gov.za** and searching for *'Our unique coastline'* and *'Coastal water quality'*.

If you wish to report a pollution incident, visit **www.capetown.gov.za/ServiceRequests**

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STAD KAAPSTAD

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