THE CITY WATER RESILIENCE APPROACH

CITY CHARACTERISATION REPORT

GQEBERHA

ACKNOWLEDGEMENTS

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ACRONYMS

AWSS	Algoa Water Supply System
CMA	Catchment Management Agency
COGTA	Department of Cooperative Governance and Traditional Affairs
CRI	City Resilience Index
CWRA	City Water Resilience Approach
CWRF	City Water Resilience Framework
DFFE	Department of Forestry, Fisheries and Environment
DWS	Department of Water and Sanitation
EWR	Environmental Water Requirements
GIB	Gamtoos Irrigation Board
GVA	Gross Value Added
IAP	Invasive alien plants
IDP	Integrated Development Plan
LSRWUA	Lower Orange River Water Users Association
MSDF	Municipal Spatial Development Framework
NMBM	Nelson Mandela Bay Municipality
NRW	Non-Revenue Water
PS	Pump Station
SACN	South African Cities Network
SEZ	Special Economic Zone
SPLUMA	Spatial Planning and Land Use Management Act
UWR	Urban Water Resilience
WC/WDM	Water Conservation Water Demand Management
WMA	Water Management Area
WMP	Water Master Plan
WRI	World Resources Institute
WSA	Water Services Authority
WSDP	Water Services Development Plan
WSP	Water Services Provider
WTW	Water treatment works
WWTW	Wastewater treatment works
WUA	Water Users Association

FOREWORD FROM PARTNERS

Gqeberha (previously known as Port Elizabeth), which forms part of the Nelson Mandela Bay Municipality (NMBM) in South Africa, is the second-largest metropolitan district by area size and the country's sixth-most-populous city. The city is a significant contributor to the national and provincial economy and its proximity to industries, export agricultural areas, an international airport, and a harbour makes Gqeberha a prime area for economic development. It is also the centre of the country's motor vehicle manufacturing industry and boasts a multibillion-dollar industrial development complex, the Coega Special Economic Zone. Despite its accolades, Gqeberha faces multiple social, environmental, and political challenges. More pressing, the city and the greater NMBM has been facing an on-going drought since 2015.

The Urban Water Resilience Initiative led by the World Resources Institute (WRI) specially aims to partner with cities such as Gqeberha that face multiple shocks and stresses in its water system. Shocks and stresses affect the resilience of the city and the urban water system the city depends on to provide critical urban services, putting the livelihoods of its population, natural systems, and economy at risk. For a city such as Gqeberha, there is an urgent need for the leaders and other key stakeholders, such as the national government, to identify the city's shocks and stresses, establish a baseline against which progress can be tracked, identify areas of opportunity for taking strategic actions, and implement priority projects towards building resilience in the city's water system.

To this point, WRI collaborated with Nelson Mandela Bay Municipality to develop a better understanding of risks and vulnerabilities in Gqeberha's urban water system and to address them in a holistic manner. With the support of local partners (South African Cities Network, Zutari, and the Department of Cooperative Governance and Traditional Affairs) the World Resources Institute initiated the programme at the start of 2022 and aims to continue supporting NMBM towards being a water resilient city.

As part of that work, this report provides an appraisal of the water context of Gqeberha and NMBM. The appraisal includes its natural basin(s), maps key man-made and natural assets, governance processes of the urban water system, and interdependencies with other systems. The report assesses key water and urban policies, programs, plans underway and in development; and identifies development shocks and stresses to develop an analysis of existing urban water resilience challenges facing the city. In doing so, the report provides factors contributing to the resilience of the city water system and those increasing its vulnerability.

The next steps following this report include a series of stakeholder engagements with the aim of assessing the city's urban water resilience. The assessments will be carried out using the City Water Resilience Framework developed by Arup. Based on the outcomes of the assessment, the team will further develop a Water Resilience Profile and Action Plan for Gqeberha, NMBM to support medium to long-term building of water resilience. Lastly, priority actions will be identified as part of the city's Action Plan, and discrete technical assistance will be provided to advance those actions towards project implementation.

This work has been made possible by the support of the German Federal Ministry for Economic Cooperation and Development (BMZ).

On behalf of the World Resources Institute and the partners, we would like to thank the Nelson Mandela Bay Municipality's Water and Sanitation Department and all City officials as the main collaborator guiding the implementation of the Urban Water Resilience Initiative.

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WORLD RESOURCES INSTITUTE

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Department:
Cooperative Governance
REPUBLIC OF SOUTH AFRICA

ZUTARI
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South African CitiesNetwork

LETTER FROM GQEBERHA, NELSON MANDELA BAY MUNICIPALITY

Gqeberha is the largest city in Nelson Mandela Bay Municipality (NMBM) and continues to be a key economic hub in the province of the Eastern Cape, South Africa. At the time of publishing this report, the city had been experiencing a seven year-ongoing drought. This is the worst drought ever recorded for the municipality. Our water supply has been in a critical condition for the past few years and climate change projections indicate that our municipality will continue to face climate change water-related shocks such as extreme drought risk and extreme coastal flood risk.

While climate change is an important contributor to the current situation we find ourselves in, there are other primary causes such as lack of investment into the sector, capacity constraints, infrastructure limitations, declining revenue collection, high rates of non-revenue water, growing urban informality, and the fast pace of urbanization. Therefore, creating water resilience is a key priority for our municipality. Given the status of our water situation, we do have several internal and external programmes that have been put in place in collaboration with partners to manage the current drought as well as to build resilience in our water system.

While these measures have been put in place to mitigate the on-going drought, we have long recognised the need for our municipality to engage in strategic long-term planning for building water resilience. This notion was further reinforced during a water resilience workshop hosted in August 2022 by the Minister of Water and Sanitation and the NMBM Mayor while engaging key stakeholders on co-creating water resilience. Sustainable urban growth in the municipality can only be achieved if the water system is resilient. While we have several water and sanitation initiatives underway, it was important for the municipality to partner with the World Resources Institute (WRI) to benchmark the municipality's water resilience, identify potential key areas for intervention, and contribute towards building medium to long-term planning water resilience in the municipality.

Through the partnership with WRI, we have an opportunity to initiate a strategic long-term planning process through baseline development, identification of priority urban water resilience actions, and advancement of the city towards implementation.

As part of the water resilience planning process, the Gqeberha City Characterization Report provides an appraisal of our city's unique context and unpacks key challenges that threaten its water resilience. In addition, it provides a unique understanding of our water system including the basin, key water assets, the governance structure, and key independencies with other urban systems.

As we continue our partnership with the WRI towards developing an action plan for building water resilience, this report will help city and city stakeholders better understand current and future vulnerabilities to water and climate shocks and stressors. We look forward to the continued partnership with WRI.

Barry Martin, Director of Water and Sanitation, Nelson Mandela Bay Municipality

nelson mandela bay MUNICIPALITY

EXECUTIVE SUMMARY

CONTEXT OF THE RESEARCH

City leaders in Africa face converging challenges: extending water and sanitation services for growing populations, managing watershed risks and competing water demands outside city jurisdiction, and designing for climate resilience. They are challenged to build urban water resilience, where communities have enough safe, reliable, and affordable water to survive and thrive through sustainable, adaptive, and resilient urban water systems. The recent COVID-19 crisis has highlighted the urgent need to close the urban services divide more than ever, given that the lack of access to essential services, including water, has exacerbated the challenge of responding effectively to the pandemic.

These converging challenges represent a significant threat to sustainable urbanisation, but this moment of growth and development also presents an opportunity to "get water right." To ensure sustainable and equitable urbanisation, cities must build resilience to water and climate risks. This will require overcoming underlying barriers to changing existing urban and water systems, such as knowledge and capacity gaps, siloed and uncoordinated planning (vertical and horizontal), and financial and technical bias toward rigid and centralised infrastructure.

The World Resources Institute's (WRI) Urban Water Resilience (UWR) initiative works to help cities overcome water challenges through research to illuminate urban water resilience challenges and pathways, create partnerships with cities to enhance capacity and demonstrate solutions, and facilitate collective action to improve enabling environments. This initiative is being led by WRI Africa, WRI Ross Centre for Sustainable Cities, the WRI Water Programme and partners. Together, these programmes and offices provide experience in creating accessible, equitable, healthy and resilient urban areas for people, businesses and the environment as well as working with businesses, governments and civil society to ensure a water-secure future by addressing water quantity, quality and governance challenges.

This study is being implemented as part of the UWR initiative to develop partnerships with cities to enhance capacity and demonstrate pathways for change using the City Water Resilience Approach. The first step of the City Water Resilience Approach is to develop a City Characterisation Report for an understanding of the local water system and the factors that contribute or detract from resilience described in this document. Therefore, this report, Gqeberha City Characterisation Report, therefore details research undertaken in Gqeberha with the aim to:

- Define the city water basins, the urban water system and its governance structure, and the interdependencies with other systems, and
- Identify the factors impacting the resilience of the city's water system and those increasing its vulnerability.

GQEBERHA, SOUTH AFRICA

Gqeberha (previously known as Port Elizabeth) forms part of the Nelson Mandela Bay Metropolitan Municipality (NMBM) and is South Africa's second-largest metropolitan district by area size and its sixth most-populous city. Gqeberha is the primary economic hub of the Eastern Cape Province, which remains South Africa's most indigent province with the highest levels of unemployment and the lowest access to basic services in South Africa. The city is a significant contributor to the national economy, and its proximity to industries, export agriculture areas and the Coega Deep Water Harbour makes

it a prime area for economic development. It is also the centre of the country's motor vehicle manufacturing industry and boasts a multibillion-dollar industrial development complex, the Coega Special Economic Zone (SEZ). Despite its accolades, Gqeberha remains a highly divided city facing multiple social, environmental and political challenges.

At the time of writing this report (June 2022), of Gqeberha, the NMBM, and the surrounding regions are experiencing a severe drought and water supply crisis due to below average rainfall (likely caused by climate change), increasing demands and infrastructure capacity limitations. The main water supply dams have been declining since November 2015 and the local dam levels are sitting at 14% as of 29 June 2022[1], the lowest storage volume recorded for this time of year since 1979. Should no significant changes occur soon, Gqeberha will likely run out of water and become South Africa's first major city to reach a 'day zero' scenario.

KEY FINDINGS

- The eastern part of NMBM derives its water from the Gariep Dam (South Africa's largest Dam) some 200km north of the city. The Gariep Dam drains the high rainfall area of the Lesotho Highlands and provides a reliable source of water for much of the country. The western and central part of NMBM derives its water from local dams and groundwater schemes that have been impacted by the drought. The NMBM's allocation from the Gariep Dam is almost suffcient to meet the current needs of the municipality, but local infrastructure constrainsts prevent this water from being distributed to the drought stricken western and central parts of the Municipality.
- The spread of invasive alien plants in the dam catchment areas supplying Gqeberha and the greater NMBM are further contributing to water losses and while there are current initiatives underway these are currently insufficient to reduce the threat posed by the continued spread of IAPs in the dam catchment areas. The growth of IAPs within the NMBM is also contributing to an increase in flooding risk particularly when combined with a lack of maintenance, clearing of culverts, and poor management of solid waste
- Climate change is a key driving force behind the current drought, and will likely increase in the future unless drastic change is taken. A consequence of the uncertainty around water security and drought has been a lack of investment in new industries, affecting the local economy. The NMBM will need to ensure water resilience for industries and the Coega Special Ecnomic Zone if they hope to sustain their economy.
- NMBM's non-revenue water[2] (NRW) was 41.3% for the month of February 2022, with the Real Losses being calculated at 28.5% during the same time. The NMBM is focussed on drastically reducing its NRW% to 36%. Reducing NRW is particularly critical for NMBM during the current drought crisis as Water Conservation Water Demand Management remains the cheapest option to save water, and with a Real Loss of 28.5% there is significant room for conserving water.
- While the drought is driven by lower-than-average rainfall, the effects have been compounded by numerous other factors. Governance is a significant challenge, and the municipality has had three mayors and five municipal managers between 2011 and 2016. Currently the NMBM has no acting City Manager due to conflicting governing parties.
- Gqeberha has one of the highest levels of access to basic services in the country.

Despite this, the City is still highly unequal and residents in informal areas do not always have adequate access to basic services, with a 47% unemployment rate in 2022.

- The City is prone to extreme growth pressures due to population growth and urbanisation as a result of being the largest economic hub in the Eastern Cape Province. Poor spatial planning and development results in the construction of informal housing on natural flood plains which cannot withstand the impacts of urban flooding.
- Environmental degradation is a critical vulnerability for Gqeberha. Overloaded and poorly maintained wastewater treatment works, polluted stormwater runoff and solid waste have all contributed to the deterioration of the water quality of the Swartkops river and estuary. Proper maintenance of sewerage systems, adequate solid waste removal services and increased policing of illegal dumping will all help mitigate this.

NEXT STEPS

Considering the current water crisis that NMBM is facing and the government's focus on short-term drought mitigation measures, the Urban Water Resilience initiative will follow an approach that is sensitive to the local context. This sensitivity will be considered when engaging with the Municipal officials and other stakeholders. We will balance the critical need to ensure future urban water resilience with the Municipality's own pressing concerns during this period of disaster. The remaining steps for the project therefore include the following:

- **Stakeholder resilience and visioning workshops:** WRI and partners will continue to work collaboratively with NMBM towards initiating and advancing a city water resilience agenda using the City Water Resilience Approach. The City Water Resilience Framework will be populated with data gathered through interactive workshops/meetings with the stakeholders in NMBM that offer a range of resilience perspectives. The resilience workshops will be followed by a visioning workshop that will develop a water resilience vision for Gqeberha's future.
- **City water resilience profile and action plan:** Based on the key action areas identified in the visioning workshop, a Resilience Profile and Action Plan for Gqeberha will be developed that will contribute to tackling the shocks and stresses that directly and indirectly impact the urban water system.
- **Technical assistance plan:** Parallel to the development of the City water resilience profile and action plan, the task team will continue engaging with the Municipality, WRI and other key partners to develop a technical assistance plan for one or two priority areas. Based on conversations had with the NMBM water lead outlined in Section 3.8, it is apparent that high non-revenue water remains a critical area of concern for the Municipality.
- In collaboration with NMBM, WRI and Zutari will identify and prioritize the development water resilient projects to be implemented through the WRI's ACWA Fund and other sources of funding.
- **Continued support for the DWS southern reconciliation study:** The southern reconciliation study (see Section 5.1) is key to ensuring long-term water supply availability for Gqeberha and the greater Algoa Water Supply System. Continued engagement with DWS and the technical team will ensure the alignment of long-term water reconciliation planning and urban water resilience planning for the City and surrounding settlements.

STRUCTURE OF THE REPORT

Chapter 1	Introduces the context of the research by outlining the purpose of the Urban Water Resilience initiative in Africa, the use of the City Water Resilience Approach and the purpose of the City Characterisation Report.
Chapter 2	Provides an overview of the Gqeberha and Nelson Mandela Bay Municipality, including the location and topography, regional and historical context, land use and cover, natural environment, climate, population, economic context, access to basic services, housing, poverty and inequality, and governance. Given the complex nature of Gqeberha's water supply system
Chapter 3	Gives an overall introduction to the water system and governance structure for water and sanitation services in Gqeberha and the broader NMBM
Chapter 4	Lists the key shocks and stresses that hamper resilience in the city as well as the vulnerabilities that prevent the city from mitigating threats.
Chapter 5	Highlights the existing policies, projects and programmes that assist towards building resilience in the city. Chapter 6 outlines the suggested way forward in scoping out the priority actions for implementation as well as the development of a resilience profile and action plan for Gqeberha.

(1) https://mygqeberha.com/dam-levels/
(2) NRW is water that has been produced and is "lost" before it reaches the customer. Losses can be real losses (through leaks, sometimes also referred to as physical losses) or apparent losses (for example, through theft or metering inaccuracies).

1 INTRODUCTION

City leaders in Africa face converging challenges: extending water and sanitation services for growing populations, managing watershed risks and competing water demands outside city jurisdiction, and designing for climate resilience. They are challenged to build urban water resilience, where communities have enough safe, reliable, and affordable water they need to survive and thrive through sustainable, adaptive, and resilient urban water systems. The recent COVID-19 crisis has highlighted the urgent need to close the urban services divide more than ever, given that the lack of access to essential services, including water, has exacerbated the challenge of responding effectively to the pandemic.

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The World Resources Institute's (WRI) Urban Water Resilience (UWR) initiative works to help cities overcome water challenges through research to illuminate urban water resilience challenges and pathways, create partnerships with cities to advance their water resilient agenda and provide technical assistance, and facilitate collective action to improve enabling environments. This initiative is being led by WRI Africa, WRI Ross Centre for Sustainable Cities, the WRI Water Programme and partners. Together, these programmes and offices provide experience in creating accessible, equitable, healthy, and resilient urban areas for people, businesses and the environment and work with governments and civil society to ensure a water-secure future by addressing water quantity, quality, and governance challenges.

The UWR initiative is focused on six African Cities, namely: Kigali & Musanze in Rwanda; Addis Ababa & Dire Dawa in Ethiopia; and Johannesburg & Gqeberha in South Africa.

This study is being implemented as part of the second component of the initiative to develop partnerships with cities to enhance capacity and demonstrate pathways for change. In South Africa, the UWR initiative is being applied in collaboration with the South African Cities Network (SACN) and Department of Cooperative Governance and Traditional Affairs (COGTA) in Johannesburg and Gqeberha (this project). Zutari is providing technical support in both of these cities. This will be developed in close partnership with the city stakeholders using the City Water Resilience Approach.

The first step of the City Water Resilience Approach is to understand the local water system and the factors that contribute or detract from resilience described in this document, the Gqeberha City Characterisation Report. Therefore, this report therefore details research undertaken in Gqeberha with the aim to:

- Define the city water basins, the urban water system and its governance structure, and the interdependencies with other systems.
- Identify the factors impacting the resilience of the city's water system and those increasing its vulnerability.

1.1 URBAN WATER RESILIENCE IN AFRICA (UWR)

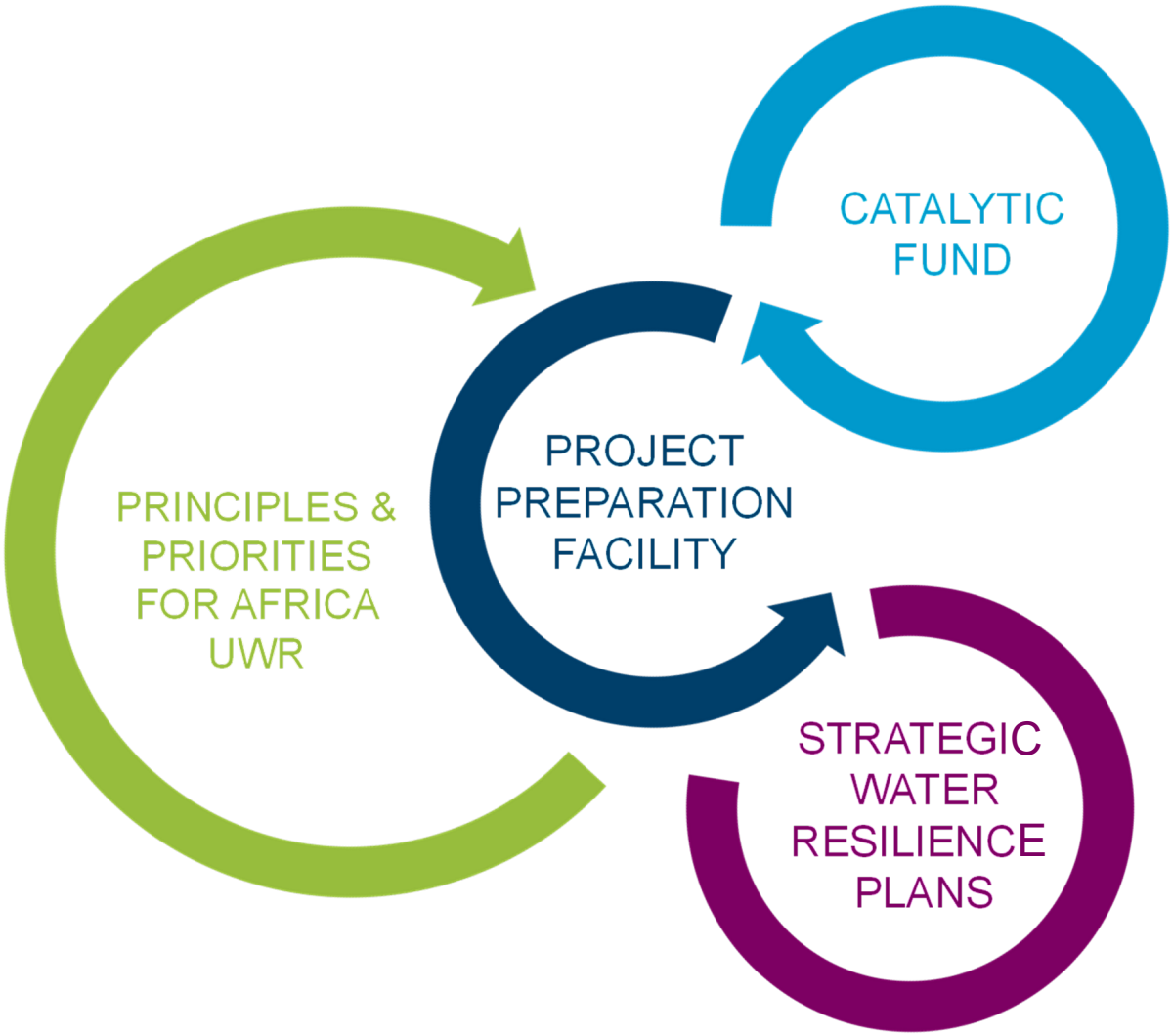
WRI is undertaking a three-year programme (2020-2022) to help advance urban water resilience in Africa. The initiative builds on WRI's strong water resources knowledge, globally recognised data and analytical capacities, as well as the WRI Ross Centre for Sustainable Cities' deep capacity and track record of helping 400+ cities globally tackle tough sustainability and equity challenges, including many cities in Africa. The overall objective of this work is to help cities address their water risks and vulnerabilities through research, technical assistance, knowledge sharing, and partnerships for collective action.

To this end, WRI and partners will work with city stakeholders to: map key water, climate and development risks facing a city; identify pathways for change (e.g., policy, planning, and governance interventions); set specific targets and owners for actions; catalyse implementation of priority actions through various capacity building initiatives, including providing technical assistance and supporting knowledge exchange; and soliciting commitments from regional and national stakeholders to create necessary enabling conditions (e.g., policy alignments and enhanced investment).

This work is made possible by a grant from the German Federal Ministry for Economic Cooperation and Development (BMZ). WRI envisions this effort as the foundation for a larger urban water resilience programme in Africa, in partnership with other international, pan-African, and local partners.

WRI helps African cities build water resilience through three key components:

- **Research to illuminate urban water resilience challenges and pathways:** Research under the Urban Water Resilience Initiative is enhancing awareness and understanding of urban planning, water resources management, governance, finance, and infrastructure design, with a focus on resilience for vulnerable populations.
- **Partnerships with cities to enhance capacity and demonstrate pathways:** WRI is partnering with a cohort of six cities and their regional and national governments, supporting cities to advance their water resilience agendas, using the City Water Resilience Approach developed by Arup and partners, providing technical assistance, and facilitating capacity building.
- **Collective action to improve enabling environments:** WRI is mobilising collective action through engagement with key stakeholders, including regional governments, financial institutions, and research institutions.



- A coalition that endorses a Practice Shift of new Priorities & Principles for UWR in Africa
- A fund that invests in low carbon resilient water solutions enhancing proof of concept for innovative solutions and financing in water
- Project design & structuring, feasibility studies, business models, bankable resilience projects, follow-on investment for implementation
- Developing strategic UWR plans at city-region scale, identifying a pipeline of opportunities; the RIGHT solutions, the RIGHT priorities

Figure 1-1.

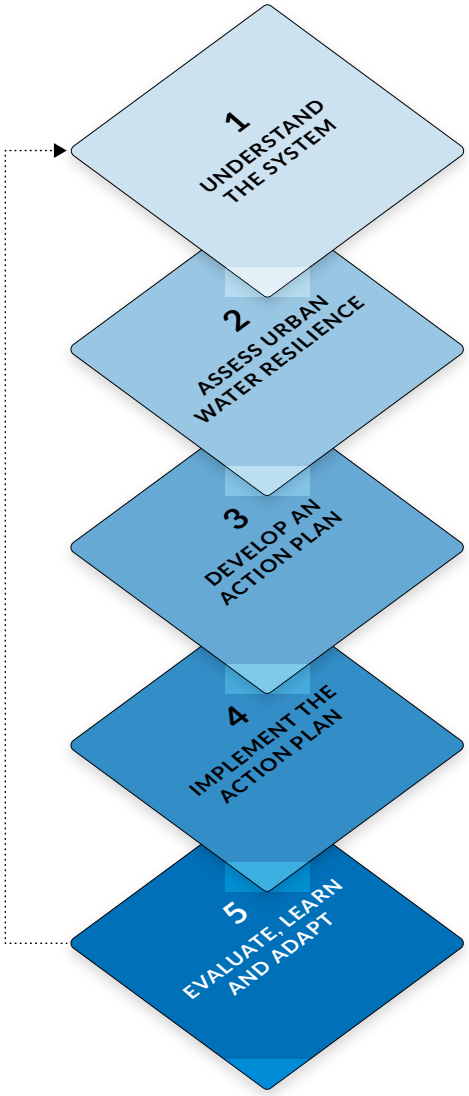
Overview of the outcomes of the three key components of WRI's Urban Water Resilience initiative in Africa

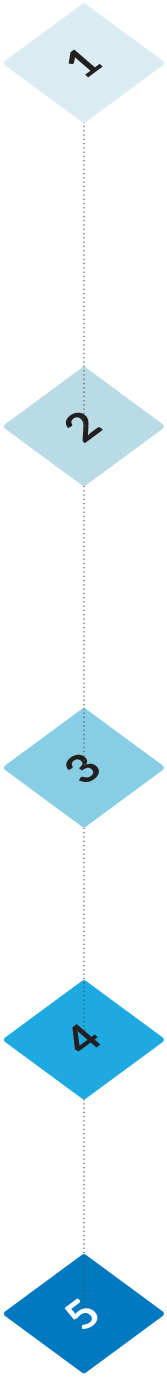
1.2 THE CITY WATER RESILIENCE APPROACH

The City Water Resilience Approach (CWRA) responds to a demand for new approaches and tools that help cities grow their capacity to provide high quality water resources for all residents, and to protect them from water-related hazards. The CWRA process outlines a path for developing urban water resilience and provides a suite of tools to help cities identify, assess, take action to address and ultimately survive and thrive in the face of water-related shocks and stresses.

The CWRA is based on fieldwork and desk research, collaborative partnerships with subject matter experts, and direct engagement with city partners. The approach was developed through investigations in eight cities and consultation with over 700 individual stakeholders by Arup. Arup worked with the Stockholm International Water Institute, 100 Resilient Cities, the Organisation for Economic Co-Operation and Development, and in close collaboration with city partners from Cape Town, Amman, Mexico City, Greater Miami and the Beaches, Hull, Rotterdam, Thessaloniki, and Greater Manchester. Each partner city confronts persistent water-related shocks or suffers chronic water-related stresses and is committed to co-creating water resilience approaches. The cities represent diverse geographies and face a range of shocks and stresses in various socio-political contexts.

The approach outlines five steps to guide partners through initial stakeholder engagement and baseline assessment, through action planning, implementation and monitoring of new initiatives that build water resilience. (See next page.)





Step 1: Understand the system
The city's unique context is appraised to understand shocks and stresses, identify system interdependencies, convene local stakeholders and map key infrastructure and governance processes. This first step of the CWRA process results in City Characterization Reports that summarize the results of this research. (i.e., this report)

Step 2: Assess urban water resilience
The city's current practices are assessed using the City Water Resilience Framework to identify areas of existing strength and weaknesses and establish a baseline against which progress is measured. This second step results in a City Water Resilience Profile, which summarizes the assessment process and outlines potential actions to build resilience.

Step 3: Develop an action plan
Based on the city assessment, an action plan is developed for realizing interventions that develop water resilience. The action plan is based on holistic evaluation of anticipated benefits and costs and prioritization of projects identified in the previous step.

Step 4: Implement the action plan
Actions agreed upon during the previous step are implemented according to best practices. In this step, the CWRA provides best practice guidance for how ongoing actions can be monitored to ensure objectives are met, and resources are used appropriately.

Step 5: Evaluate, learn and adapt
Implementation is evaluated. Adjustments are made to the implementation plan to account for new developments or changing circumstances in the city, and to align with updated objectives for the next period.

To guide cities through this process, the CWRA offers a suite of resources that target specific challenges identified by cities in their efforts to build water resilience:

OURWATER

OurWater is a digital tool that helps cities better understand the types of shocks and stresses they confront, their impact on natural and man-made infrastructural systems, and the interaction between key stakeholders involved in urban water management. The OurWater tool is used in Step 1 of the CWRA to map the infrastructure and governance arrangements that define the urban water system.

THE CITY WATER RESILIENCE FRAMEWORK (CWRF)

CWRF assesses the resilience of a city to water-based shocks and stresses and allows the city to identify and prioritize future action. Understanding their resilience helps cities formulate a clear vision of what urban water resilience means to them, including what specific conditions must be in place to achieve this vision, what efforts will be required to build resilience and what actors are involved. The CWRF is the primary tool used in Step 2 to assess urban water resilience, and the focal point for workshops conducted in the city.

The CWRA and the main deliverables are shown in Figure 1 3. It is recognised that each city will be at a different stage in terms of water resilience. As a result, it may be necessary to adapt the above framework based on the local context and existing programmes. Proposed adaptions are set as levels to ensure that a holistic set of indicators are used rather than an ad hoc selection of indicators that might compromise the whole system view. The CWRA has been applied in the past to Cape Town, another South African city, and lessons learnt from the application of the approach in Cape Town will be considered for the application in Gqeberha.

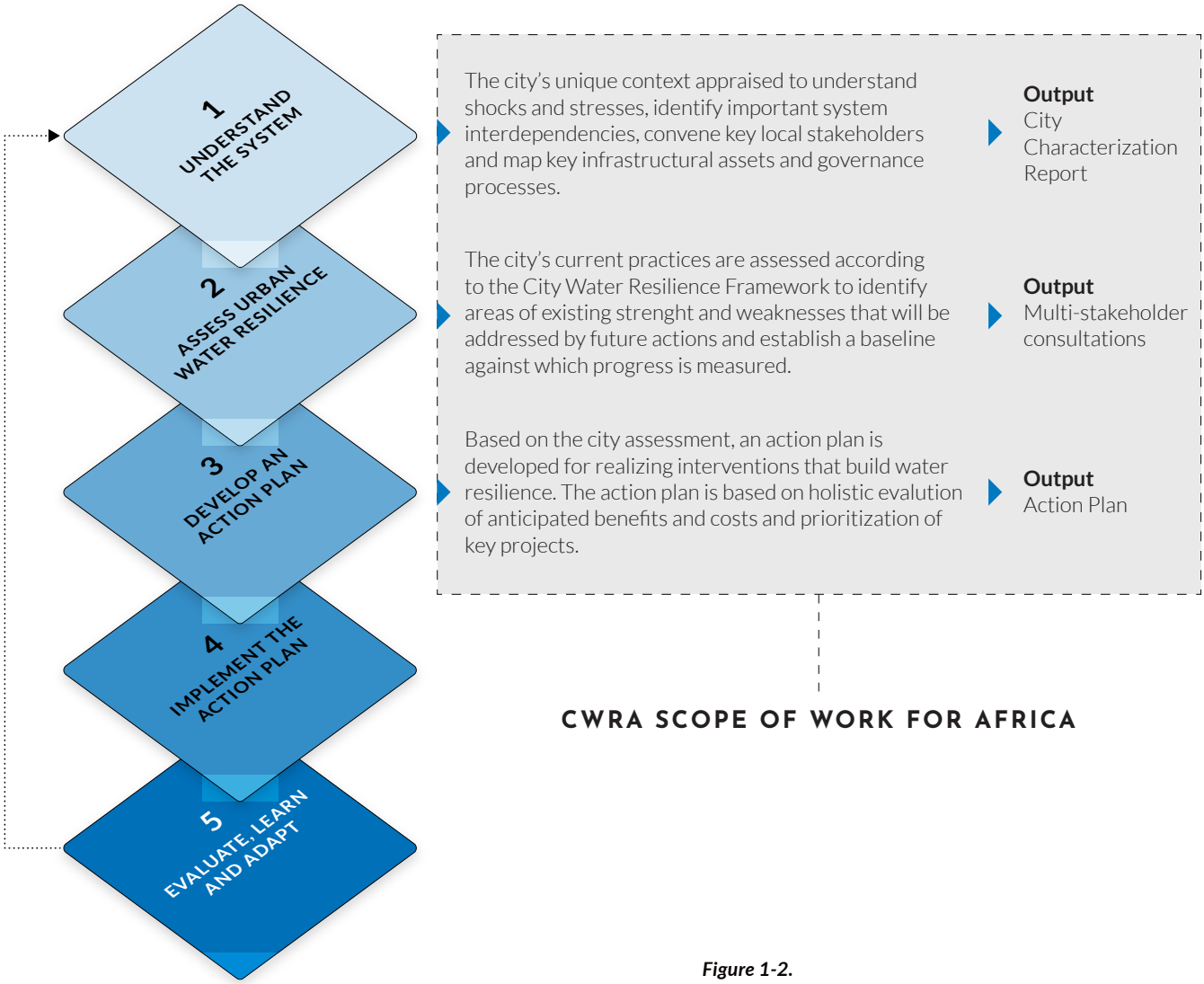


Figure 1-2.
Overview of the City Water Resilience Approach and its application for the AUWI

1.3 PURPOSE OF THE CITY CHARACTERISATION REPORT

The first step of the CWRA is to understand the local water system and the factors that contribute or detract from resilience described in this document, the City Characterisation Report. This report details research undertaken in Gqeberha to:

- Define the city water basins, the urban water system and its governance structure, and the interdependencies with other systems.
- Identify the factors impacting the resilience of the city's water system and those increasing its vulnerability.

The data for this report was collected through extensive desktop research and the authors' collective experience working on water and urban issues in Gqeberha. This report aims to outline what has been done in the city to enable water resilience to date and use this information to adapt the application of the CWRA as is appropriate towards the development of a resilience profile & action plan, the next step in the CWRA methodology.

2

OVERVIEW OF GQEBERHA

2.1 LOCATION AND TOPOGRAPHY

The city of Gqeberha, formally known as Port Elizabeth, is South Africa's second-oldest city and is mostly referred to as the "friendly city" or the "water sports capital of Africa". It is often regarded as the official gateway to the scenic Eastern Cape Province and the world-renowned Garden Route. It boasts a pristine scenic coastline and multitude Blue Flag Beaches and is recognised as both the Angora goat (Mohair) and Bottlenose Dolphin Capital of the world and is home to the largest breeding colony of the African Penguin. It is the only city that boasts the Big 7 (Elephant, Rhino, Buffalo, Lion, Leopard, Southern Right Whale and the Great White Shark) within its municipal boundaries.

Gqeberha forms part of the Nelson Mandela Bay Municipality (NMBM) which includes several other smaller towns including Kariega (previously Uitenhage), Despatch and Colchester (Figure 2 1). It is also South Africa's second-largest metropolitan district by area size, its sixth-most-populous city, and the most populous city in the Eastern Cape Province, one of South Africa's nine provinces (StatsSA, 2021). The NMBM is a Category A metropolitan municipality established on 5 December 2000, a municipality that has exclusive municipal executive and legislative authority in its area. Gqeberha was the first city in South Africa to establish a fully integrated democratic local authority. The city is home to the Port Elizabeth International Airport, the only international air access point in the Eastern Cape Province. The City's maritime entry point showcases its developmental capabilities, boasting the most modern deep-water port in the Southern Hemisphere, the Port of Ngqura.

NMBM and Gqeberha are managed as a single unit, and for the purpose of this report these names will be used interchangeably. Some maps may also reflect the name Port Elizabeth, as the name change to Gqeberha took place recently in 2021.

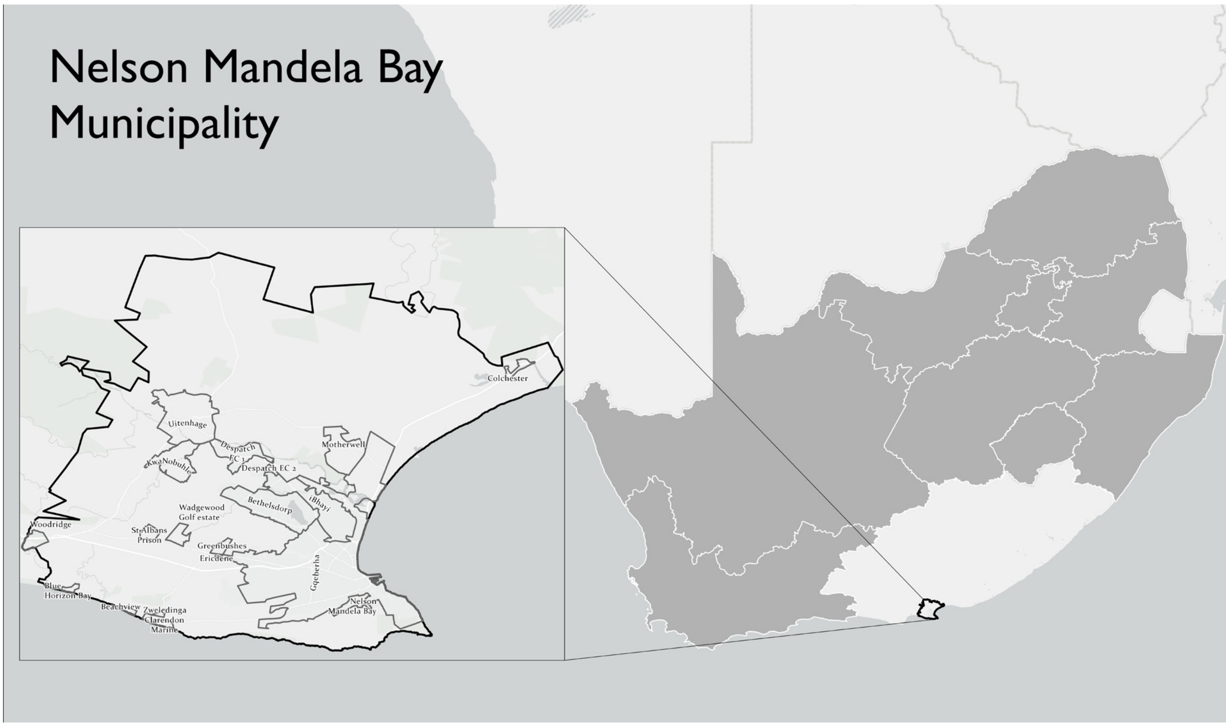
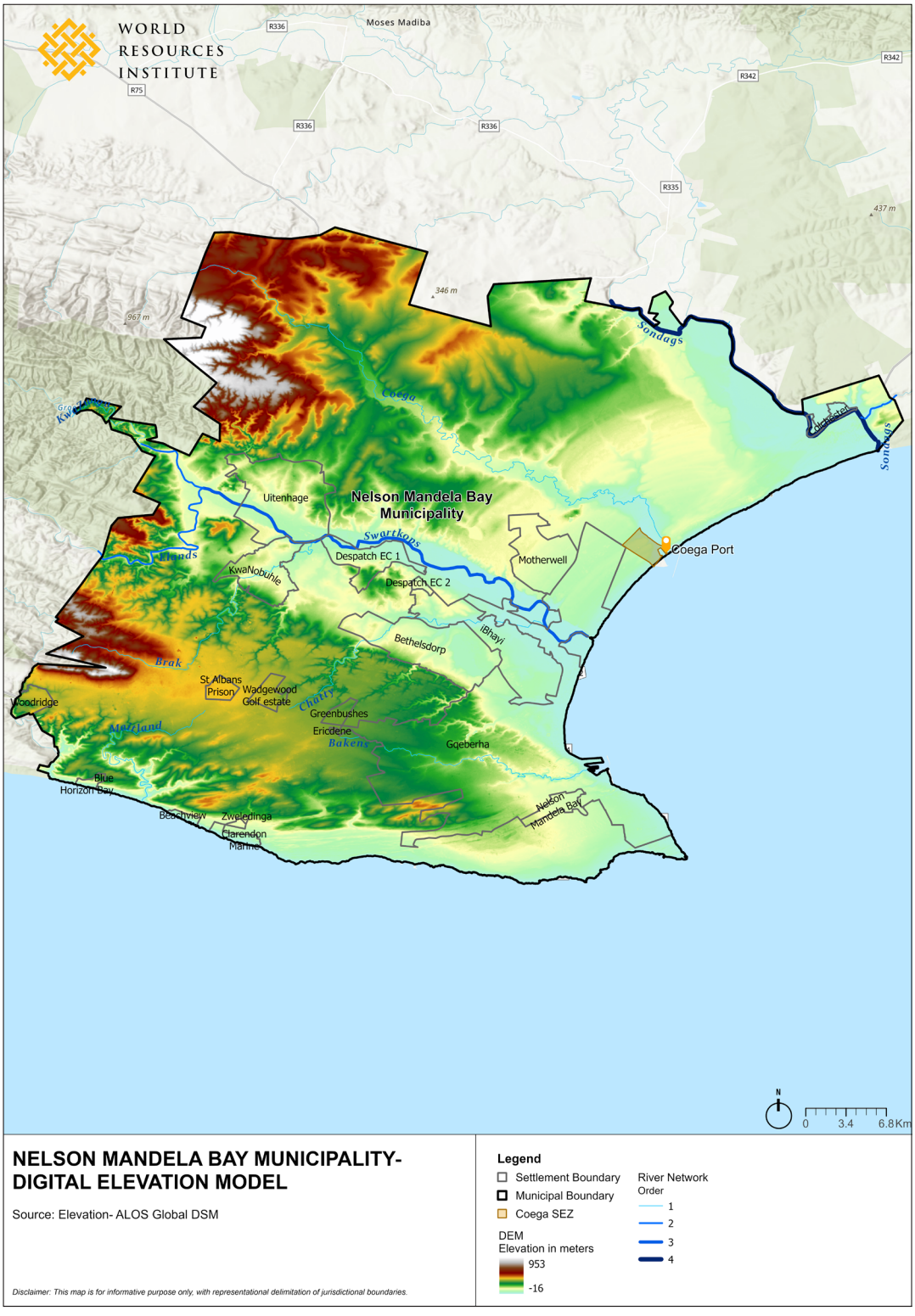


Figure 2-1.
Location of Gqeberha and NMBM

NMBM has a maximum elevation of 1,147m along its western boundary, and an average elevation of 142m (Figure 2-2). The main rivers that drain the area are the Sundays, Coega and Swartkops Rivers, with the others being minor rivers.

Roughly half of the municipality's water is derived from the Gariep Dam, situated some 200km north of the city at an elevation of 1,320m on the boundary between the Free State, Northern Cape and Eastern Cape provinces. The other half is derived from local catchments draining the Cape Fold Mountains that start at the western boundary of the municipality and stretch out parallel to the coast.

Figure 2-2
Elevation of the NMBM



2.2 REGIONAL AND HISTORICAL CONTEXT

When considering Gqeberha, it is important to understand the historical context of South Africa and the Eastern Cape Province. Gqeberha is the economic hotspot of the province, and while the city is developed, much of the Eastern Cape Province remains rural and has the lowest percentage access to basic services in the country (StatsSA, 2016). The province also has the highest unemployment rate (47% in comparison to the national average of 35%[3]) and lowest income per capital in South Africa (StatsSA, 2021).

Gqeberha was established in 1820 as a British settlement around Fort Frederick and was incorporated as a town in 1861. It was named by Sir Rufane Donkin, the acting governor of the Cape Colony, after his deceased wife Lady Elizabeth. One hundred years later, the apartheid South African government established legal racial segregation and started forced relocation of non-whites under the auspices of the Group Areas Act (1950). Under the Group Areas Act, much of what is now the Eastern Cape Province was designated as 'homeland' territory and included 2 of the 10 homelands, namely Transkei and Ciskei (Figure 2-3). Between 1960 and 1994 close to half a million black South African citizens were forcibly removed from their land in designated 'white areas' and moved to the homelands, where many then had to work as migrant labourers in the cities of South Africa, living in townships designated by the apartheid government. The homelands were additionally characterised by an inferior 'Bantu education', few local employment opportunities, poor living conditions and limited public services, such as water and electricity. Although it is now three decades since the end of Apartheid, the Eastern Cape Province and its urban and rural areas are still affected by the systemic impacts of the destructive Apartheid policies.

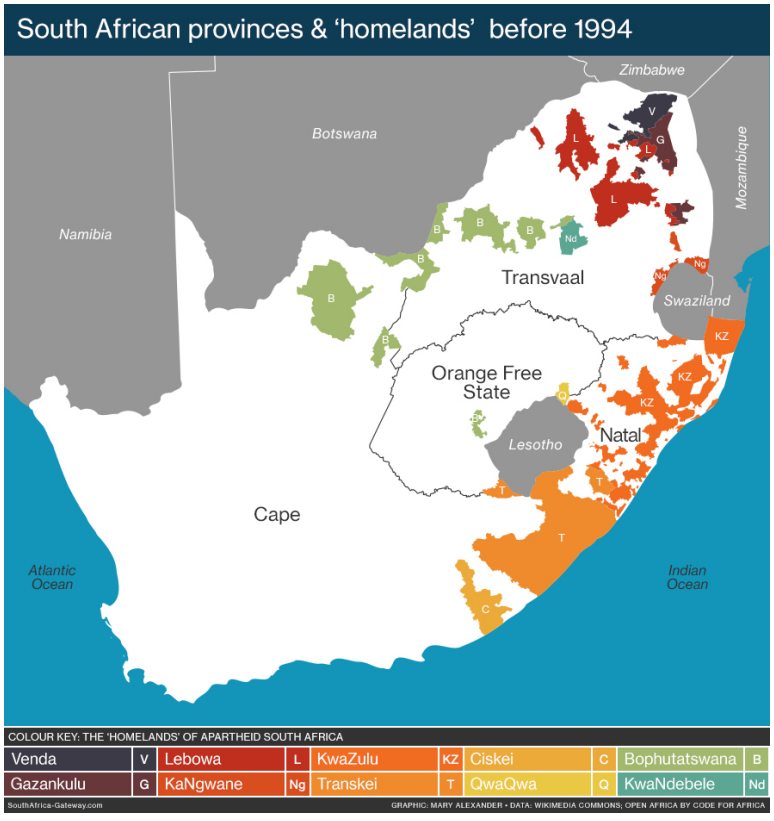


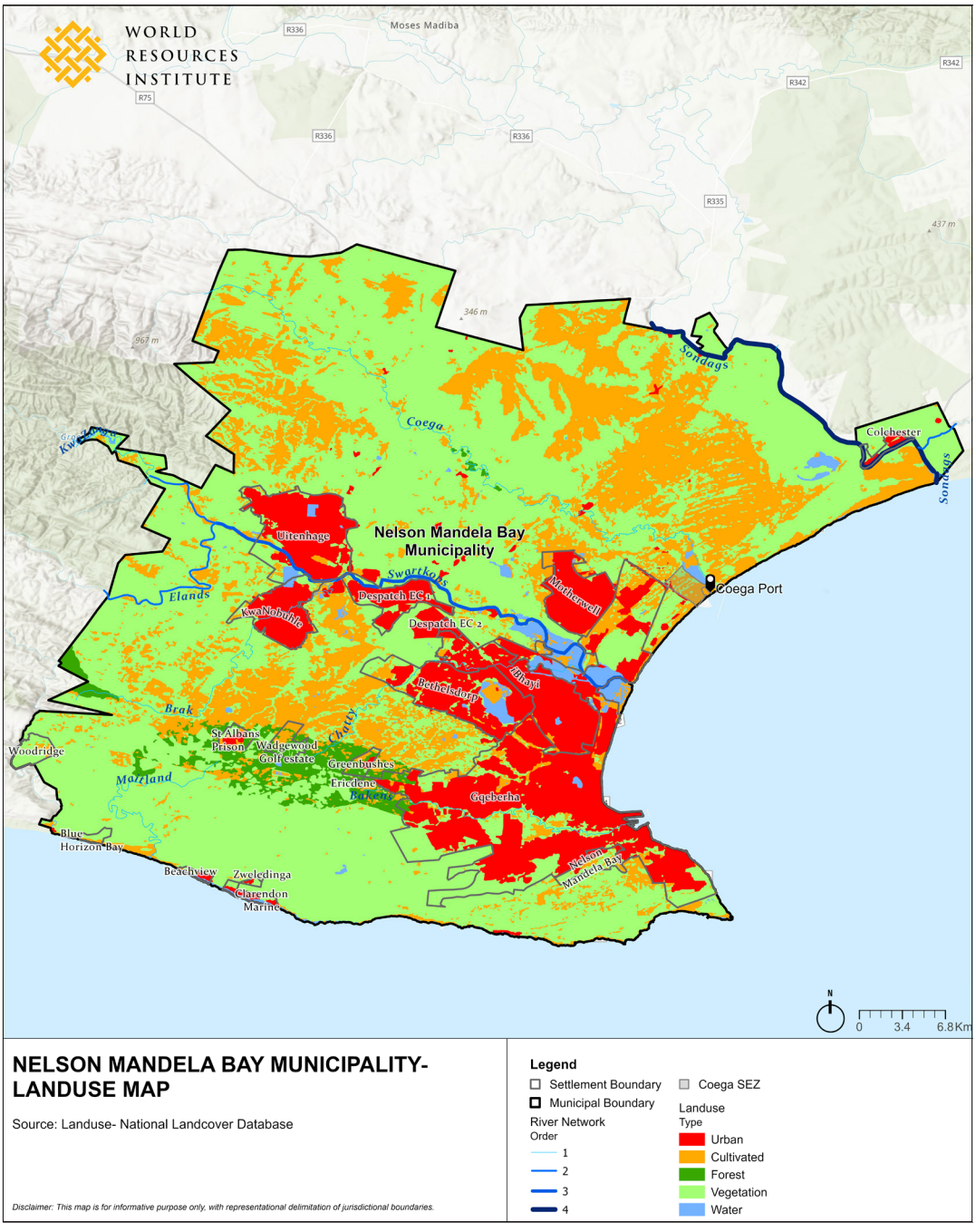
Figure 2-3.
South African Homelands prior to 1994[4]

(3) https://www.ecsecc.org/newsitem/eastern-cape-unemployment-rate-increases-by-03-per
(4) https://southafrica-info.com/land/nine-provinces-south-africa/attachment/map-of-south-african-provinces-and-homelands-before-1994/

2.3 LAND USE AND LAND COVER

The central and eastern parts of NMBM are largely developed for residential, commercial, and industrial purposes. The northern, western, and most southern parts of NMBM are rural in nature and are predominantly used for agriculture, low density residential and conservation purposes (Figure 2 4).

Figure 2-4. Land use map

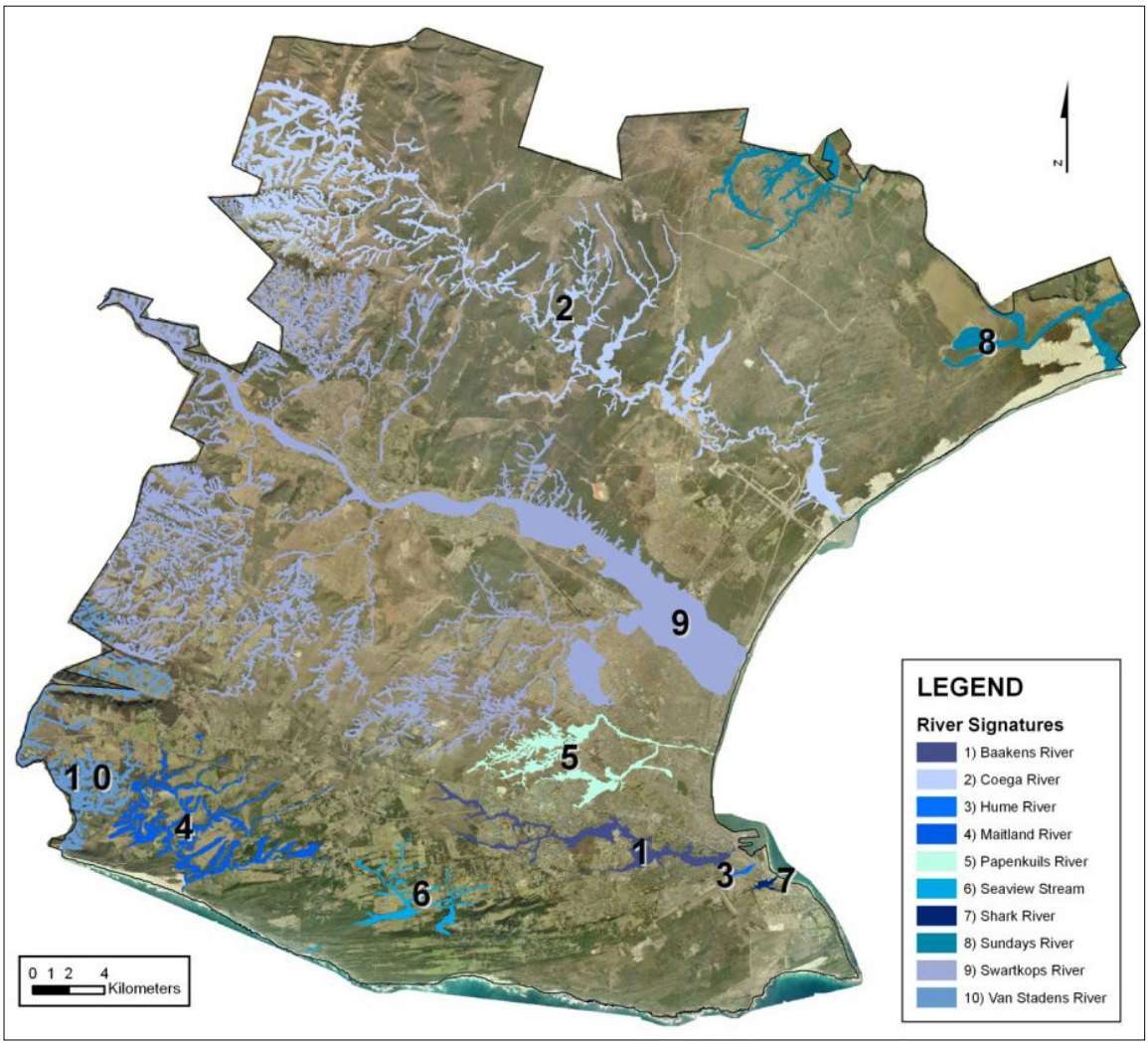


2.4 NATURAL ENVIRONMENT

Gqeberha and its surrounding settlements occur at the convergence of five of South Africa's seven biomes: namely the Fynbos, Subtropical Thicket, Forest, Nama Karoo and Grassland Biomes (Low & Rebelo, 1998). Such a concentration of biomes, particularly within the boundaries of an urban area, is unparalleled in the world. A total of 52 vegetation types are present in NMBM.

Four estuaries are found within NMBM (Figure 2 5), of which two are permanently open (Swartkops River and Sunday's River). A fifth estuary was present at the confluence of Papenskuil River with the sea, but this has been canalised for decades. Permanent and seasonal wetlands are found in depressions throughout the coastal zones. The coastal zone is home to an immense abundance of coastal and marine fauna and flora. This diversity is facilitated by Nelson Mandela Bay's transition zone between the cool Benguela current in the west and the warm Agulhas current in the east.

Figure 2-5.
River and wetland systems (SRK Consulting, 2010)



In addition to indigenous flora, NMBM has a high density of Invasive Alien Plants (IAPs). IAPs spread quickly and invade grasslands and riparian areas, preventing little else from growing. They are a big problem in many South African catchments and drain approximately 8.7% of the registered water use in NMBM (Cullis, et al., 2007). IAPs are particularly prevalent in the south of the NMBM, placing pressure on critical local catchments (Figure 2 6).

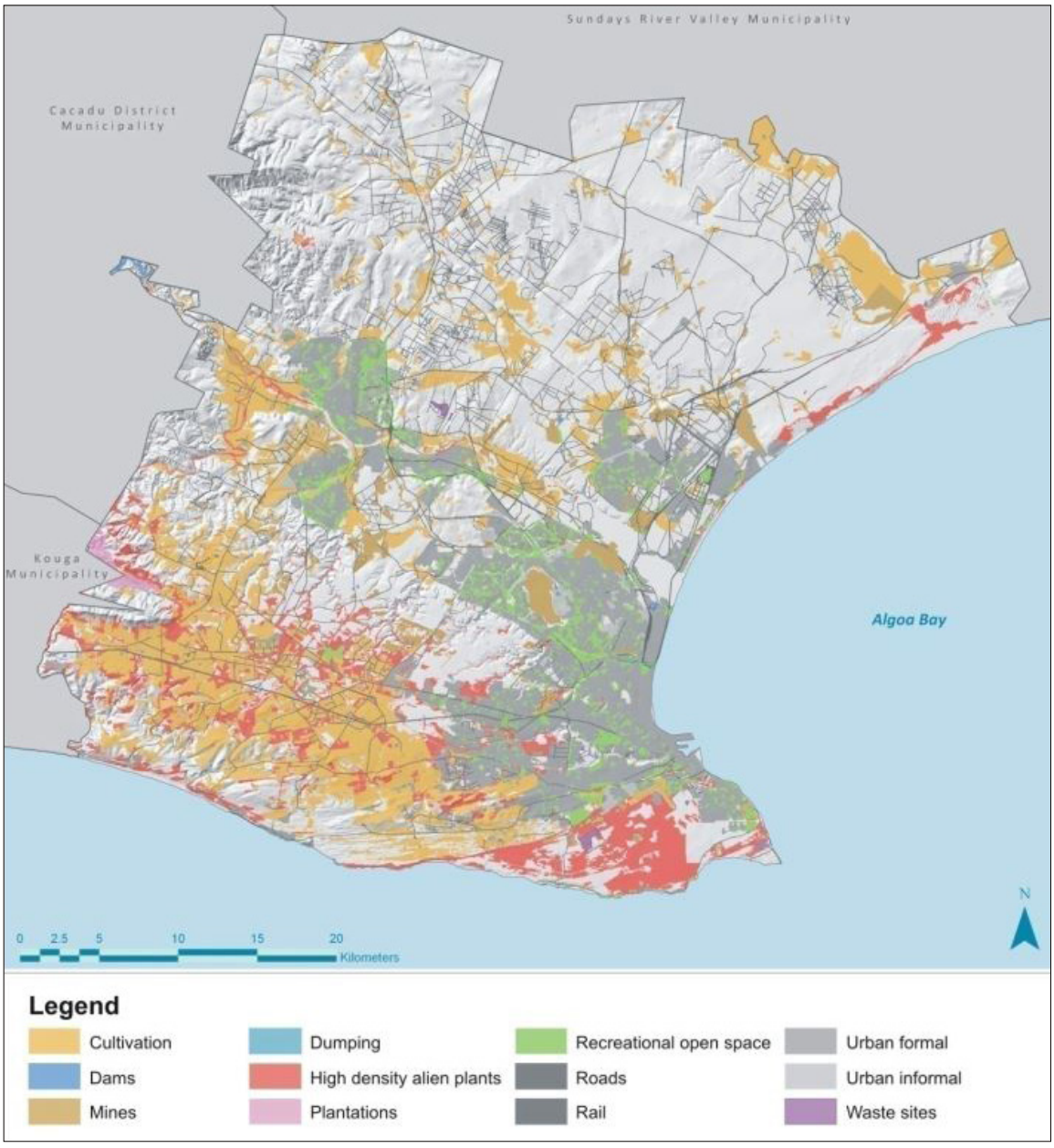
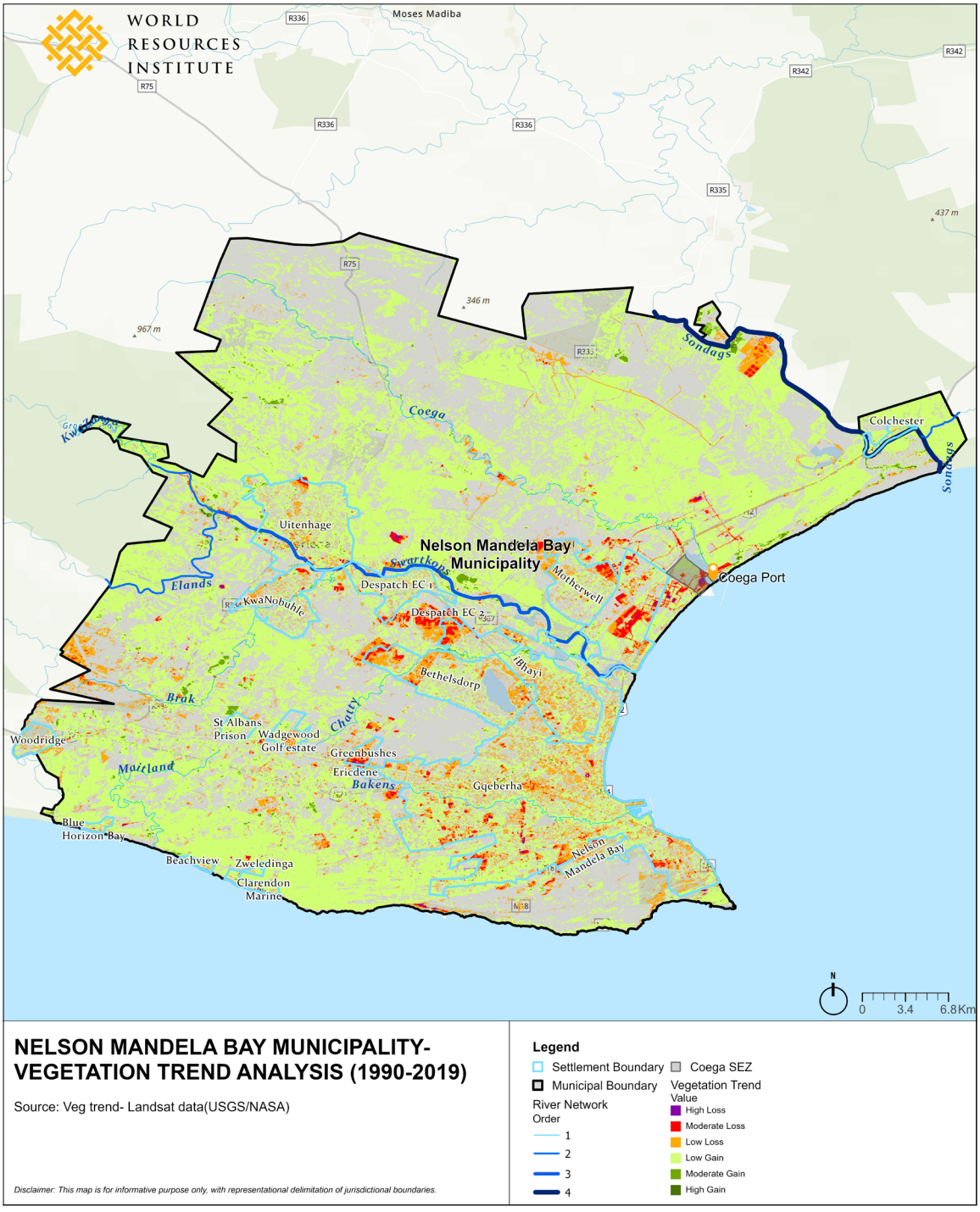


Figure 2-6.
Land-use and vegetation types (SRK Consulting, 2010)

Much of the greater NMBM has experienced a low gain in vegetation cover since 1990, partly due to the spread of IAPs (Figure 2 7). The areas of the municipality which show significant loss of vegetation cover correlate with high population growth settlements, namely Gqeberha, Bethelsdorp, Despath and Coega Special Economic Zone (further discussed in Section 2.6).

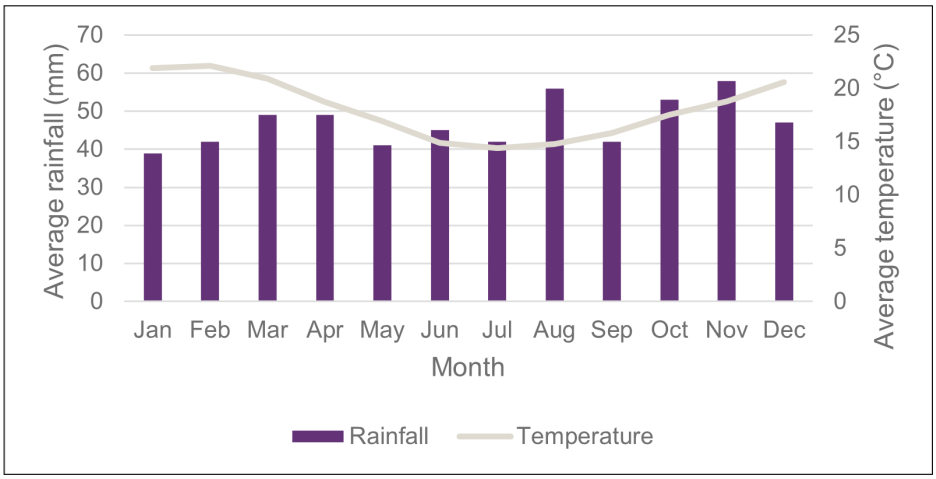
Figure 2-7. *Vegetation trend analysis*



2.5 CLIMATE

Gqeberha's climate is moderate, with maximum average daily temperatures of 22°C in January and February and minimum average daily temperatures of 14°C in July and August. The average annual rainfall is 550 mm (Figure 2 8).

Figure 2-8. *Average monthly rainfall and temperature*



There is significant interannual variability for rainfall in Gqeberha and the region has been experiencing below average annual rainfall since 2015 (Figure 2-9). This has resulted in a seven-year drought, reduced streamflow, and declining local dam levels (Figure 2-10) and is a significant contributing factor to NMBM's current water security challenges.

The local climate is influenced by its location relative to the coast and the topography of the surrounding mountain ranges. It sits in the transition zone between a semi-arid climate in the west (with lower annual rainfall all year around) and a temperate oceanic climate in the east (with higher annual rainfall in the summer months) (Figure 3 2). The higher rainfall regions are found to the east of NMBM and along the coast to the west of the NMBM.

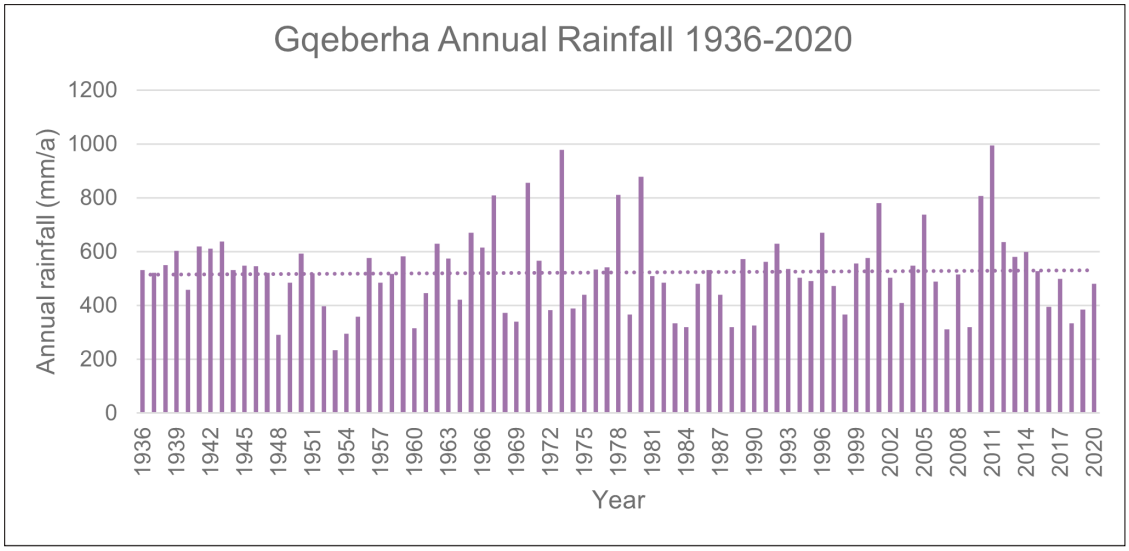


Figure 2-9.
Annual rainfall from 1936 to 2020

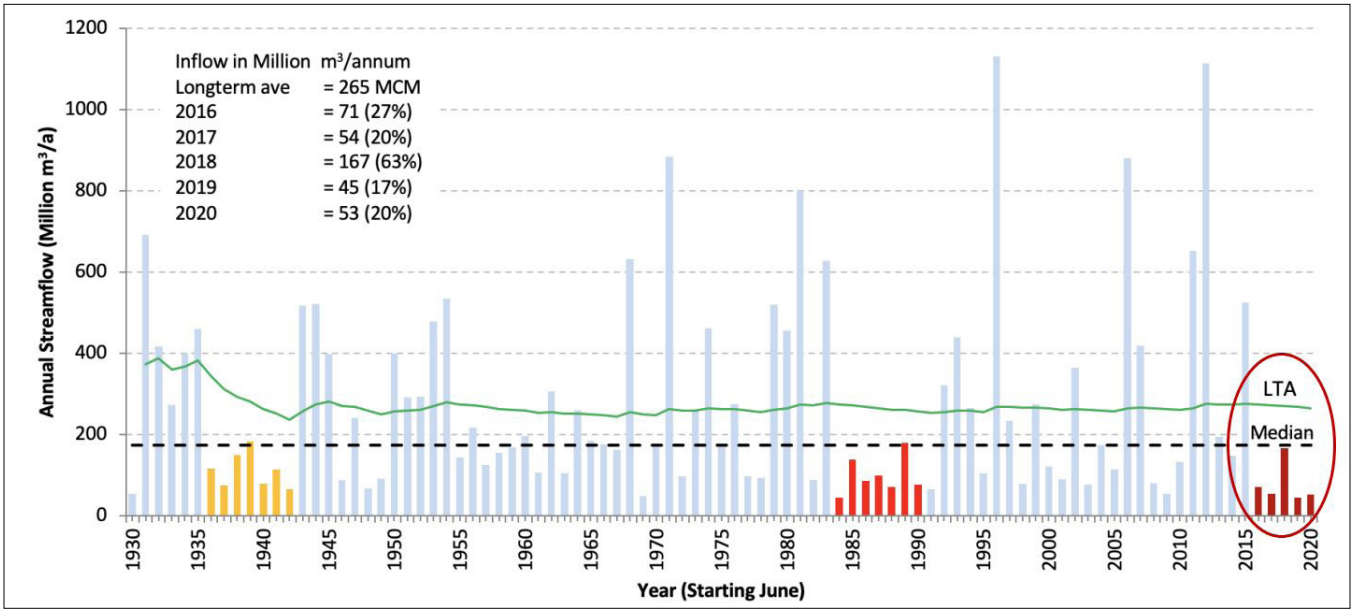
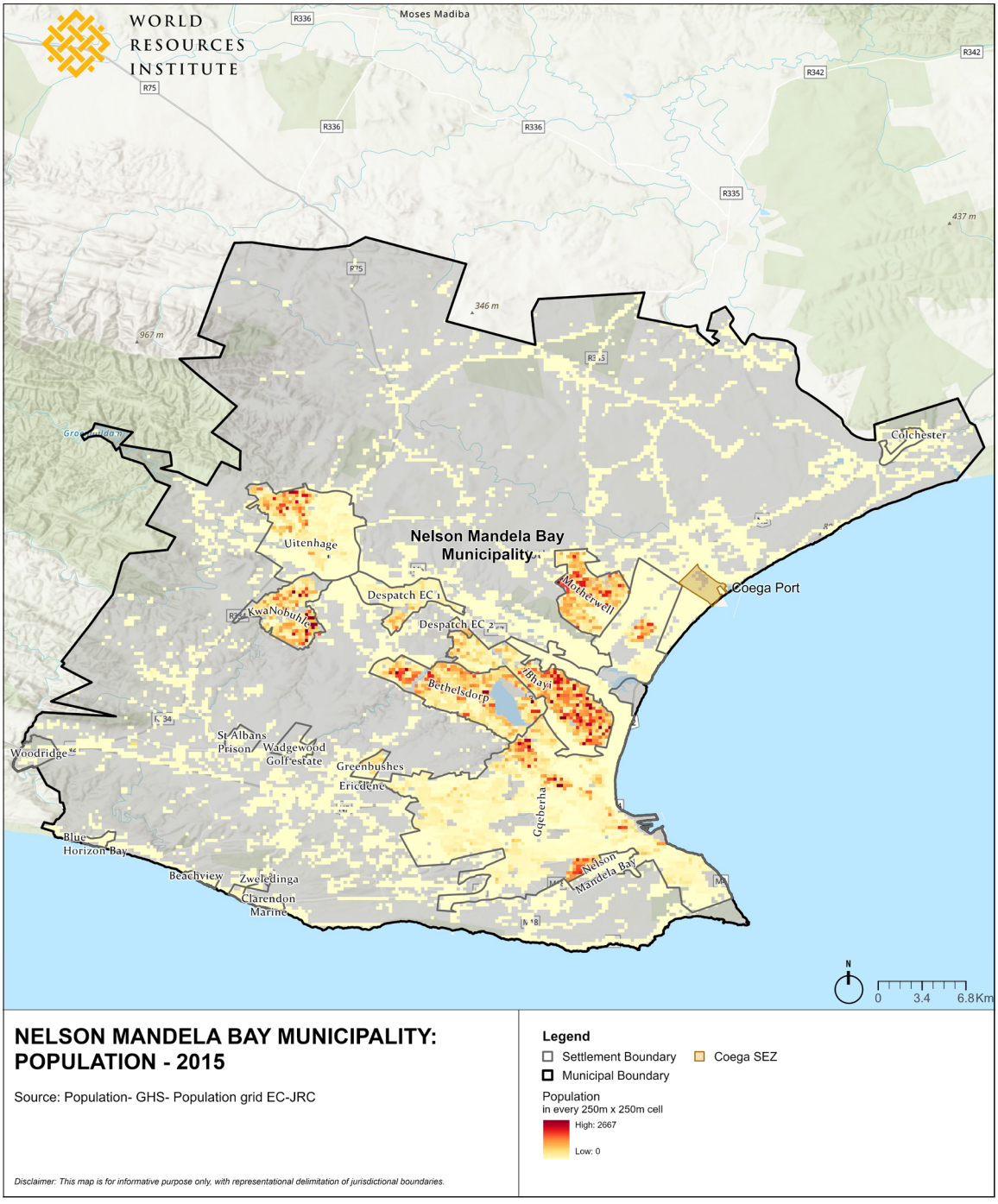


Figure 2-10.
Annual streamflow in local dams from 1930 to 2020 (NMBM, 2022b)

2.6 POPULATION DENSITY

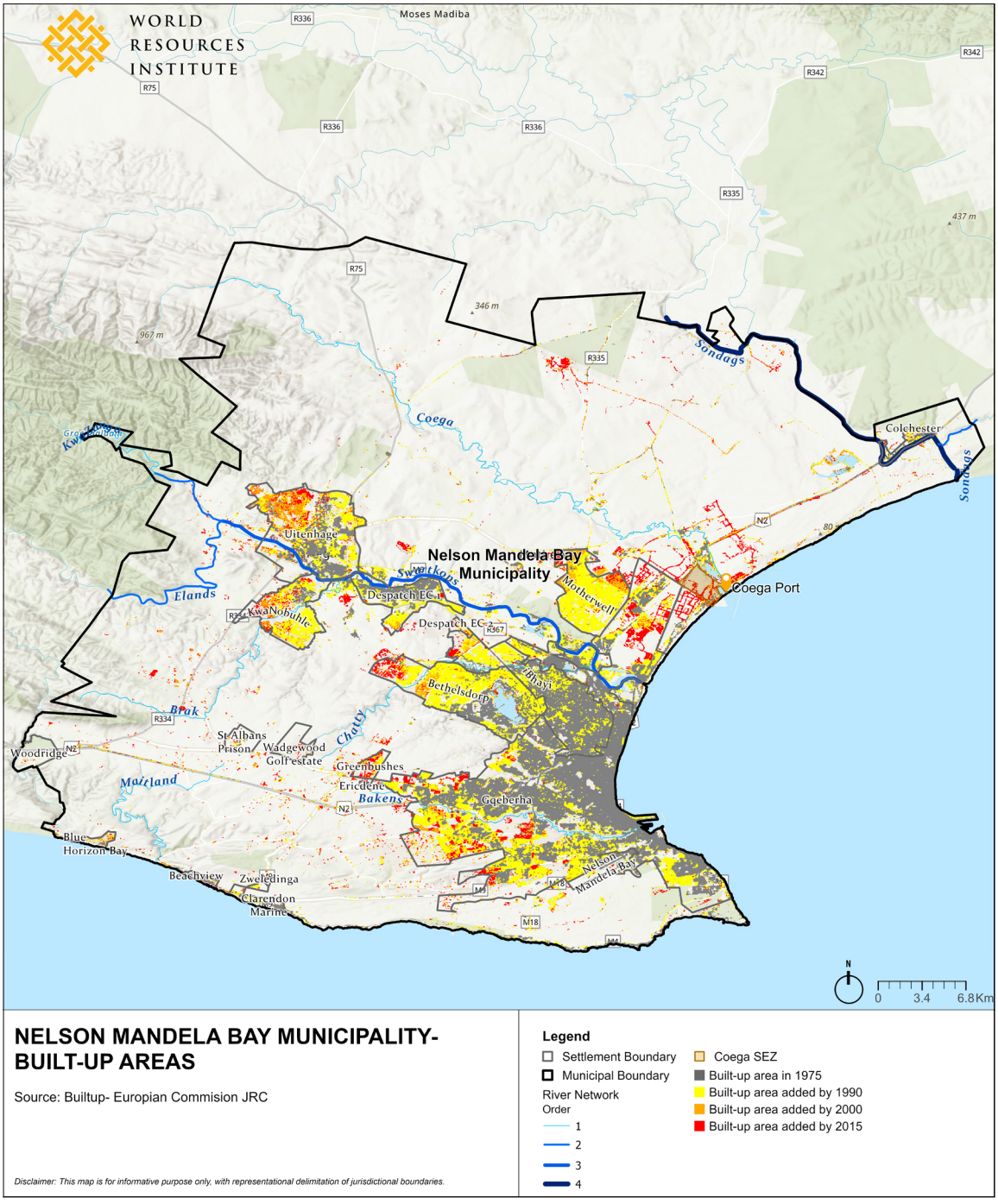
The NMBM has a population of 1.27 million people (NMBM, 2021b), housing approximately 2.1% of South Africa's total population (60.14 million) (StatsSA, 2021). The population density is greatest in KwaNobuhle, northern Kariega (previously Uitenhage), Motherwell, iBhayi, Bethelsdorp, and parts of Gqeberha (Figure 2-11).

Figure 2-11. *Population density*



High population density corresponds spatially with the built up areas that developed after 1990 (Figure 2 12) which are often also informal settlements (Figure 2 20). This highlights the strong correlation between urbanisation, urban sprawl, population density and socio-economic conditions in the city.

Figure 2-12.
Built up areas (1975-2015)



2.7 DEMOGRAPHICS (COGTA, 2020B)

The municipality has approximately 19% of the Population of the Eastern Cape Province.

Population growth rate	The average pre-COVID population growth rate was **1.36% per annum** (Figure 2 13) – which is lower than the 1.61% growth rate for the whole of South Africa. The NMBM growth rate in population is expected to be between **1.1% and 1.49% per annum** for the next 25 years.
Largest age group	The NMBM largest age group is between **25 and 29**, and it has a significantly larger share of young working age people (20 – 34) compared to the national picture (Figure 2-14).
Migration	NMBM appears to be a migrant receiving area, with many of people migrating into NMBM, either from abroad, or from the more rural areas in the country, mainly the Eastern Cape Province, looking for better opportunities.
Gender	In terms of gender, NMBM has slightly more **females (51%)** compared to **males (49%)**.
Household head	42% of households in NMBM are headed by women. This is on par with the national average of 41%, but lower than the average of 80% for the Eastern Cape Province as a whole.
Race	The population race is dominantly **Black Africans (60%)**, followed by Coloured (24%), then White (15%) and Indian or Asian (1%).
Language	The predominant languages spoken are **isiXhosa (54%)**, Afrikaans (30%) and English (13%).
Religion	The largest religious groupings are **Christian (89.4% of residents)**, no religion (6.1%), Muslim (1.5%), Jewish (0.4%) and Hindu (0.3%).

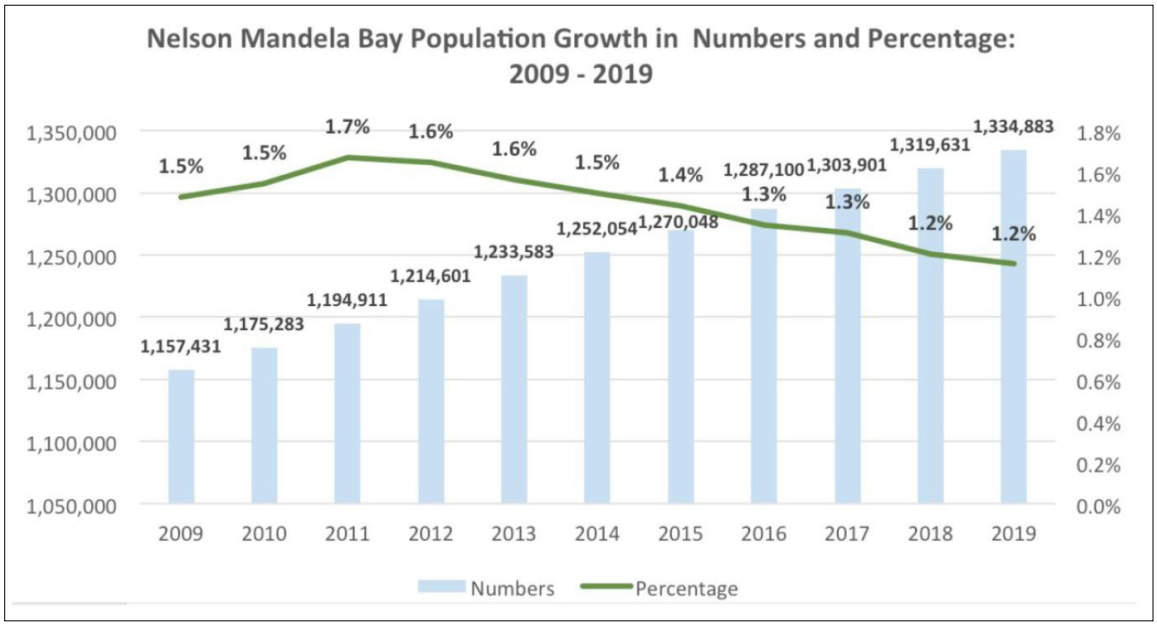


Figure 2-13. *Historical Population Growth (COGTA, 2020b)*

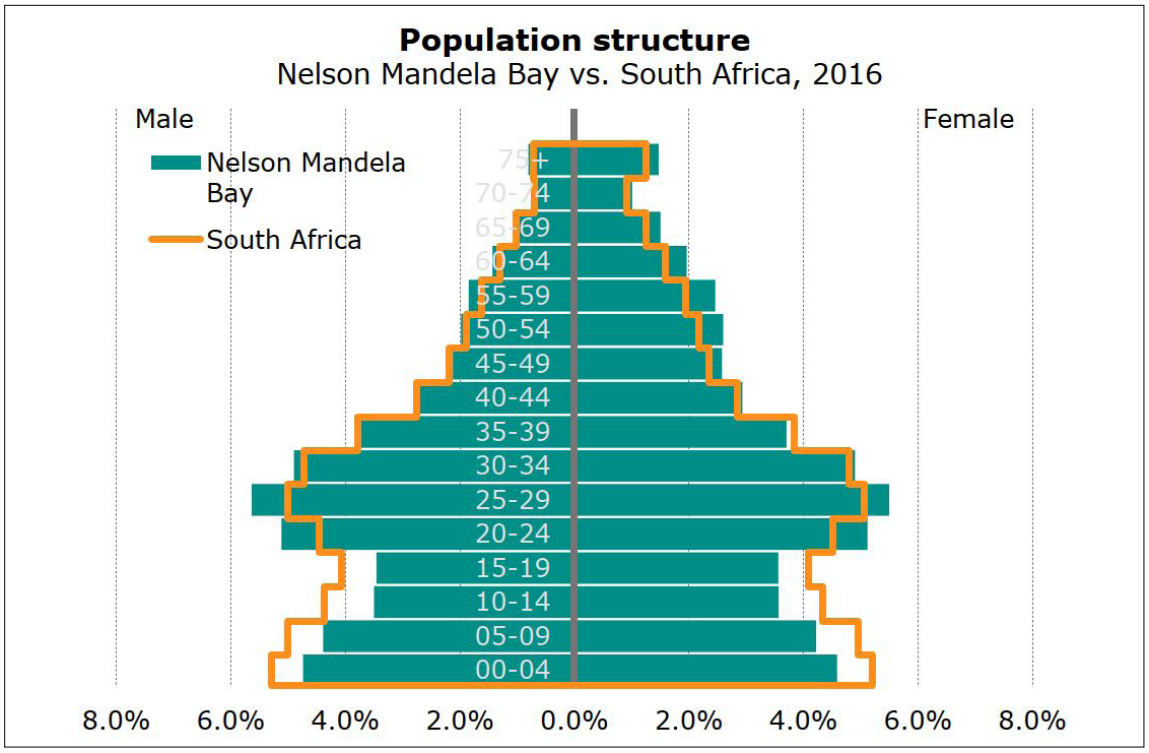


Figure 2-14. *Population pyramid of NMBM versus South Africa in 2016 (ECSECC, 2017)*

2.8 ECONOMIC CONTEXT

Gqeberha, as well as entire NMBM ,is a significant contributor to both the national and provincial economies. It is the main economic hub of the Eastern Cape Province, and its proximity to industries, export agriculture areas and the Coega Deep Water Harbour makes it a prime area for economic development. It is also the centre of the country's motor vehicle manufacturing industry and boasts a multibillion-dollar industrial development complex, the Coega Special Economic Zone (SEZ), customised for heavy, medium and light industries. The Coega SEZ is not operating at its full capacity due to water and energy constraints that will be further discussed in Section 4.2.1.1.

The Nelson Mandela Business Chamber focuses on the following catalytic economic sectors that are key to the trade and investment strategy of Nelson Mandela Bay: Agro-processing, Automotive, Creative industry, Light manufacturing, Maritime/Ocean economy, Oil, Gas, Tourism and Hospitality (NMBM, 2021a. These sectors were also identified as ones where the Municipality could influence growth and development. Their growth would not only benefit the economy but also provide an opportunity for inclusive growth in the municipality through employment opportunities.

The Nelson Mandela Bay Business Chamber is a non-profit organisation representative of a broad spectrum of businesses in Nelson Mandela Bay. The Chamber is particularly interested in building water resilience and has recently established a business coalition to positively impact the metropole's response to its projected climate change challenges, highlighting the impact that extreme storm surges, rising sea level and temperature increases will have on NMBM. Following the outcome of this, the Eastern Cape Climate Change Coalition was established and includes the CEOs of key local industries such as Volkswagen and Coca-Cola. An assessment on the impact of climate change on businesses in NMBM has been completed and will further be discussed under Section 4.

The economy of the NMBM is well diversified (Figure 2 15), and the key industries are as follows:

- **Community, social & personal services (25% GVA, 25% employment):** This includes public administration, educational services, health and social work, and sporting and recreational activities, among others. NMBM is a cental point for many of these services in the Eastern Cape.
- **Finance, real estate & business services (21% GVA, 16% employment):** This comprises the second largest economic sector in NMBM due to its position as the economic capital of the Eastern Cape Province.
- **Manufacturing (21% GVA, 16% employment):** NMBM has the most advanced infrastructure in the Eastern Cape Province including the deep Port of Ngqura and other trading platforms which assist in its economic performance. The automotive industry is the largest manufacturing sector in South Africa's economy and about 35% of the South African automotive components industry is located in the Nelson Mandela Bay area, including General Motors SA, Volkswagen, the Ford Engine Plant and First Automotive Works among others.
- **Trade and hospitality (17% GVA, 23% employment):** Tourism is an important economic sector in NMBM, employing 23% of the working force in 2020/21. This sector was hit by the impacts of Covid-19 and has shown a gradual decline since 2019. The tourism sector is largely driven by the natural beauty of Gqeberha, however environmental degradation and the impacts of climate change could impact this.

- **Transport, storage & communications (11% GVA, 7% employment):** One of the city's unique advantages is possessing two ports, namely Port Elizabeth Harbour and Ngqura. This gives the municipality a very large comparative advantage in the manufacturing sector and particularly, the transport sector from a value add perspective and trade.
- **Construction (3% GVA, 8% employment):** Although not a major contributer to the GVA of NMBM, the manufacturing sector does employ a significant percentage of the work force due to the labour-intensive nature of the industry. The construction industry is key for creating jobs in the country's post-COVID economic plan[5].

Like other cities in Africa, Gqeberha has a large informal economy and 37% of the population is employed in the informal sector (COGTA, 2020b). The informal economy includes[6]

- People working in informal sector entities such as small corner shops or hair salons.
- Informal employees in formal firms or private households.
- Self-employed workers in activities such as street trading or waste collection but are not registered for tax or VAT and do not employ others.

Individuals working in the informal economy do not have access to social protection or job security, making them extremely vulnerable to climate-related risks.

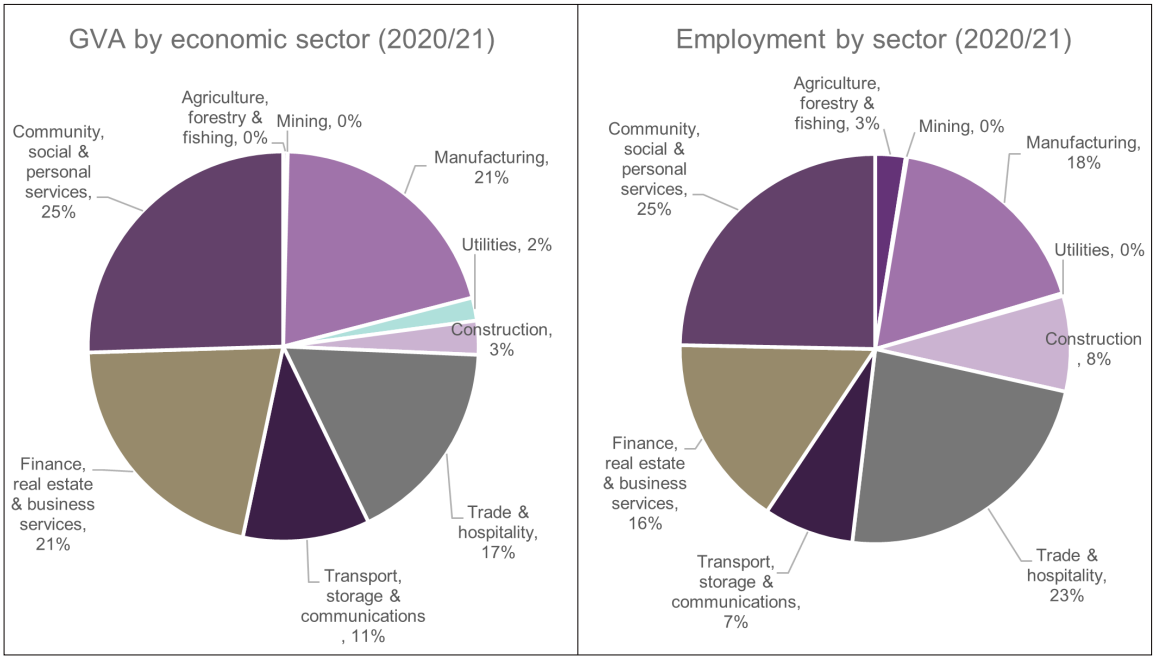


Figure 2-15. *Population pyramid of NMBM versus South Africa in 2016 (ECSECC, 2017)*

(5) https://www.engineeringnews.co.za/article/construction-industry-holds-key-role-in-economic-recovery-2021-11-10
(6) https://theconversation.com/informal-economies-are-diverse-south-african-policies-need-to-recognise-this-104586

2.9 ACCESS TO BASIC SERVICES

Most municipalities in South Africa struggle to provide and maintain basic services, despite the significant gains made since the end of Apartheid. NMBM has the highest levels of access to basic services in the Eastern Cape Province and is comparable to other major cities in South Africa:

- **Access to basic electricity in NMBM is 98.6%,** with an infrastructure quality index[7] of 4.9. This was the highest national score, followed by Cape Town and Johannesburg.
- **Access to basic water supply in NMBM is 97.7%**, with an infrastructure quality index of 4.7.
- **Access to basic sanitation in NMBM is 97.1%**, with an infrastructure quality index 4.79.
- **Access to weekly soild waste removal in NMBM is 88.3%**, infrastructure quality index 4.64%, second only to Cape Town.

Figure 2-16.
Residents fetch water from a truck in KwaNobuhle, Gqeberha (September 2020)[10], Photo: Thamsanqa Mbovane

Except for communities occupying private land illegally, all informal settlements receive water through standpipes and water tanks (NMBM, 2021b) (Figure 2 16). The effects of the drought and impacts of the COVID-19 pandemic have been detrimental to the improved provision of water and sanitation, particularly to the most vulnerable residents in the City. Several water storage tanks and water tankers serve the most critical parts of the city affected by the drought. However, multiple complaints remain about empty water tanks in the informal areas of the City[8]. In this regard, the provision of water in most areas of the city where water outages occur frequently receive priority attention through daily troubleshooting. A number of water storage tanks and water tankers have been made available to ensure a continuous supply of water, particularly in the most vulnerable parts of the city, however multiple complaints remain about empty water tanks in the informal areas of the city[9].

Basic sanitation services are supplied through waterborne sanitation to households and communal sites, as well as chemical toilets and pit latrines in informal settlements. Approximately 5,756 buckets[11] were in circulation in informal settlements as a means of sanitation in 2019, and these are a key focus in the NMBM Bucket Eradication Programme. Despite the provision of basic sanitation services, some residents still opt to use the bucket system due to safety concerns at communal flush toilets which are also often poor quality and prone to vandalism (Figure 2-17).

Nearly 90% of residents in Gqeberha have access to weekly solid waste removal. However, this service is concentrated in formal areas and is not equally distributed across the city. Similar to water supply and sanitation, residents in informal settlements often have limited access to solid waste removal services (Figure 2-18).

Figure 2-17. *Communal flush toilets in Kliprand informal settlement. Residents have opted for the bucket system instead of communal toilets because of safety concerns. Photo: Mkhuseli Sizani.*[12]

Figure 2-18.
A resident of Powerline informal settlement in Motherwell, Gqeberha (November 2021)[13], Photo: Joseph Chirume

(7) The infrastructure quality index is used to describe the available engineering services infrastructure with reference to the available level of service
(8) https://www.groundup.org.za/article/overflowing-toilets-piles-rubbish-and-empty-water-tanks-plague-gqeberha-shack-dwellers/
(9) https://www.groundup.org.za/article/overflowing-toilets-piles-rubbish-and-empty-water-tanks-plague-gqeberha-shack-dwellers/
(10) https://www.groundup.org.za/article/day-zero-water-stricken-mandela-bay/
(11) A bucket toilet is a basic form of a dry toilet whereby a bucket (pail) is used to collect faeces and urine. The bucket may be situated inside a dwelling, or in a nearby outhouse. The term "bucket toilet" or "bucket system" is nowadays very much stigmatised and politically charged in South Africa, and protests against bucket toilets are still occurring. The waste from bucket toilets is often disposed of directly into nearby water courses without prior treatment, resulting in significant environmental impacts.
(12) https://www.groundup.org.za/article/not-safe-go-toilet-port-elizabeth/
(13) https://www.groundup.org.za/article/overflowing-toilets-piles-rubbish-and-empty-water-tanks-plague-gqeberha-shack-dwellers/

2.10 HOUSING

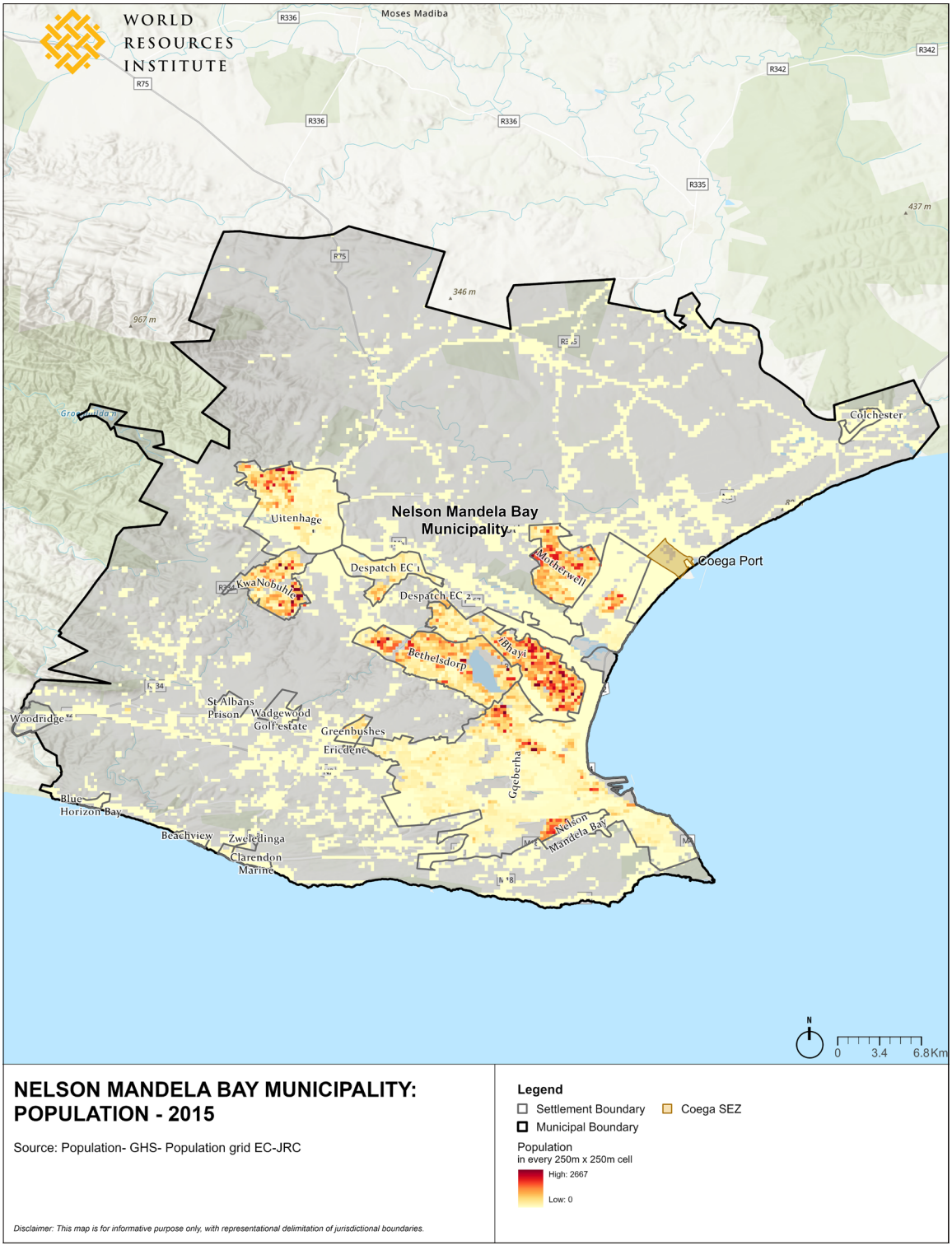
The Eastern Cape Province has the highest percentage of indigent household in the country (44%). Within the Eastern Cape Province, NMBM has one of the highest numbers of indigent households (112,419)[14]. Indigent households qualify for free basic services including water, electricity, and housing. However, housing backlogs have led to extensive waiting periods for free government housing as the government has not been able to keep up with the demand. The outcome of this is the growth of informal settlements in and around South Africa's townships. Currently 6.9% of the households in NMBM live in makeshift settlements or shacks (COGTA, 2020a) (Figure 2-19).

The term 'township' is typically given to underdeveloped, formerly racially segregated urban areas for non-white citizens that were developed under the Apartheid regime. Townships often have neighbouring informal settlements. SOS, KwaNobuhle, Motherwell, and Ibhayi are the largest townships in Gqeberha and contain several fragmented informal settlements, such as the Powerline informal settlement in Motherwell (Figure 2-20). Townships are typically associated with poor service delivery, inadequate housing and low economic development.

(14) https://www.statssa.gov.za/?p=11722
(15) https://www.iol.co.za/the-star/opinion-analysis/give-people-dignity-by-bettering-their-lives-with-service-delivery-not-changing-their-towns-name-f482f91e-227b-468a-86db-0b085ef20e2f

Figure 2-19. *A woman at her makeshift home in an informal settlement in Gqeberha[15]. Photo: Obed Zilwa/ AP*

Figure 2-20.
Housing typology



2.11 POVERTY AND INEQUALITY

A challenge for NMBM is the high levels of unemployment, despite a large economic sector. The 2011 Census indicated that the unemployment rate in the NMBM was 37%[16], but this has since increased to 47% following the economic impacts of COVID-19. The highest levels of unemployment are among the youth. The high level of unemployment stems from systematic inequalities from the Apartheid era. It is exacerbated by a lack of service delivery and infrastructure, poor education and limited economic opportunities which all create a weak enabling environment for attracting investment opportunities to the area. NMBM is a highly unequal society and has a Gini Coefficient of 0.63 which is higher than the Easter Cape Province at 0.62 (COGTA, 2020b). The poverty rate has been steadily increasing at an average of 1.51% per annum between 2006 and 2016 (Figure 2-21).

(16) https://www.statssa.gov.za/?page_id=1021&id=nelson-mandela-bay-municipality

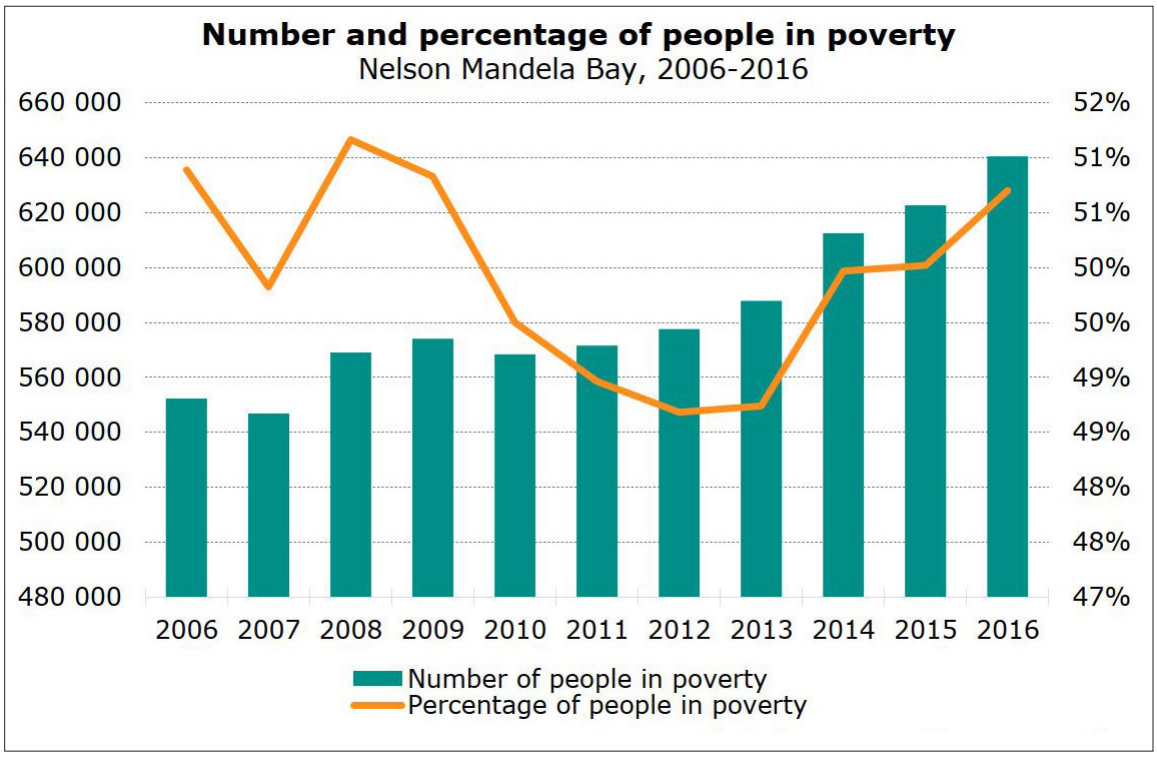


Figure 2-21. *Number and percentage of people living in poverty in Nelson Mandela Bay (2006 – 2016) (ECSECC, 2017)*

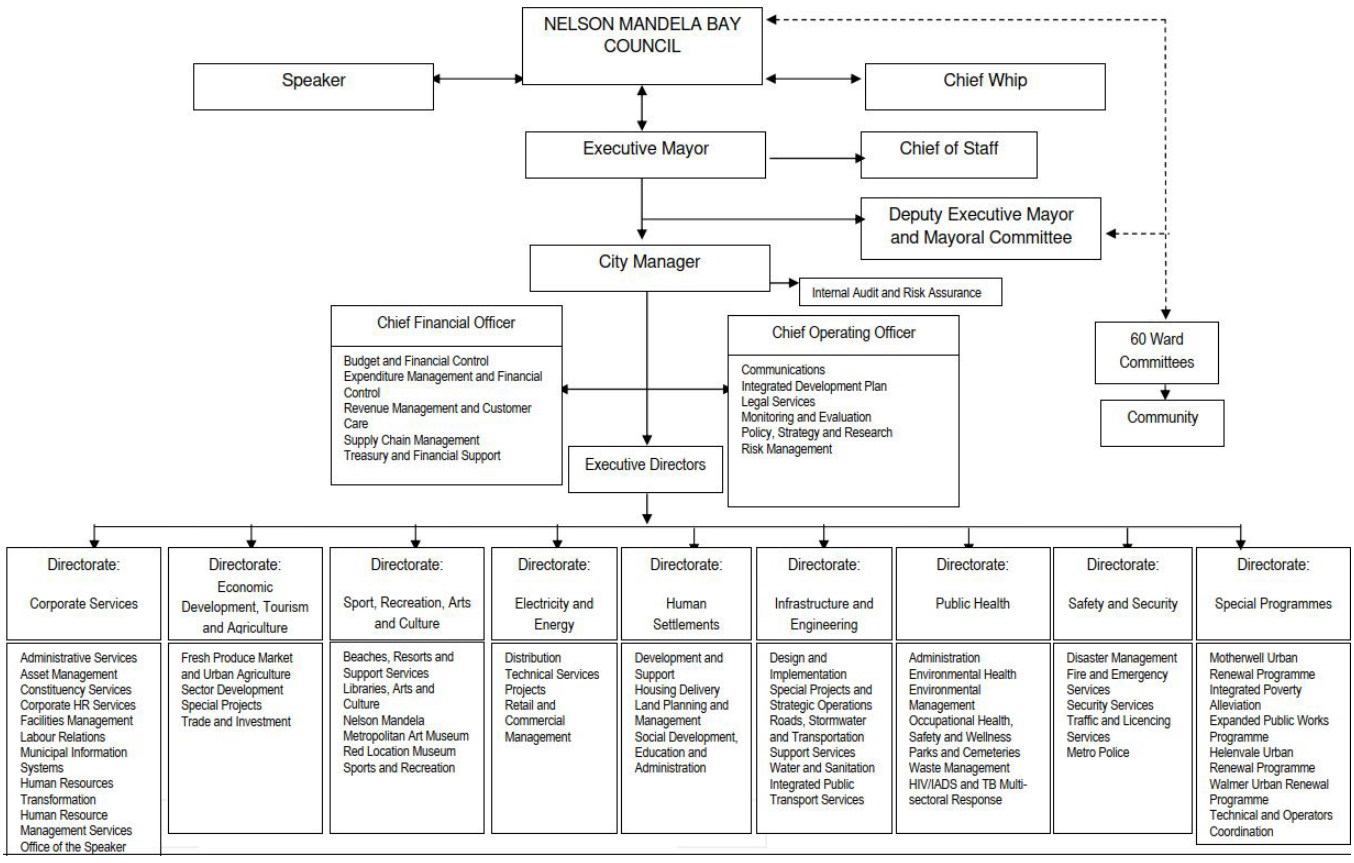
2.12 GOVERNANCE

The Republic of South Africa (RSA) is a constitutional democracy with an independent judiciary and a three-tier governance system; the national, provincial, and local levels defined as distinctive, interdependent and interrelated that have legislative and executive authority in their own spheres. The Eastern Cape Provincial Government is the provincial government that operates in the Eastern Cape region with NMBM as the metropolitan municipality. The organisational structure is shown in Figure 2-22.

The NMBM facilitates the provision of the following basic services to its citizens:

- Integrated human settlements
- Water and sanitation services
- Electricity services
- Waste management services
- Stormwater drainage
- Roads
- Public transport

Figure 2-22.
Organisational structure of NMBM (NMBM, 2021a)



Port Elizabeth, Eastern Cape, Photo: flowcomm/flickr.com

3

UNDERSTANDING GQEBERHA'S WATER SUPPLY SYSTEM

3.1 OVERVIEW OF THE WATER SUPPLY SYSTEM

The primary water source for Gqeberha is the Algoa Water Supply System (AWSS) (Figure 3-2) which supplies water to the NMBM and several smaller towns in the neighbouring municipality, Kouga Local Municipality, for urban, agricultural, and industrial use. The AWSS is owned and manged by the national Department of Water and Sanitation (DWS) with several stakeholders including Nelson Mandela Bay Municipality (NMBM), other smaller municipalities, the Gamtoos Irrigation Board (GIB), and the Lower Sundays River Water User Association (LSRWUA), which are members of the AWSS steering committee chaired by DWS.

The AWSS is sub-divided into the Western-, Eastern- and Central- Sub-systems (Figure 3-1):

- **The Eastern Sub-system** consists of an inter-basin transfer scheme from the Gariep Dam on the Orange River via the Fish and Sundays Rivers to the east.
- **The Western Sub-system** has two major dams (Impofu and Kouga Dams) and their associated supply dams (Churchhill and Loerie).
- **The Central Sun-system** consists of several smaller dams (including the Sand, Bulk and Groendal Dams), and a spring and boreholes situated near to Gqeberha.

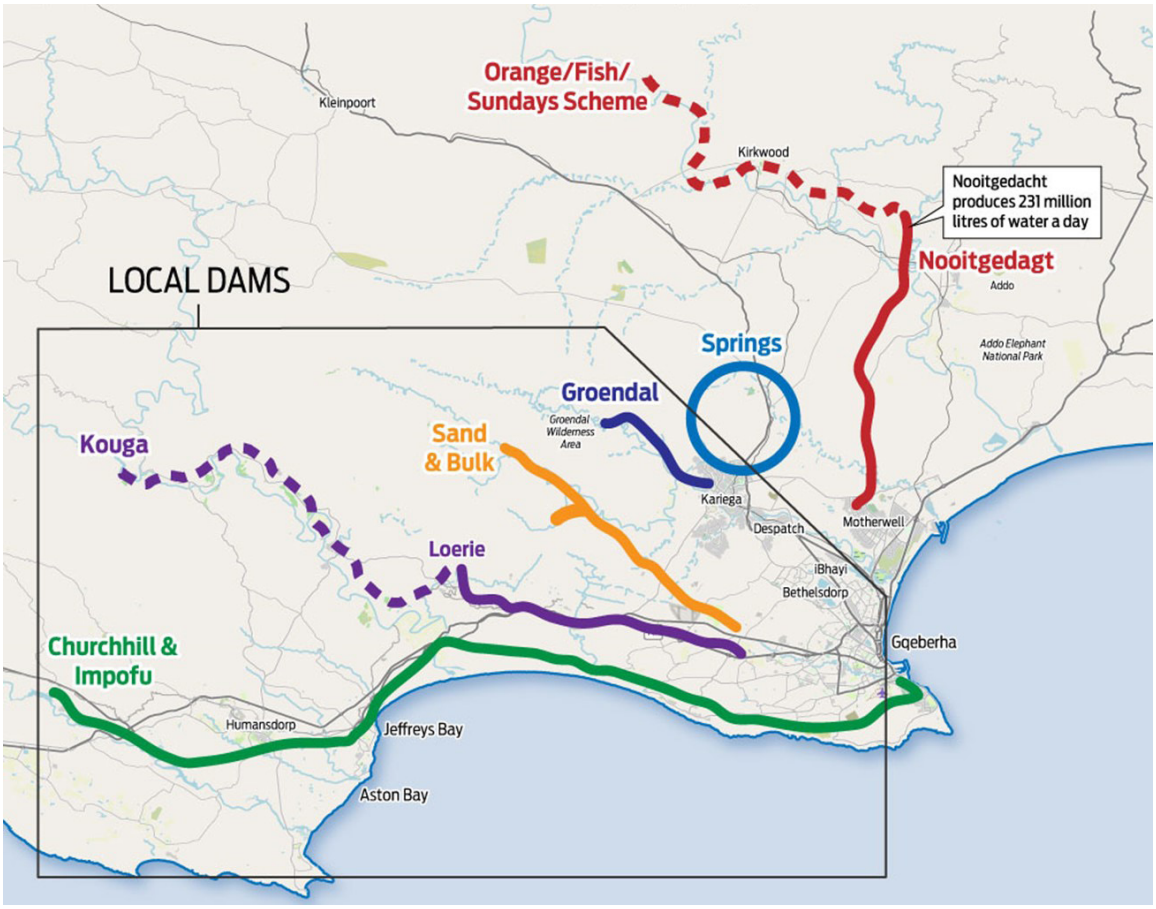


Figure 3-1. *Overview of the Algoa Water Supply System (AWSS) (source: NMBM)*

The Eastern Sub-System meets approaximately 52% of NMBM's water demand and abstracts water from the Gariep Dam, South Africa's largest dam that receives water from the Lesotho highlands. This source is more resilient to the impacts of climate change due to its large catchment area that drains the Lesotho Highlands (Figure 3 2) and the large capacity of the dam. NMBM has an allocation of 210 Ml/d from the Gariep Dam, which is close to the City's 2022 demand of 300 Ml/d. However, local infrastructure currently restricts the supply to only the eastern side of Gqeberha, and NMBM is not using their full allocation. Infrastructure upgrades are required for NMBM to access its full allocation. One of the issues that they are trying to address is additional security on the western side of NMBM as it is more vulnerable and requires further investments.

The Western and Central Sub-systems should meet 48% of Gqeberha's water demand, but are almost entirely dependent on rainfall, making them extremely vulnerable to the impacts of climate change and drought. Although NMBM's allocation from these sources is 194 Ml/d, the actual available water for supply is much less due to low dam storage (see Bay Water Savers for a live estimate of dam storage).

The water supply sources for NMBM and the owners, operators, associated treatment works and other users are shown in Figure 3-2 and Table 3-1.

Figure 3-2.
Algoa Water Supply System

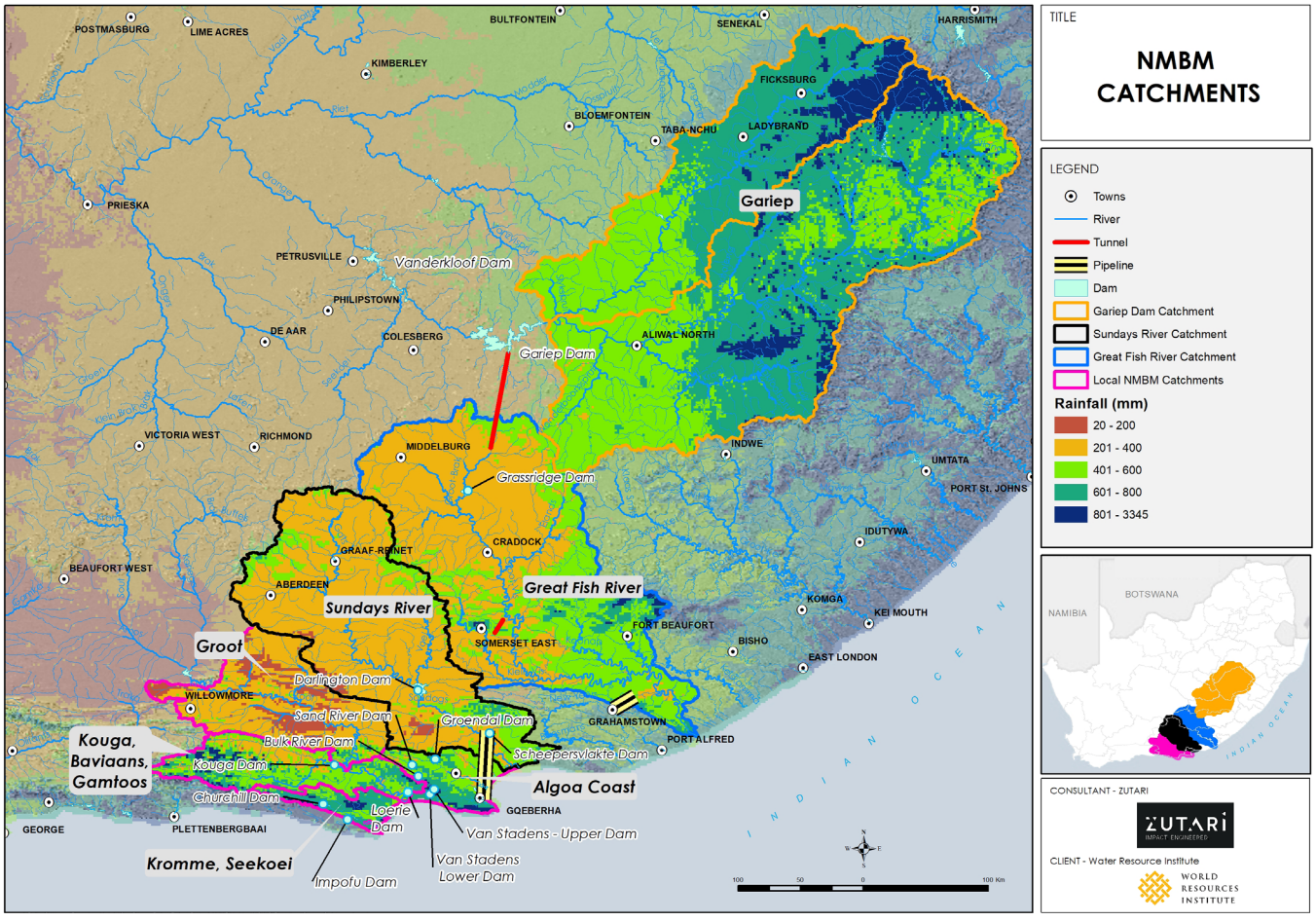


Table 3-1:
Major water supply sources for Nelson Mandela Bay

	Source of supply	Full supply capacity (million m^3)	NMBM 2022 allocation (Ml/d) (Zutari, 2022)	% of NMBM's supply[17]	Owner	Operator	NMBM Water treatment works	Other local users
Eastern Sub-system	**Orange-Fish-Sundays River Transfer originating at Gariep Dam**	5,343.00		-	DWS	DWS	-	Irrigation on the Orange River and Bloem Water
	Water is transferred from the Orange River to the Darlington Dam on the Sundays River.	80.0[18]			DWS	DWS	-	-
	Scheepersvlakte balancing dam: Water is abstracted for NMBM		209.7[19]	52%	DWS	LSRWUA	Nooitgedacht WTW	Irrigation (LSRWUA)
Western Sub-system	**Impofu Dam** on the Kromme River (fed by the Churchill Dam)	107.5	49.3	12%	DWS	NMBM	Elandsjagt WTW	-
	Churchill Dam on the Kromme River (releases into the Impofu Dam)	35.7	55.0	14%	NMBM	NMBM	Churchill WTW	-
	Kouga Dam on the Kouga River (releases into the Loerie Dam via a canal)	128.7	63.0	16%	DWS	GIB	Loerie WTW	Irrigation (GIB)
	Loerie Balancing Dam on the Loerie River (fed by the Kouga Dam) – abstraction point for NMBM	3.4			DWS	NMBM		-
Central Sub-system	**Groendal Dam** on the Kwazunga River (a tributary of the Swartkops River)	11.7	8.4	2%	NMBM	NMBM	Groendal WTW	Selected areas within Kariega Municipality and local farmers
	Bulk Dam on the Bulk River		2.5	1%	NMBM	NMBM	Linton and Rocklands WTWs	-
	Upper Van Stadens Dams on the Van Stadens River		1.0		NMBM	NMBM		-
	Lower Van Stadens Dams on the Van Stadens River		2.0		NMBM	NMBM		-
	Sand Dam on Sand River		7.0	2%	NMBM	NMBM		-
	Uitenhage Spring		5.9	1%	NMBM	NMBM	Spring WTW	
	Coega Kop boreholes		403.9					

(17) Anticipated % of supply based on allocation, and not actual supply
(18)The maximum operating capacity of the Darlington Dam is currently kept at 43% (80 million m^3) of its full storage capacity (187 million m^3), due to dam safety constraints (DWS, 2022)
(19)Values are DWA allocations to NMBM and not based on long term yields
(20) The Coegakop Wellfield is scheduled to be completed in September 2022, so it is not active yet. This water will be treated at the Coegakop Wellfield WTW. From here it will be pumped to the Coegakop Reservoir and then distributed to the Coega SEZ.

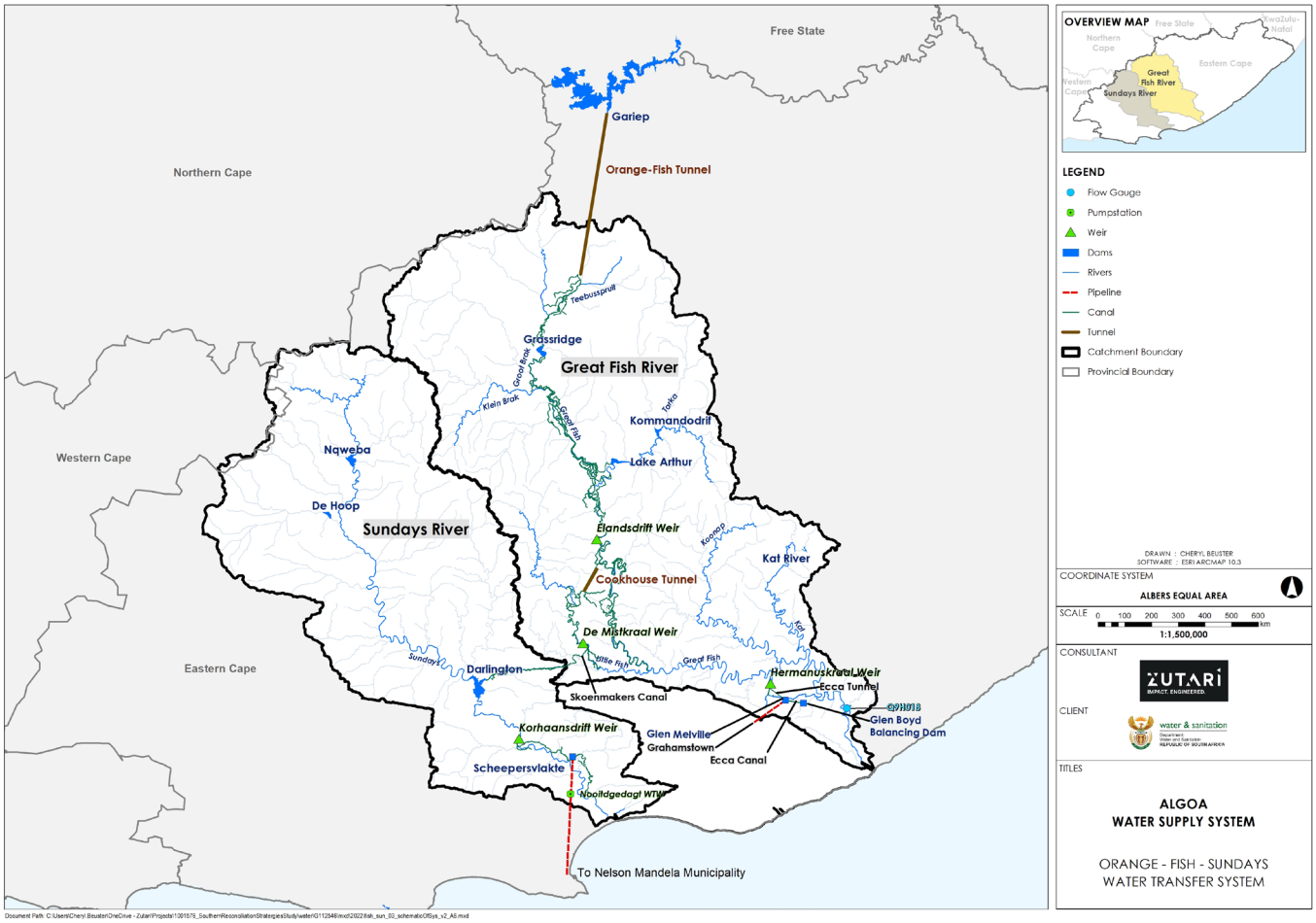
3.1.1 OVERVIEW OF THE EASTERN SUB-SYSTEM

The Orange-Fish and Lower-Sundays River Transfer Scheme (DWS owned) was implemented in the 1970s, together with a network of canals, weirs and balancing dams, restoring, and enabling thousands of hectares of irrigation. This was in response to many years of severe water shortages in the Eastern Cape Province.

The original Orange River Project involved the supply of water to other of the Vaal, Fish and Sundays River catchments, including the 82-km Orange–Fish Transfer Tunnel from Gariep Dam to Grassridge Dam (located on a tributary of the Great Fish River). Gariep Dam serves to generate hydropower for Eskom (South Africa's electricity utility), capable of providing up to 360 MW of electricity at a flow rate of 800 m3/s (four generators, each having the capacity of 90 MW at a flow rate of approximately 200 m3/s). Gariep Dam also supplies water for irrigation along the Orange River, as well as a water treatment plant owned by Bloem Water (OraSeCom, 2013).

The Orange–Fish Tunnel was completed in 1975 and is the key structure by which water is delivered from the Gariep Dam on the Orange River, situated some 450 kms north of Gqeberha (Orange River WMA) to Grassridge Dam located in the upper reaches of the Great Fish River (Mzimvubu-Tsitsikamma WMA). Water is then transferred from the Great Fish River to the Sundays River valley (though a network of tunnels and pipelines), supplementing local water supply for irrigation and urban use. The Lower Sundays River Irrigation Scheme supplies water for irrigation as well as for two major water users, namely the Sundays River Valley Local Municipality and NMBM for domestic water supply. NMBM abstracts water from the Scheepersvlakte Dam, although its key storage dam is Darlington Dam.

Figure 3-3.
Overview of the Orange-Fish and Lower-Sundays River Transfer Scheme (DWS, 2022). The key supply and storage dams for NMBM are indicated in red.



3.1.2 OVERVIEW OF THE WESTERN AND CENTRAL SUB-SYSTEMS

The largest dams in the Western Sub-system are the Churchill Dam (Figure 3 4) and Impofu Dam on the Krom River. Water to Gqeberha is also supplied from the Kouga Dam on the Kouga River, via the Gamtoos Irrigation system to the Loerie Balancing Dam on the Loerie Spruit, a tributary of the Gamtoos River. Churchill Dam is the only dam owned by NMBM, while DWS owns the other western dams. The bulk supply system is therefore operated jointly by the NMBM and the DWS.

The bulk supply from the combined Western Sub-system amounts to approximately 210 Ml/day, under unrestricted conditions, at an assurance of 1 in 50 years. This means that severe restrictions should be required only about once every 50 years. The Gamtoos Irrigation Board (GIB) has an allocation from Kouga Dam of around 165 Ml/day under unrestricted conditions. It is therefore a significant user in comparison to the NMBM. There is also relatively small usage by irrigators and several smaller towns supplied by this sub-system within the Kouga Local Municipality, which includes Cape St. Francis, St. Francis Bay, Hankey, Humansdorp, Kruisfontein, Jeffreys Bay, Oyster Bay, Patensie and Thornhill. As required, there is a small provision for Ecological Water Requirements (EWR) below Impofu Dam. The GIB is also investing in the clearing of invasive alien plants in the Kouga Dam catchment.

The Central Sub-system consists of the older dams on the Sand, Bulk, Van Stadens and Kwa Zunga (a tributary of the Swartkops) Rivers and the Uitenhage Springs, all of which are owned by the NMBM.

Figure 3-4.
Dams and associated catchments in the western and central sub-systems (NMBM, 2022b)

Figure 3-5.
Top View of Churchill Dam Wall and Intake Tower (Nov 2021) (Zutari, 2022)

3.2 CURRENT AND FUTURE WATER REQUIREMENTS

The total water allocation for the NMBM from these existing supply sources is 404 Ml/day as shown in Table 3-1. The increase in available supply since 1995 is primarily due to increased allocations from the Orange River through the Sundays River Scheme. In contrast, some of the existing systems such as the Churchill and Impofu Dams have had a reduction in yield. This is potentially related to the anticipated drying and increased variability due to climate change.

Figure 3-6 shows that historic water demands for NMBM have grown consistently at around 2.3% per annum and would have exceeded the current availability of supply had it not been for the emergency measures and restrictions put in place resulting from the extended drought period from 2007 to 2011. The estimated demand for NMBM is currently around 300 Ml/day and is expected to increase to 479 Ml/d by 2035 (NMBM, 2012b). The existing system yield will only be sufficient to meet potable water demands until about 2023. Beyond this, additional sources are required to meet demand (Figure 3-7).

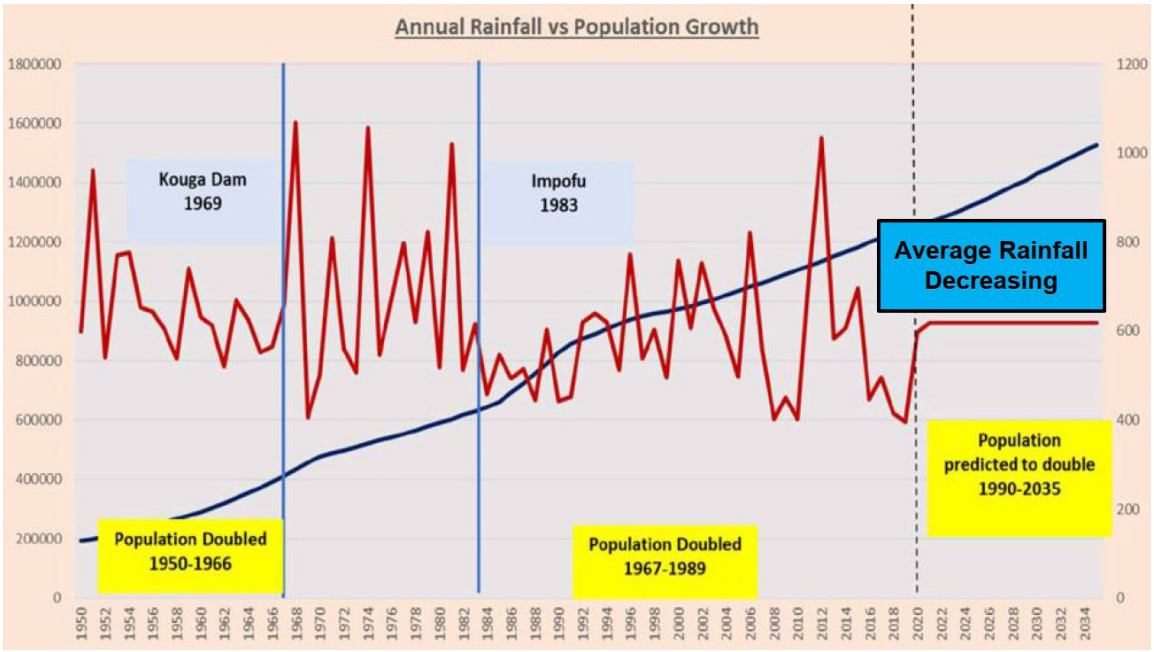
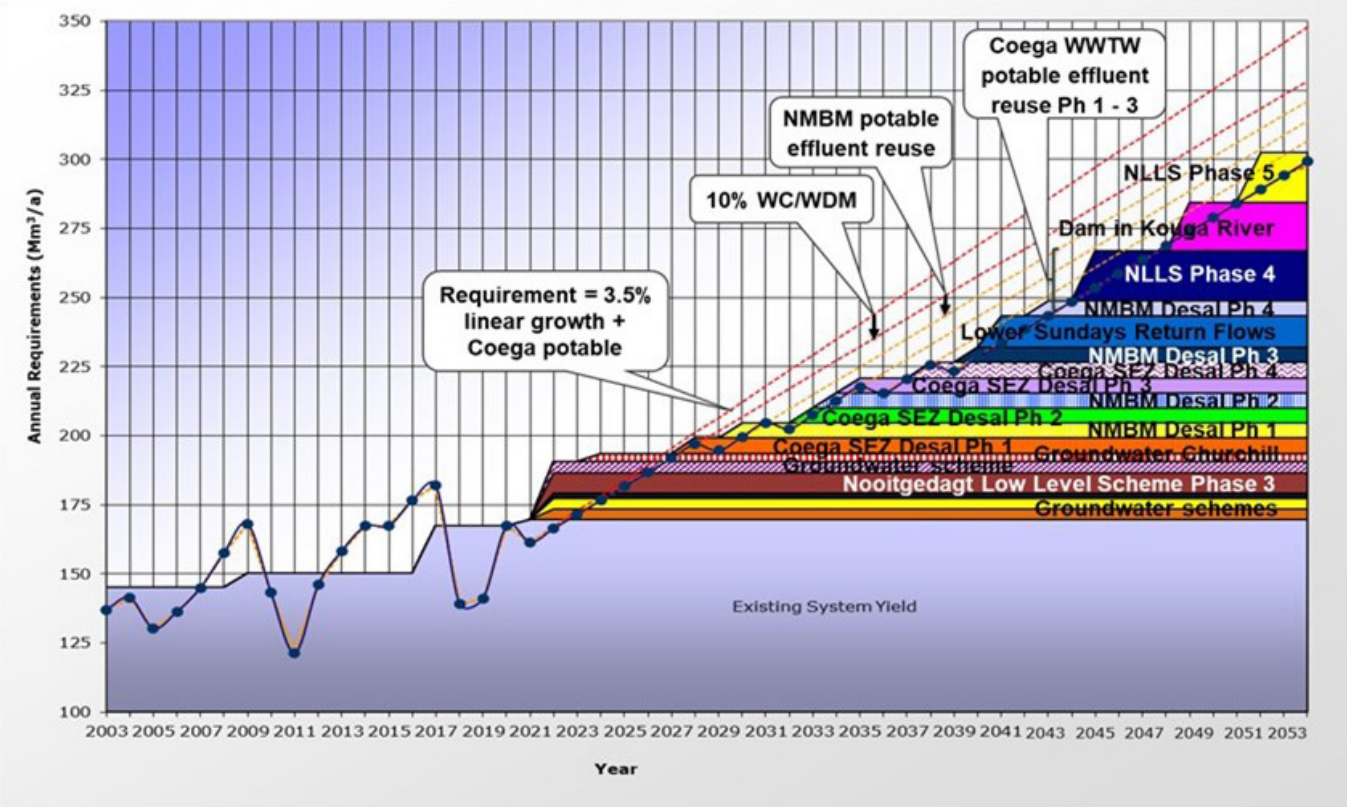


Figure 3-6. *Historical water demand as compared to rainfall in the local catchments (NMBM, 2022b)*

Figure 3-7.
Comparison of future demands and supply options for NMBM potable water (Zutari, 2022)



3.3 WATER SUPPLY DISTRIBUTION NETWORK

Gqeberha is serviced by a complex network of treatment works, reservoirs, pipelines, and pump stations (Figure 3 8).

Raw water is treated at eight water treatment works (WTW) prior to distribution to consumers. Water originating from the larger dams (Churchill, Impofu, Groendal and Kouga) is treated at plants at or near the dam sites from where it is transported to the city via bulk supply lines. Water from the smaller dams (Sand & Bulk River) is conveyed via raw water bulk pipelines to the Linton Water Treatment Works for purification. Water obtained from the Lower Sundays River Government Water Scheme is treated at the Nooitgedagt WTW near Addo Elephant Park. The treated water is then pumped to Grassridge Reservoir from where it gravitates to Motherwell and Coegakop Reservoirs. The water treatment works of the AWSS are owned and operated by NMBM and are listed in Table 3-2.

The sewerage reticulation network is subdivided into fourteen distinct catchments (drainage areas). Wastewater collected by the reticulation networks is treated at eight wastewater treatment works (WWTW) as detailed in Table 3-3.

Figure 3-8.
Water supply distribution network of NMBM

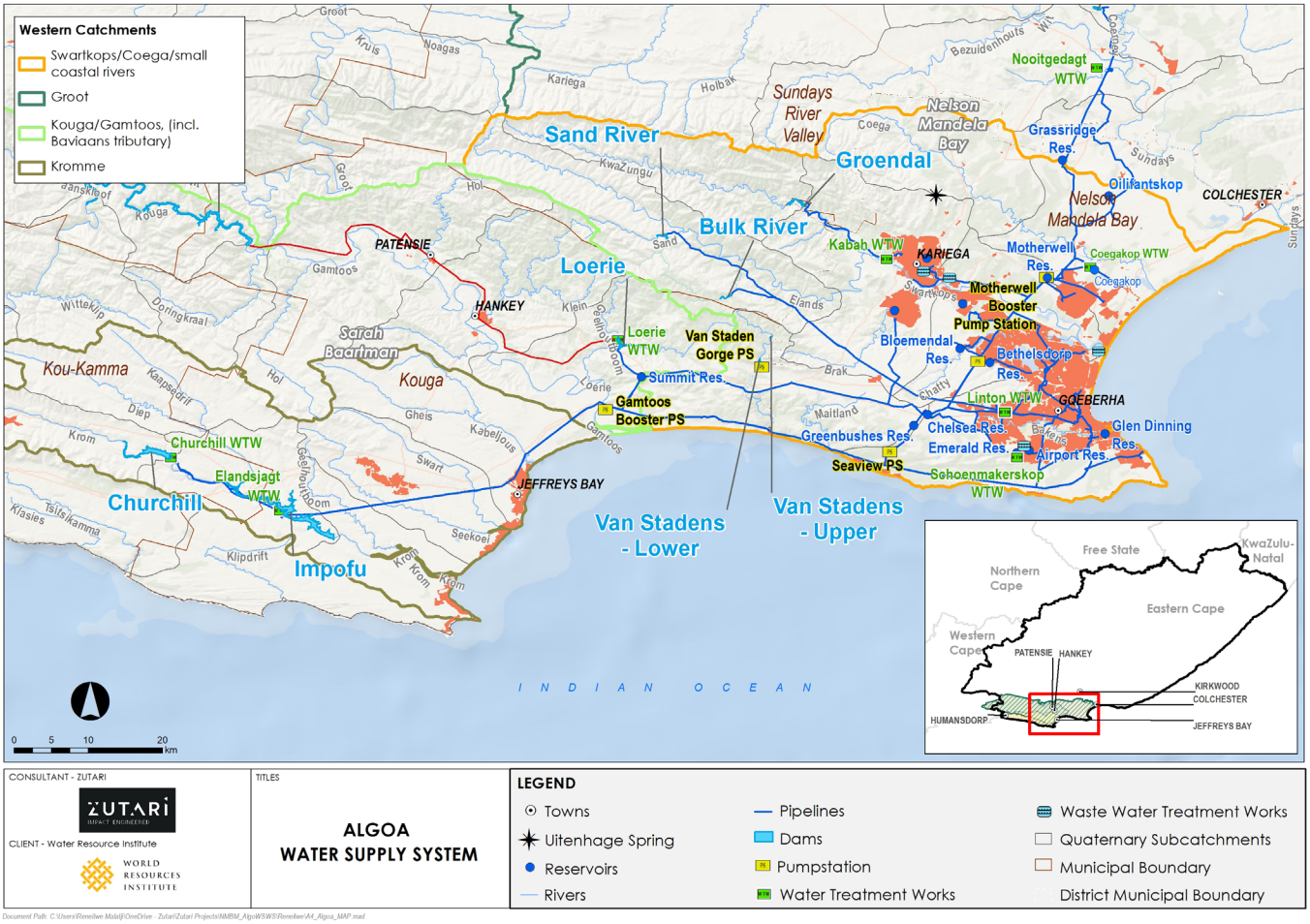


Table 3-2.
Water supply distribution network of NMBM

Water Treatment Works	Commission Date	Capacity (Ml/day)	Catchment Area
Nooitgedagt WTW	1992	160	Scheepersvlakte Dam
Loerie WTW	1968	100	Kouga &Loerie Dam
Churchill WTW	1947	100	Chruchill Dam
Elandsjagt WTW	1985	105	Impofu Dam
Groendal WTW	1985	20	Groendal Dam
Linton WTW	1936	10	Bulk & Sand River Dams
Springs WTW	1940	6	Uitenhage Springs
Rocklands WTW	2006	0.25	Bulk & Sand River Dams

Table 3-3.
Wastewater Treatment Works

	Wastewater Treatment Works	Type	Commission Date	Last Upgrade	Peak Capacity (Ml/d)	Discharge
1	**Cape Recife**	Activated sludge	1971	2013	9.00	Marine outfall
2	**Despatch**	Activated sludge	1969	2005	8.86	Swartkops River
3	**Driftsands**	Activated sludge	1985	2018	22.00	Marine outfall
4	**Fishwater Flats**	Activated sludge	1976	2018	132.00	Marine outfall
5	**Kelvin Jones**	Activated sludge	1936	2018	24.00	Swartkops River
6	**Kwanobuhle**	Activated sludge	1985	1999	9.00	Swartkops River
7	**Rocklands SBR**	Activated sludge	2006	-	0.18	Elands River
8	**Brickfield**	Pre-treatment	-	-	-	-

3.4 WATER SECURITY CHALLENGES

Like other cities in South Africa, Gqeberha is facing increasing water security challenges due to population growth, increasing demands for basic services and climate change impacts. Gqeberha also faces water quality, environmental degradation and flood risk challenges. At the time of writing this report, Gqeberha, and the wider NMBM and surrounding regions were experiencing a severe drought and water supply crisis due to below average rainfall (Figure 3-9), increasing demands and infrastructure capacity limitations. The local western water supply dams have been declining since November 2015 and were sitting at 16% in February 2022 (Figure 3-10), the lowest storage volume recorded for this time of year since 1979.

The NMBM is investigating several emergency water supply options, including improvement of local sources and infrastructure, groundwater, desalination and reuse of treated effluent (see Appendix A for further details on these individual schemes). However, a more long-term solution is required, particularly as the region is likely to be increasingly impacted by climate change.

Figure 3-9.
Water supply distribution network of NMBM

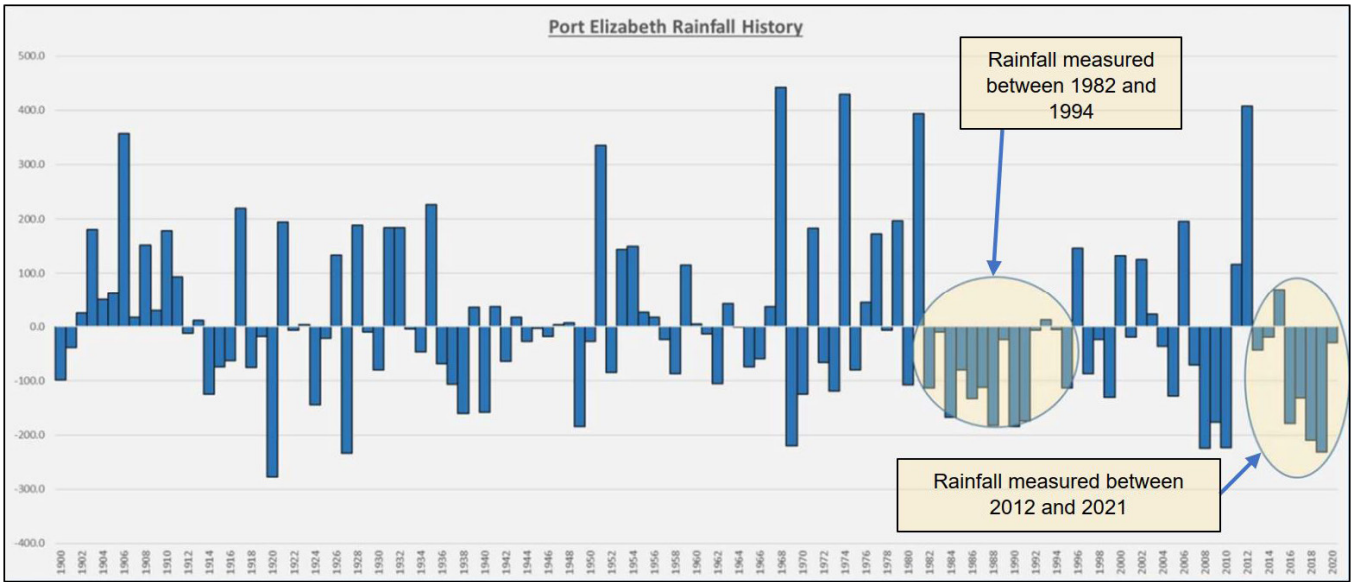
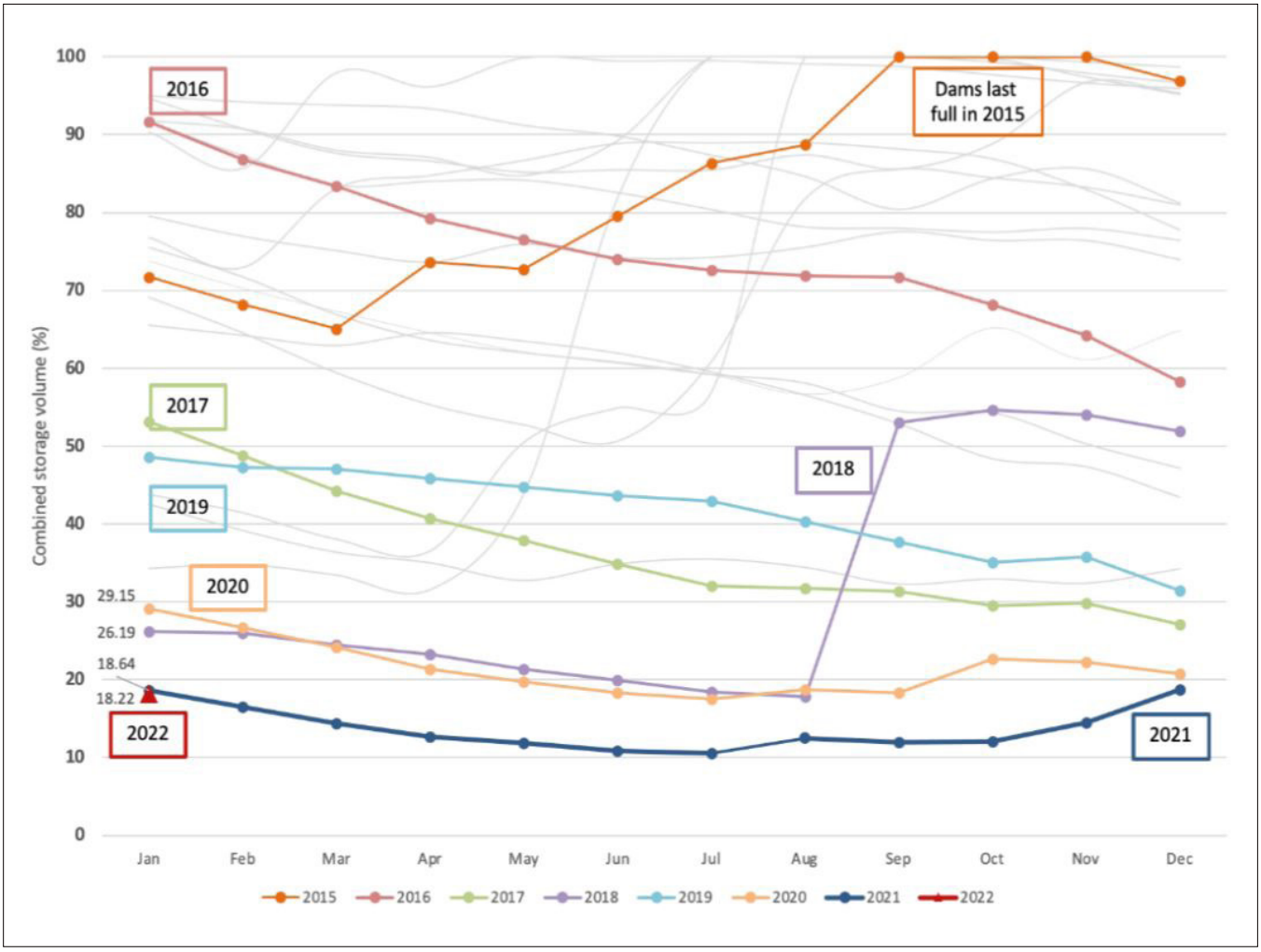


Figure 3-10.

Combined dam storage volumes for NMBM tracked over the past 20 years, highlighting the years from 2015 to 2021 and showing them at only 18% full in January 2022 (NMBM, 2022a)



3.5 WATER GOVERNANCE AND RESPONSIBILITY

The following government agencies play a critical role in ensuring the security of water supply and sanitation in Gqeberha:

National – The National Department of Water and Sanitation (DWS) which manages and operates the Algoa Water Supply System (AWSS)

Regional – Regional DWS (Eastern Cape) and the Mzimvubu-Tsitsikamm CMA (not yet established) as well as several irrigation boards and water user associations (WUAs) which form part of the AWSS which is managed by the national DWS.

Local – Nelson Mandela Bay Municipality (NMBM) which acts as both the responsible Water Services Authority (WSA) and the Water Services Provider (WSP) for Gqeberha as well as several other towns and local municipalities in the region.

Several other key stakeholders described below.

3.5.1 NATIONAL WATER GOVERNANCE

According to the Constitution of South Africa 1996, "Everyone has the right to have access to sufficient food and water…(and) the state must take reasonable legislative and other measures, within its available resources, to achieve the progressive realisation of each of these rights." (Republic of South Africa, 1996). To achieve this objective, several acts govern the management of water resources and supply in South Africa. These include:

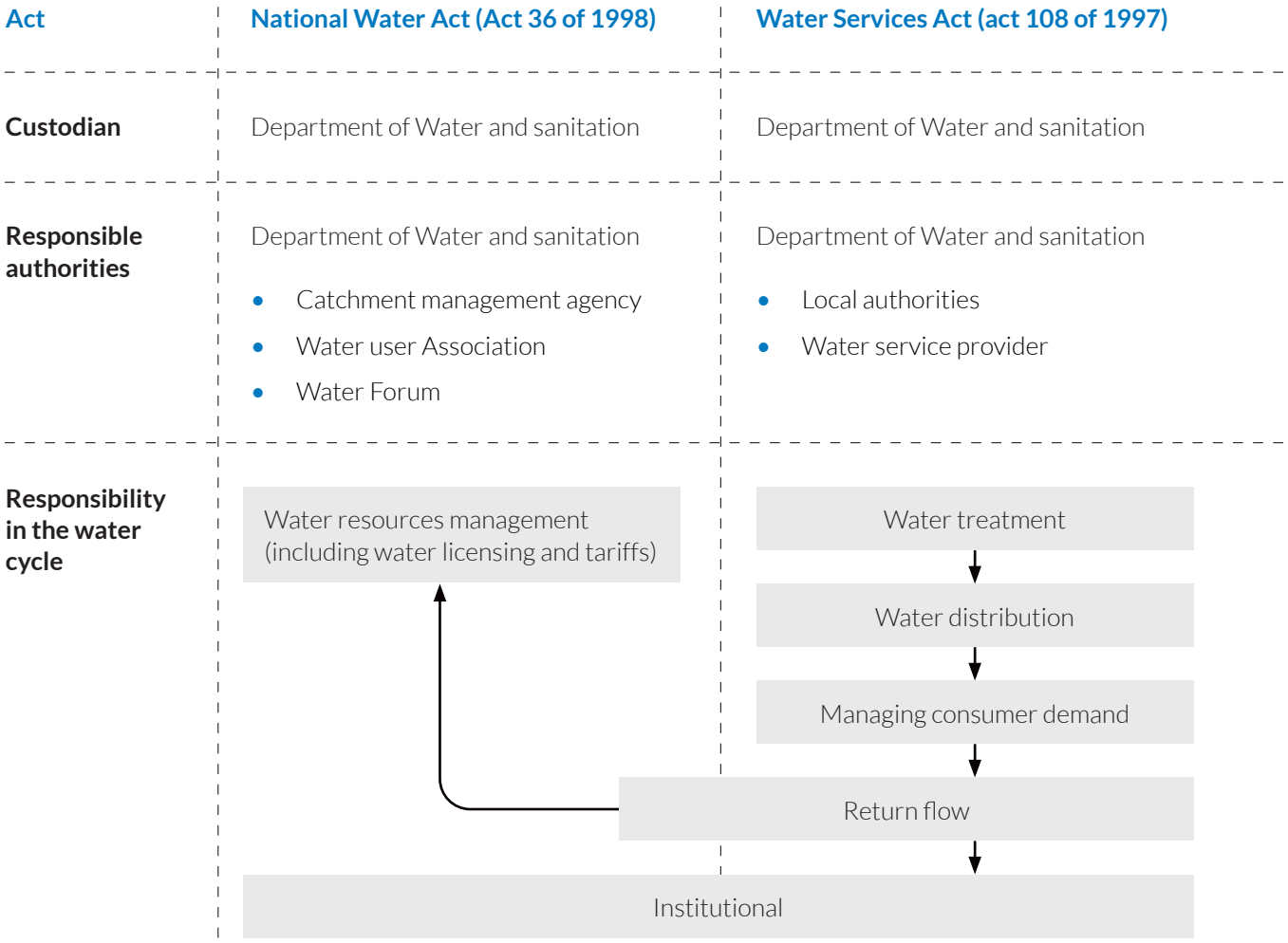
The Constitution of South Africa (Act 108 of 1996) assigns the responsibility of ensuring access to water services to local government (Republic of South Africa, 1996). The role of the national and provincial spheres of government is to support, monitor and regulate local government.

The National Water Act (Act 36 of 1998) defines water as an indivisible national resource, which national government is the custodian of. It further outlines a new way of managing South Africa's scarce water resources (Republic of South Africa, 1998b). The key responsibilities under this act are shown in Figure 3 11.

The Water Services Act (Act 108 of 1997) further defines the municipal functions related to ensuring water services provision (Republic of South Africa, 1997). The key responsibilities under this act are shown in Figure 3 11.

The National Environmental Management Act (Act 107 of 1998) provides the overarching framework for environmental management in South Africa by providing for "co-operative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for coordinating environmental functions exercised by organs of state; to provide for the prohibition, restriction or control of activities which are likely to have a detrimental effect on the environment" (Republic of South Africa, 1998a)

Figure 3-11.
Responsibilities under the National Water Act and Water Services Act



The Department of Water and Sanitation (DWS), on behalf of the Minister, is the custodian of the nation's water resources and is responsible to ensure the availability and supply of water at a national level and to ensure efficient supply of water services at a local level. DWS legislative mandate is to ensure that the country's water resources are protected, managed, used, developed, conserved, and controlled in a manner that is sustainable, equitable and efficient according to the policy requirements outlined in the National Water Act and the Water Services Act. The DWS regulatory function includes setting and regulating raw water tariffs and regulating water services tariffs in line with norms and standards set by the department.

In Gqeberha, the DWS is the custodian of several dams and critical bulk water infrastructure assets (Table 3-1) and is responsible for the overall management and augmentation of the AWSS. The DWS manages the AWSS through a Steering committee consisting of key stakeholders including the NMBM, other municipalities, provincial departments, irrigation boards and WUAs.

3.5.2 REGIONAL WATER GOVERNANCE

At the provincial level, DWS has an office located in Gqeberha and is in the process of establishing a **Catchment Management Agency (CMA)** which will take over the regional water resource management responsibilities. The National Water Act requires the establishment of a CMA, but only two CMAs have been successfully established within South Africa, namely the Inkomati-Usuthu CMA and the Breede-Gouritz CMA. The remaining seven Water Management Areas (WMA) do not have established CMAs (Figure 3-12).

Gqeberha and its main water supply catchments fall within the Mzimvubu-Tsitsikamma Water Management Area (WMA) and should therefore come under the management of the Mzimvubu-Tsitsikamm CMA once it has been established. However, given that the bulk of the water comes from the Orange River catchments, Gqeberha is also dependent on the management of the Orange-Senqu river system which includes the Orange WMA (and Orange proto-CMA) as well as parts of Lesotho.

Other regional bodies include the **Lower Sundays River Water User Association (LSRWUA)**[21] and **Gamtoos Irrigation Board**[22] **(GIB)**. The LSRWUA operates the bulk water infrastructure along part of the Eastern Sub-system (Orange River transfer scheme) within the AWSS and is responsible for water provision to the eastern part of Gqeberha. The GIB is a licenced irrigation board and major water user of the AWSS, sharing the supply from Kouga Dam with NMBM.

(21) Water User Associations are in effect co-operative associations of individual water users who wish to undertake water-related activities for their mutual benefit.
(22) Irrigation boards serve a similar function to Water User Associations and are in fact required under the National Water Act to transition into WUAs.

Figure 3-12: *The 9 Water Management Areas (WMA) of South Africa (source: DWS)*

3.5.3 LOCAL WATER GOVERNANCE

Several key acts determine the functioning of local water supply.

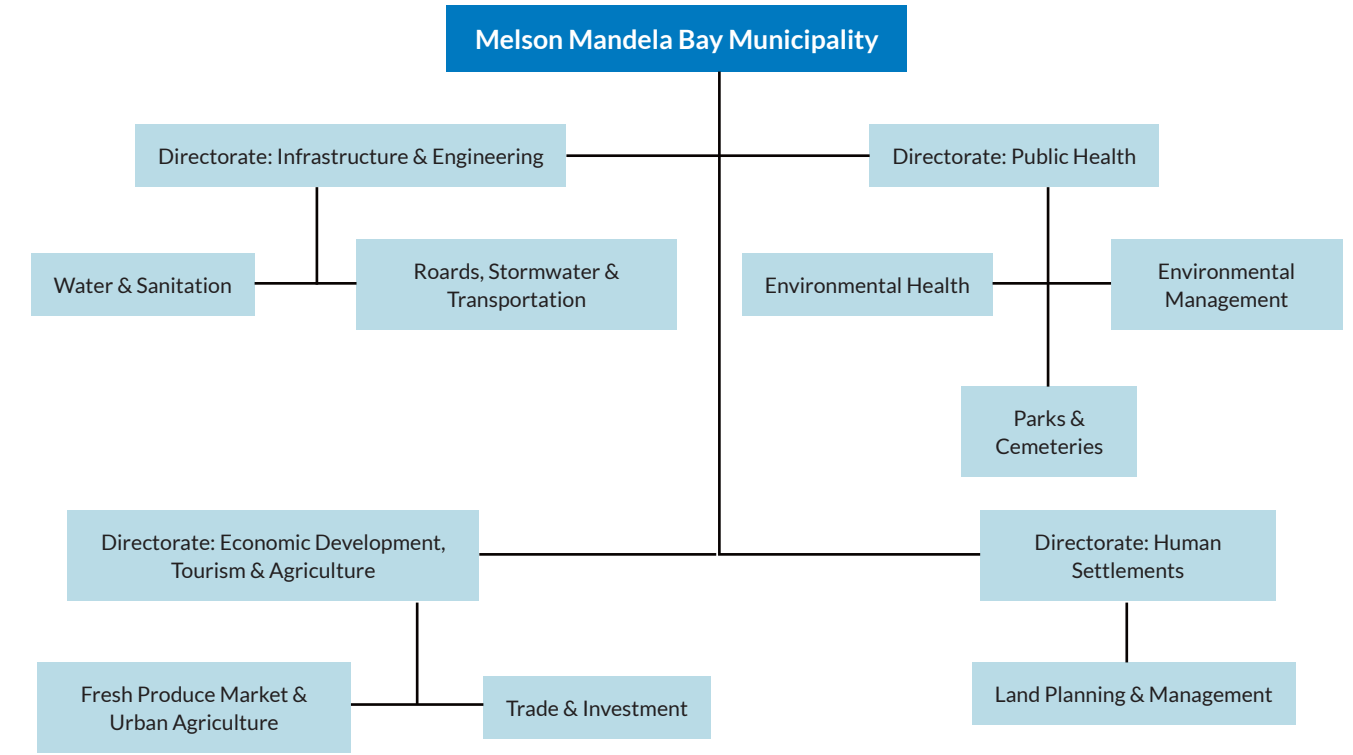
- The **Municipal Demarcation Act** (Act 27 of 1998) provides a legal framework for defining and implementing a post-transitional system of local government.
- The **Municipal Systems Act** (Act 32 of 2000) defines how local government should operate, and allows for various types of partnership arrangements which a municipality may enter into to ensure delivery of services (e.g., water services).
- The **Municipal Structures Act**, Act 117 of 1998, defines types and structures of municipalities. Three categories of municipalities exist in South Africa after demarcation, namely: Category A (Metropolitan), Category B (Local), Category C (District).
- The **Municipal Structures Amendment Act** (Act 33 of 2000) places the function of ensuring access to water services (as well as Health and Electricity) at a district level, unless a local municipality is authorised to perform this function.

Although the national DWS is ultimately responsible for water supply, it does not have the capacity to engage with local institutions and ensure water provision on a local level. This is where **Water Services Authorities (WSA)** and **Water Service Providers (WSP)** come into the picture, as per the Water Services Act (Figure 3-11).

For Gqeberha, the **Nelson Mandela Bay Municipality (NMBM)** is both the designated WSP and WSA. The NMBM provides 98.5% of water supplied to the municipality. From this supply, 78% of the households are provided with a house connection, 16% of the households have a standpipe within the yard, 3% from a communal stand and 1% of water supplied being public or communal (COGTA, 2020a). Within NMBM, the Department of Water & Sanitation and the Department of Roads, Stormwater & Transportation, which both fall under the Directorate of Infrastructure and Engineering, are the main departments that act as the custodians of water related infrastructure (Figure 3-13).

Figure 3-13.

Organogram for the NMBM Directorate of Infrastructure & Engineering and Public Health, highlighting the key departments for water-related infrastructure (red) and climate change resilience (orange)



3.6 WATER QUALITY ISSUES AND CONCERNS

The Blue Drop Report[23] (DWS, 2022a) ranked NMBM's potable water supply as a low risk, and Rocklands and Groendal WTWs were among the top ten performing water treatment works in the Eastern Cape Province. However, low dam levels are resulting in significant water quality issues. In February 2022, NMBM issued a notice warning resident to not drink the tap water, saying that its system had failed quality checks, "certain microbiological limits" were exceeded and the municipality had "detected failures in water compliance with SANS standards"[24].

(23) The Blue Drop Report (DWS, 2022a)) scores all WTW in South Africa according to the following risks: Design Capacity and Risk; Operational Capacity in terms of design capacity; Water Quality Compliance; Technical Skills; and Water Safety Plans.
The municipalities are then scored according to the following risk profiles: Low risk category (48% of water supply systems in South Africa); Medium risk category (18%); High risk category (11%); Critical risk category (23%)
(24) https://www.dailymaverick.co.za/article/2022-03-07-revealed-test-results-show-nelson-mandela-bay-turned-a-blind-eye-to-dodgy-water-quality/

3.7 SANITATION SERVICES AND WASTEWATER TREATMENT

The DWS Green Drop Report (DWS, 2022b) similarly ranks the risks of all WWTWs in the country, and the 2022 results are not good. The Daily Maverick, an investigative journalist newspaper, noted that "More than 60% of South Africa's sewage and wastewater treatment works have been officially classified as being in a 'poor to critical' state — and the estimated price tag for fixing the shambles is more than R8.14-billion"[25].

Despite many municipalities scoring poorly in the 2022 Green Drop Report, the report notes that "Nelson Mandela Bay is commended for maintaining all their treatment facilities in low and moderate risk positions - an exemplary status" (DWS, 2022b). The municipality received the second highest score in the Eastern Cape Province, after Buffalo City.

Figure 3-14: *Green drops scores for WWTW in NMBM (DWS, 2022b)*

Water Service Authority	**Nelson Mandela Bay politan Municipality**
Water Service Provider	Nelson Mandela Bay politan Municipality

Municipal Green Drop Score	
2021 Green Drop Score	**58%↓**
2013 Green Drop Score	**65%**
2011 Green Drop Score	**81%**
2009 Green Drop Score	**70%**

VROOM Impression (Towards restoring functionality):

1. Screening
2. Sludge wastage
3. Disposal of the dried/stabilised sludge
4. Sludge lagoons fencing
5. Sludge disposal

VROOM Estimate:

- R112,079,000

Key Performance Area	**Unit**	**Cape Receife**	**Despatch**	**Fishwater Flats**	**Kelvin Jones**
Green Drop Score (2021)		**71%**	**75%**	**62%**	**76%**
2013 Green Drop Score		**71%**	**71%**	**63%**	**63%**
2011 Green Drop Score		**83%**	**87%**	**79%**	**82%**
2009 Green Drop Score		**71%**	**72%**	**51%**	**72%**
System Design Capacity	Ml/d	8	8.6	132	24
Design Capacity Utilisation (%)		75%	38%	76%	71%
Resource Discharged into		Marine outfall	Swartkkops River	Marine Outfall	Swartkops River
Wastewater Risk Rating (CRR% of CRR_{max})		**Cape Receife**	**Despatch**	**Fishwater Flats**	**Kelvin Jones**
CRR (2011)	%	36.4%	36.4%	50.0%	59.3%
CRR (2013)	%	59.1%	50.0%	65.6%	63.0%
CRR (2021)	%	59.1%	45.5%	56.8%	55.6%

Key Performance Area	**Unit**	**KwaNobuhle**	**Rocklands**	**Driftsands**
Green Drop Score (2021)		**66%**	**67%**	**73%**
2013 Green Drop Score		**67%**	**60%**	**88%**
2011 Green Drop Score		**86%**	**71%**	**91%**
2009 Green Drop Score		**72%**	**72%**	**77%**
System Design Capacity	Ml/d	9	0.18	22
Design Capacity Utilisation (%)		50%	50%	57%
Resource Discharged into		Swartkops River	Elands River	Marine outfall
Wastewater Risk Rating (CRR% of CRR_{max})		**KwaNobuhle**	**Rocklands**	**Driftsands**
CRR (2011)	%	59.1%	47.8%	59.1%
CRR (2013)	%	68.2%	70.6%	50.0%
CRR (2021)	%	50.0%	58.8%	55.6%

Technical Site Assessment: **KwaNobuhle WWTW 63%; Kelvin Jones WWTW 56%**

Figure 3-15.

WWTW risk ratings for local municipalities in the Eastern Cape Province (DWS, 2022b)

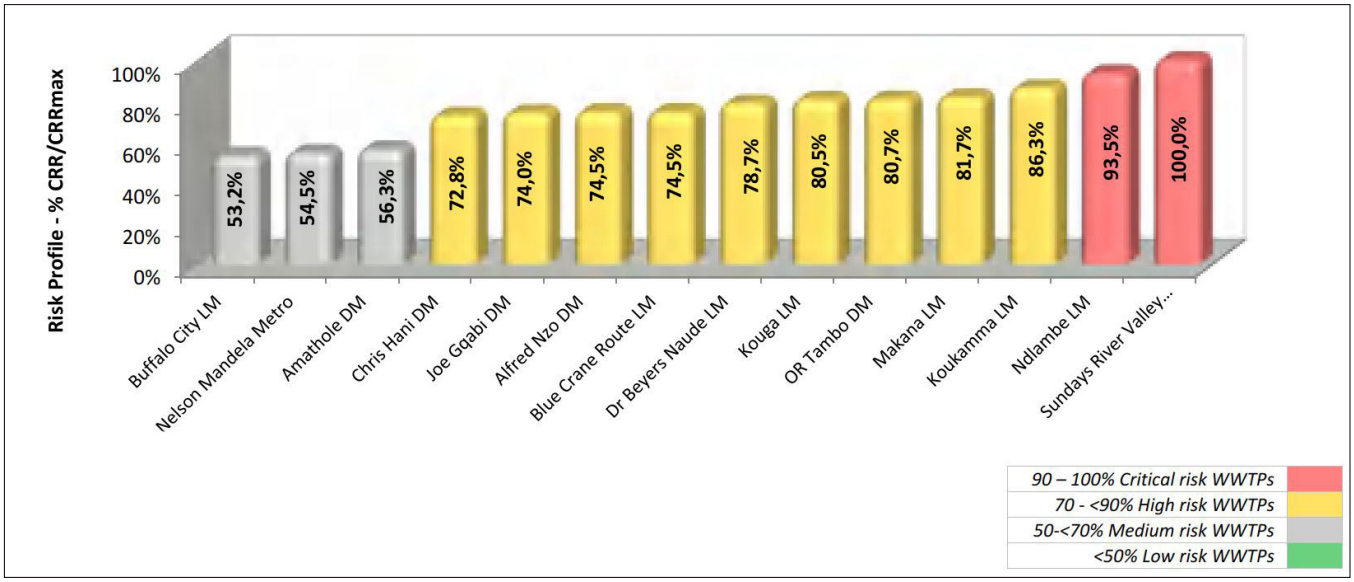
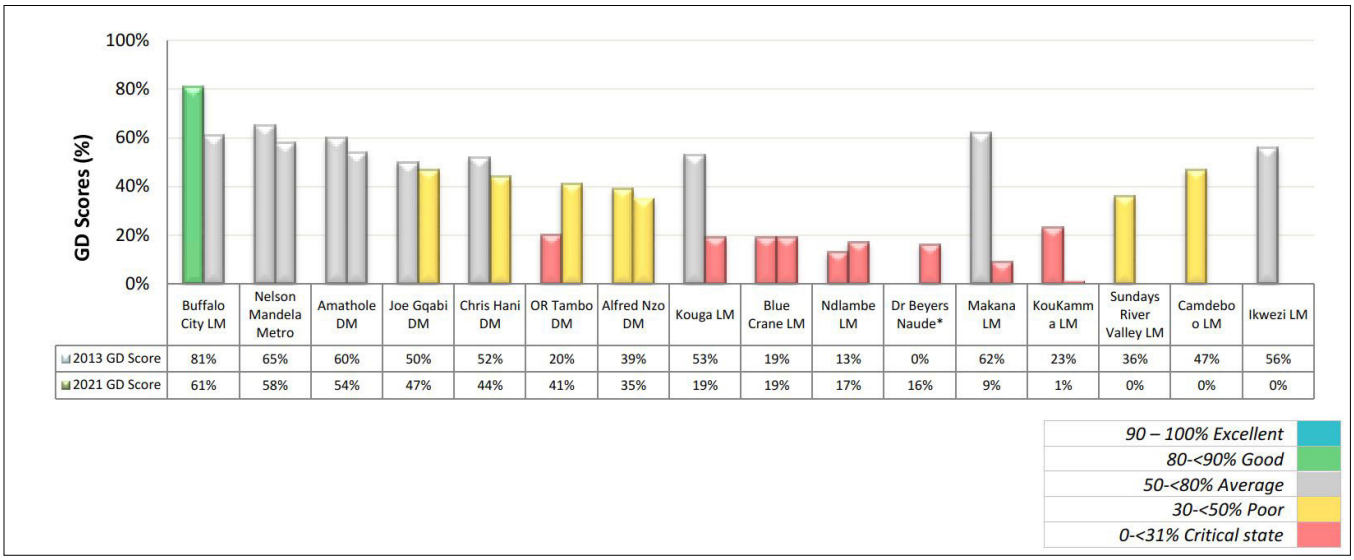


Figure 3-16.

WWTW green drop scores for local municipalities in the Eastern Cape Province (DWS, 2022b)



	Buffalo City LM	Nelson Mandela Metro	Amathole DM	Joe Gqabi DM	Chris Hani DM	OR Tambo DM	Alfred Nzo DM	Kouga LM	Blue Crane LM	Ndlambe LM	Dr Beyers Naude*	Makana LM	KouKamma LM	Sundays River Valley LM	Camdeboo LM	Ikwezi LM
2013 GD Score	81%	65%	60%	50%	52%	20%	39%	53%	19%	13%	0%	62%	23%	36%	47%	56%
2021 GD Score	61%	58%	54%	47%	44%	41%	35%	19%	19%	17%	16%	9%	1%	0%	0%	0%

3.8 NON-REVENUE WATER

NMBM's non-revenue water[26] (NRW) was 41.3% for the month of February 2022, with the Real Losses being calculated as 28.5% during the same time (NMBM, 2022a). The NMBM is focussed on reducing its NRW% to 36% and aims to ensure that all Water Conservation Water Demand Management (WC/WDM) workstreams are running smoothly in parallel to achieve this goal. Reducing NRW is particularly critical for NMBM during the current drought crisis as WC/WDM remains the cheapest option to save water, and with a Real loss of 28.5% there is significant room for conserving water.

The NMBM has implemented numerous WC/WDM interventions since 2010 to improve service delivery and ensure sustainability. In 2017 the NMBM developed a 10-year NRW business plan. The aim of this strategy is "to lower the NRW in Nelson Mandela Bay Municipality on a sustainable basis from the present ≥40% to at most 20 - 25% and physical losses 15 – 20% within a period of 10 years".

As part of this plan, the following sixteen WC/WDM interventions were prioritised and are monitored on a bi-annual basis (NMBM, 2017):

1. Bulk Water Meters to establish bulk water balance
2. District metering programme (GMA and DMA meters)
3. Non-Revenue Water monitoring and reporting
4. Remote metering through Advanced Metering Infrastructure
5. Pressure management
6. ICI consumers and billing database
7. School leak repair programme
8. Cluster leak repair programme
9. Leak fixing festival
10. ATTP programme
11. Repair and Maintenance Service Provider
12. Pipe replacement programme
13. Completion of water loss audits on domestic meters, valves and hydrants
14. Meter Replacement Programme
15. Reservoir rehabilitation
16. Awareness and education among communities and schools.

The plan indicated that the annual budget provision for NRW management must be in the order of R100 million (3.3 million USD) at 2017 prices. While the NMBM is meeting some of these targets, significantly more work needs to be done to reduce the high real water losses. High NRW also creates a dilemma for local municipalities. Municipalities require grants/loans to address their various water challenges, but these funds will only be granted if the municipality can show a reduction in NRW. The City of Cape Town has 30-40 staff members responsible for NRW and WC/WDM, but at the time of writing this report NMBM has no operational WC/WDM unit and only one staff member dedicated to this (Martin, 2022). The NMBM will only be able to get funds from National Treasury when they can show that their NRW has reduced. NRW reduction is therefore at the top of the agenda for the municipality, and they aim to create a suite of bankable NRW projects (Martin, 2022).

(26) Non-revenue water (NRW) is water that has been produced and is "lost" before it reaches the customer. Losses can be real losses (through leaks, sometimes also referred to as physical losses) or apparent losses (for example through theft or metering inaccuracies).

3.9 WATER CONSERVATION AND DEMAND MANAGEMENT

Gqeberha is severely at risk of depleting its water resources. To ensure water security in and around the city it has become imperative to implement measures to mitigate and address the drought situation. This has led to the investigation and identification of several short-term measures to curb the current water demand. The measures described in this section are either currently being implemented or are planned for implementation.

3.9.1 WATER RESTRICTIONS AND PUNITIVE TARIFFS

The most effective method to ensure continuous water supply is to reduce overall consumption. The NMBM was able to reduce water consumption by issuing various restriction notices over the last five years (2016 – 2021). The water restrictions, which were initially imposed in September 2016, went together with stepped tariffs and increasing rates for higher water usage. As the drought persisted, more punitive tariffs were progressively introduced so that higher water use came at an increased cost. This initiative was able to deter excessive water consumption and resulted in the water demand reducing from 290 Ml/day to an average of 235Ml/day in June 2018.

3.9.2 WATER SAVING TARGETS

Water is distributed through Gqeberha's reticulation network across several different zones. As a result of the current drought, NMBM has divided the water distribution network into three zones (NMBM, 2022).

Zone 1- 20% savings required: Zone 1 is supplied with water from the eastern sub-system which is currently not experiencing any water shortages. However, restrictions are imposed for the municipality to transfer water to the other zones that are typically reliant on the western sub-system. In addition, these low-lying areas have an added advantage in terms of water supply. The zone 1 area includes the areas of Kariega, Despatch and Coega industrial zone, as well as Motherwell and Ibhayi townships (the latter being the largest township in the Eastern Cape).

Zone 2 – 40% saving required: Zone 2 covers part of Gqeberha's CBD. It is supplied by the eastern and central sub-systems that are currently experiencing a severe drought. There is no option to have their supply augmented with water from the Eastern Sub-system, and it is therefore critical that they reduce demand.

Zone 3 - 40% saving required: Zone 3 covers part of Gqeberha's CBD. This zone is supplied by the eastern sub-system, but due to the high demand, it has also been drawing from the drought stricken western supply system.

3.9.3 HOUSEHOLD FLOW LIMITING DISK AND METERS

The restriction notice issued by the NMBM not only aimed at encouraging consumers to limit and restrict water usage, but also enabled physical restrictive demand measures, such as the installation of flow limiting meters. These flow restrictors are in the form of round disks of the same internal diameter as the water meter and are installed at the household connection to reduce the pressure and flow to the property. Flow limiting disks are installed to restrict domestic consumers who have an average water usage exceeding 15 kl/month, over a 3-month period. These water management devices are installed at the cost of the consumers with excessively high-water consumption levels and are calibrated to ensure only a basic amount can be consumed by the property owner. The NMBM has identified over 24 000 domestic consumers to be retrofitted with the flow limiting disk. As of early 2022, 4,829 single residential flow limiting disks have been installed.

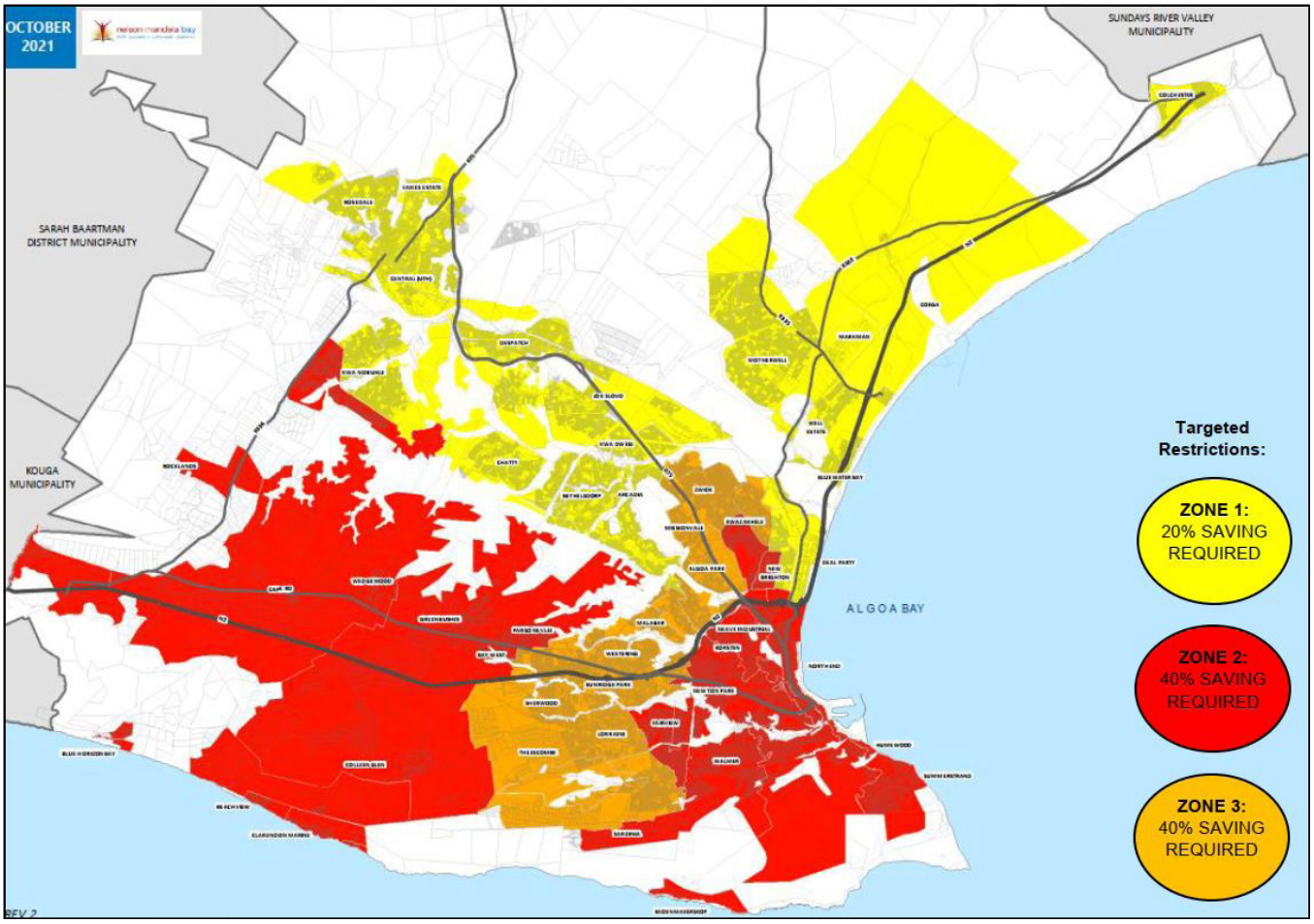


Figure 3-17: *Current water saving requirements for the three distribution zones defined by NMBM (NMBM, 2022b)*

3.9.4 PRESSURE REDUCTION THROUGHOUT THE NMBM

Excessive network pressure has several negative effects on distribution systems (e.g., higher pipe failure rates and leakage rates). As of January 2021, the NMBM had 64 pressure managed zones. The pressure management programme was accelerated during January 2021 to identify and implement new pressure zones. By the end of July 2021, the NMBM had commissioned 8 additional pressure managed zones. In November 2021, the average water savings peaked at 10 Ml/day from the optimization of the existing, as well as new pressure managed zones. The NMBM planned to commission an additional 14 pressure managed zones in January 2022.

3.9.5 LEAK REPAIR PROGRAMME

Municipalities in South Africa are experiencing challenges with the wastage of drinking water through leaks – due to aging infrastructure and limited maintenance. Therefore, the NMBM has implemented an intensified water leaks programme that focuses on reducing the time it takes to fix damaged water pipes and water meter that contribute to water leaks, thus reducing losses accordingly.

The NMBM has also partnered with the Nelson Mandela Bay Business Chamber and the Strategic Water Partnership Network to assist with a leak repair and NRW. The programmes identified, investigated and adapted the schools with the highest water usage in an effort to potentially reduce water wastage significantly.

4

CHARACTERISING RESILIENCE

The concept of resilience has been explored more in the general context of cities than it has for water specifically. The City Resilience Index (CRI) helped advance the concept of urban resilience worldwide. The CRI defines city resilience as "the capacity of cities to function, so that the people living and working in cities – particularly the poor and vulnerable – survive and thrive no matter what stresses or shocks they encounter." This definition considers urban resilience as a function of specific systems that make up the city, and notes that water is one of many critical urban systems (Arup, 2015).

Although the concept of water resilience is still a relatively new one, it is unsurprisingly gaining traction with growing water security. The World Economic Forum's global risk report (published on an annual basis at the Davos convention), highlights the critical need to address this risk. Water Crises is the one risk that has consistently been ranked in the top 5 since 2012 (WEF, 2021), and is arguably one of the greatest risks that the world faces.

4.1 UNDERLYING VULNERABILITY

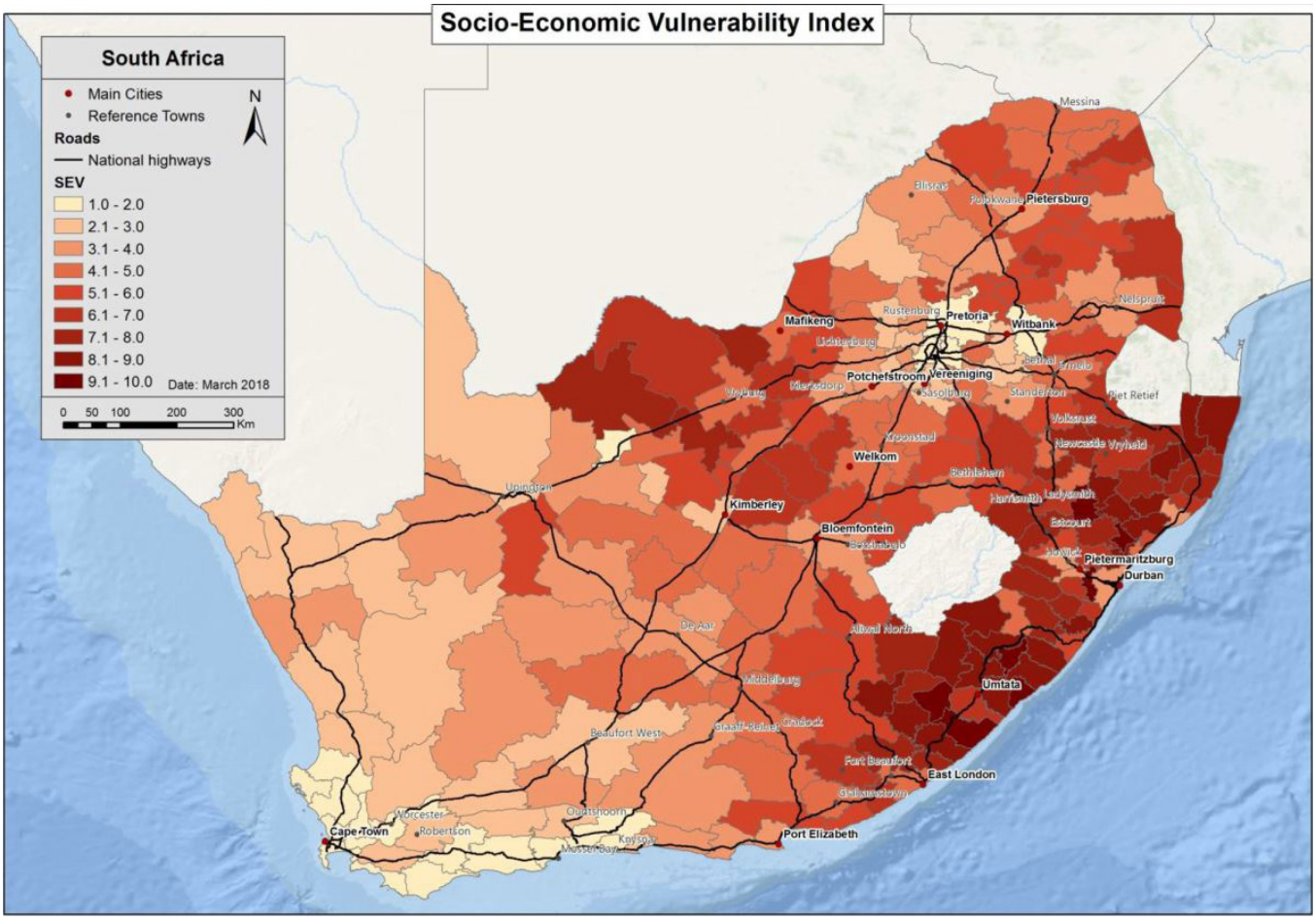
4.1.1 MUNICIPAL LEVEL VULNERABILITY

The CSIR Green Book, a practical planning tool for adapting South African settlements to climate change, uses the following definitions to describe the four types of vulnerability (Le Roux, et al., 2019).

Socio-Economic Vulnerability Index

Social inequalities are the factors that shape and influence the susceptibility and coping mechanisms of communities. Indicators for social vulnerability attempt to consider a population's sensitivity to natural hazards and its ability to respond to and recover from the impacts caused by the natural hazard. This type of vulnerability is characterised by the following: household composition, income composition, education, mobility, health, access to basic services, access to social government services, political instability, and safety & security. The Socio-Economic Vulnerability Index for NMBM is between 3.0-4.0 (with 10.0 being the most vulnerable), ranking NMBM 57/213 in South Africa indicating that the Socio-Economic situation in Gqeberha is average to good overall (Figure 4-1).

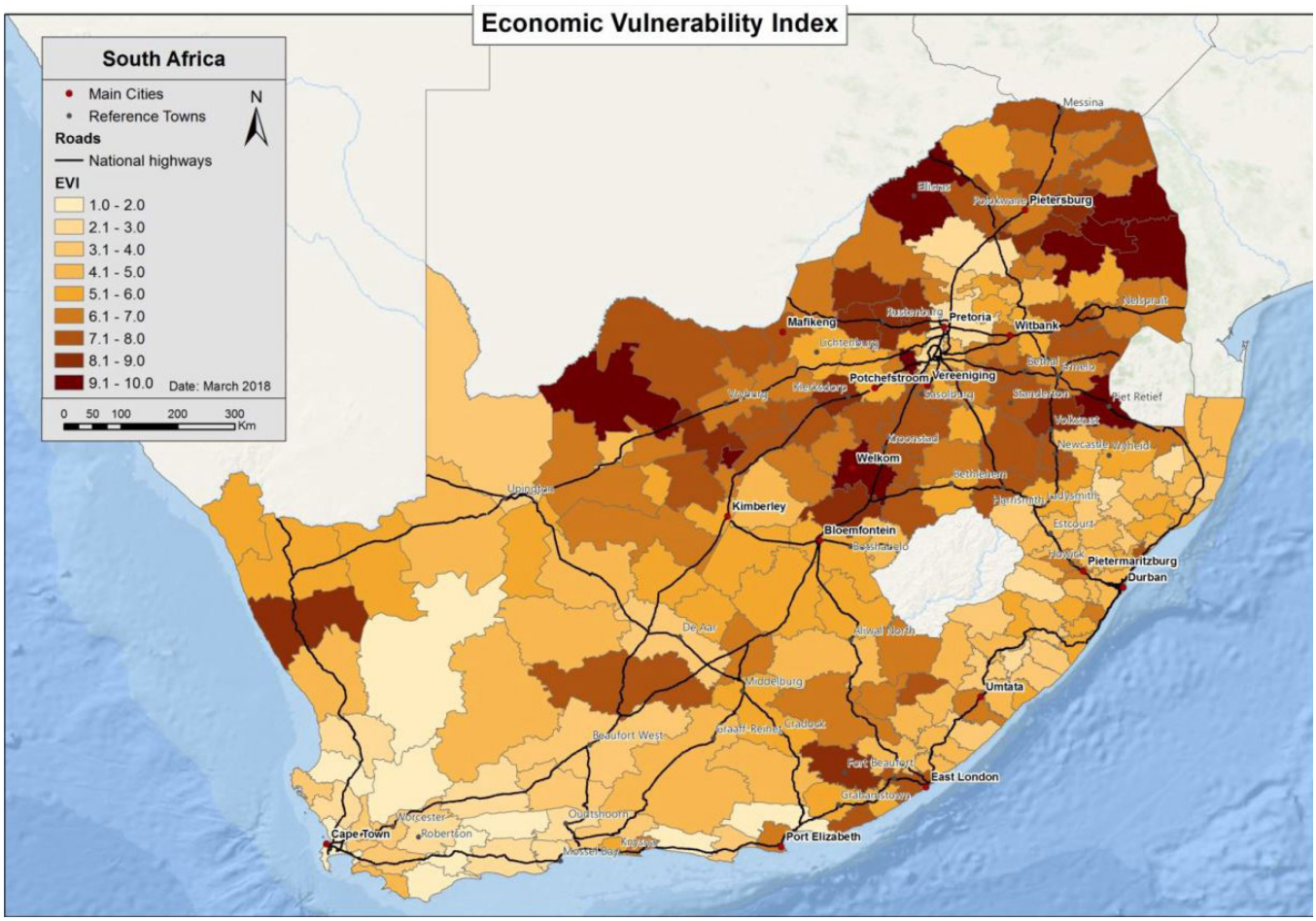
Figure 4-1: *Socio-Economic Vulnerability Index for South Africa (Le Roux, et al., 2019)*



Economic Vulnerability Index

The economic dimension of vulnerability can be described as the potential risks posed by hazards on economic assets and processes within the settlements and their municipalities. Potential hazards can be job losses, increased poverty and interruptions in business activities. Economic vulnerability includes the lack of diversity of a local economy and a dependency on declining sectors. Economic vulnerability also includes a focus on people living in poverty as they are inevitably more vulnerable to disasters and climate-related hazards. This is due to the lack of necessary resources to build (and re-build) safe and secure homes, limited or no access to insurance, and limited access to good quality basic services. Economic vulnerability is characterised by diversification, size of economy, labour force, GDP growth/decline pressure, and inequality. The Economic Vulnerability Index for NMBM is between 6.0-7.0 (with 10.0 being the most vulnerable), ranking NMBM 150/213 in South Africa indicating that Gqeberha is one of the more vulnerable cities in South Africa in terms of economic resilisence (Figure 4-2).

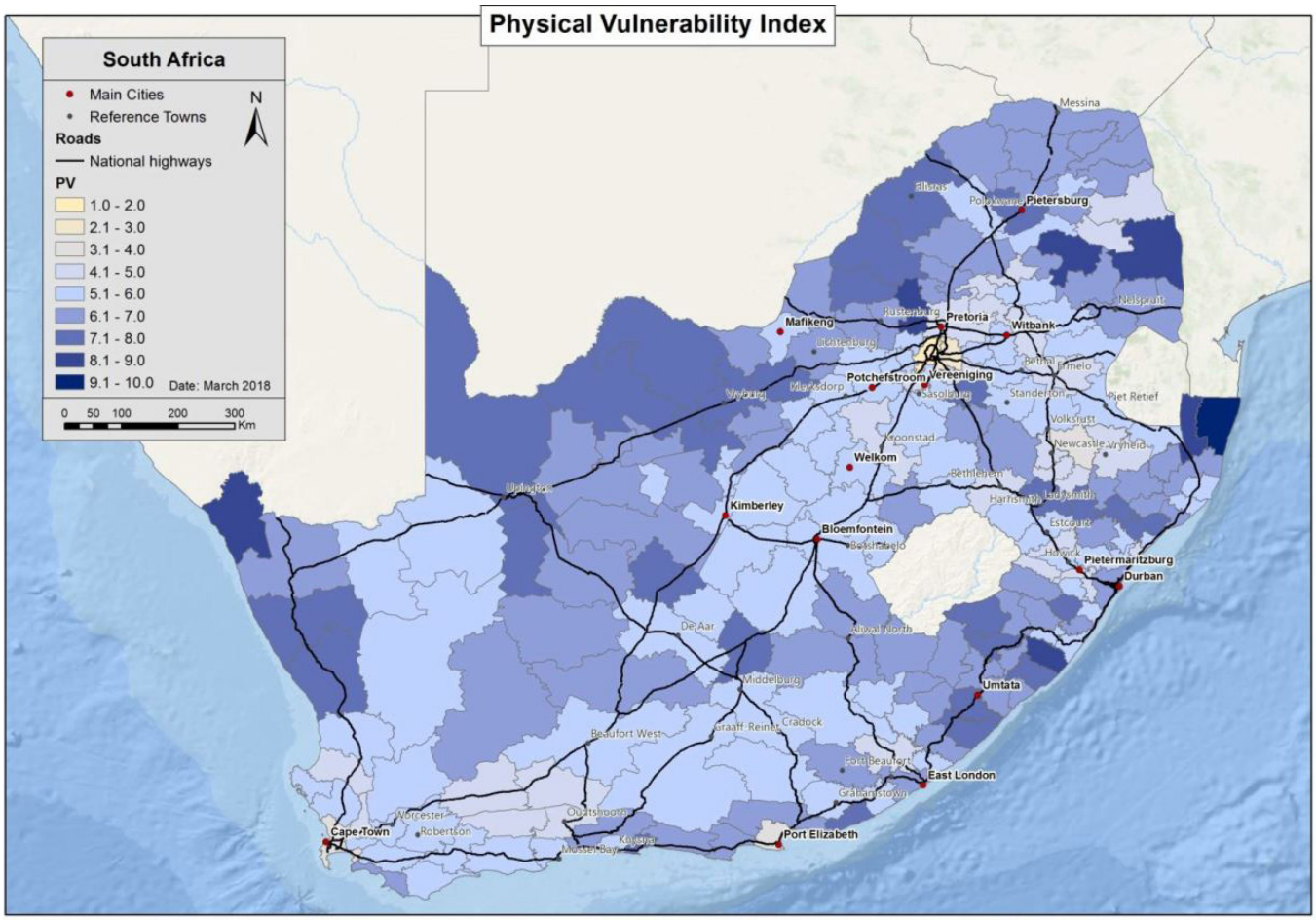
Figure 4-2: *Economic Vulnerability Index for South Africa (Le Roux, et al., 2019)*



Physical Vulnerability Index

The physical dimension of vulnerability relates to the built environment, its fabric and built structures (buildings and infrastructure) and focuses mainly on the conditions that exist before a hazard occurs (exposed elements and their characteristics) and the expected degree of loss which results from the occurrence of a hazard of a given magnitude. Physical vulnerability is determined through assessing road infrastructure, housing type, maintenance of infrastructure, density, and accessibility within the local municipality. The Physical Vulnerability Index NMBM is between 3.0-4.0 (with 10.0 being the most vulnerable), ranking NMBM 5/213 in South Africa indicating that the Physical situation in Gqeberha is good (Figure 4 3).

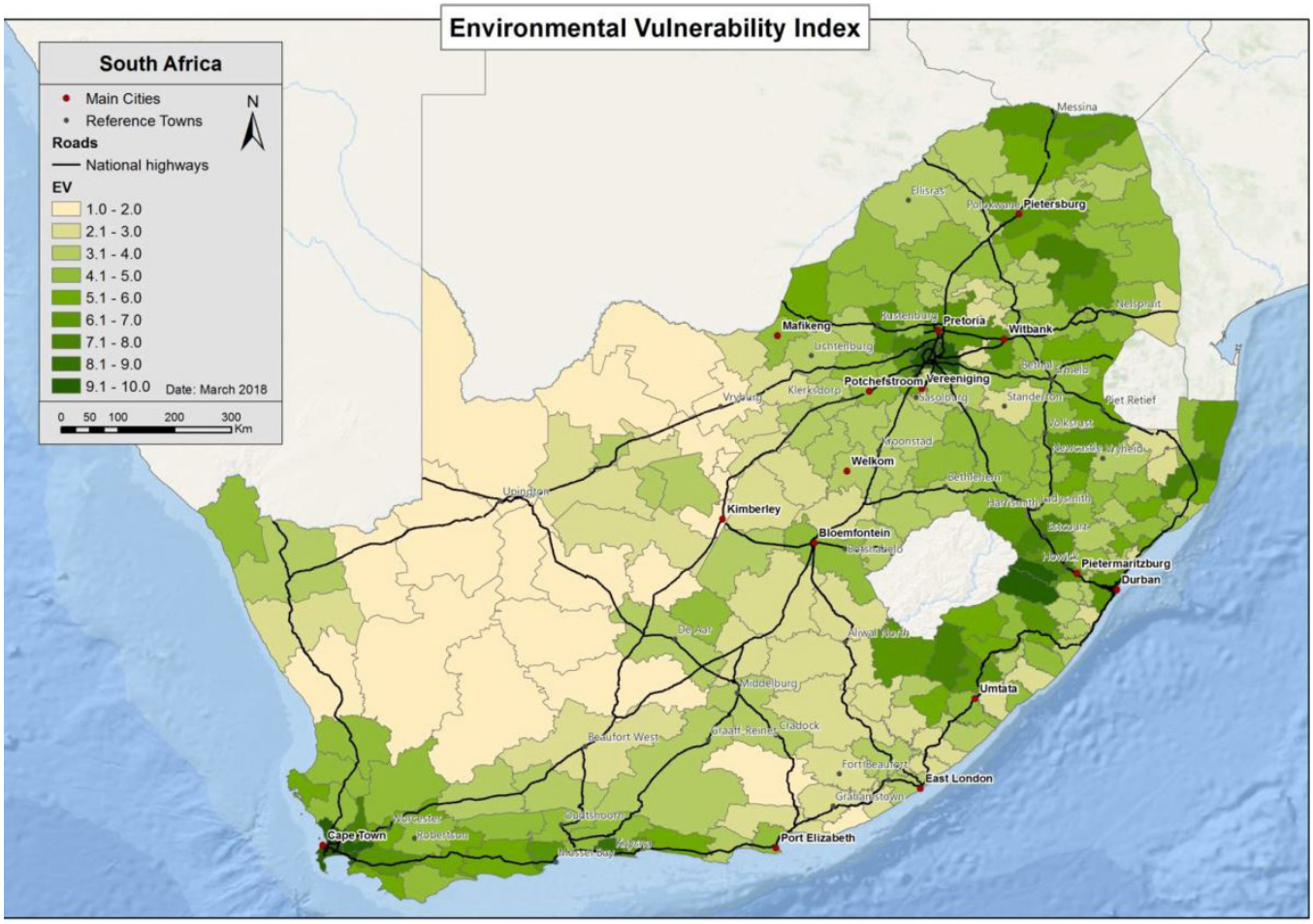
Figure 4-3:
Physical Vulnerability Index for South Africa (Le Roux, et al., 2019)



Environmental Vulnerability Index

The environmental dimension of vulnerability can be defined as the vulnerability and risk to the natural environment and in the case of settlements the impacts on the ecological infrastructure on which such settlements are dependent. The environment that is at risk includes populations and communities of organisms, ecosystems, habitats, physical and biological processes such as reproduction, diversity, energy flows, ecological resilience and natural selection. In essence, it is considered to be the external conditions, factors and influences that affect and surround a settlement or community, including both human-built and natural elements. Environmental vulnerability is characterised by human influence on the environment, ecological infrastructure, water resources, health, and environmental governance. The Environmental Vulnerability Index for NMBM is between 4.0-5.0 (with 10.0 being the most vulnerable), ranking NMBM 142/213 in South Africa indicating that Gqeberha is vulnerable to environmental degredation (Figure 4-4).

Figure 4-4: *Environmental Vulnerability Index for South Africa (Le Roux, et al., 2019)*



NMBM is ranked on a municipal scale against the rest of the municipalities in South Africa according to the four indicators that determine local municipality vulnerability. For the socio-economic and physical vulnerabilities, NMBM performs well against the rest of South Africa maintaining a position in the top 10% of least vulnerable cities in South Africa (Table 4 1).

4.1.2 SETTLEMENT LEVEL VULNERABILITY

Within NMBM, Gqeberha shows significantly different vulnerabilities and risks in comparison to other settlements in the municipality (Figure 4 5). For Gqeberha (i.e. Nelson Mandela Bay), access to services, economic opportunities, and regional connectivity all present low challenges in comparison to other settlements in the municipality. However, the city particularly struggles with environmental threats, growth threats and socio-economic well-being, all indicators of a rapidly growing city and an increasing inequality divide.

Type of Local Municipal Vulnerability	Country-wide Rating (/213), with 1 being the least vulnerable
Socio-Economic Vulnerability	57
Economic Vulnerability	150
Physical Vulnerability	5
Environmental Vulnerability	142

Table 4-1.
NMBM Municipality Ranking (Le Roux, et al., 2019)

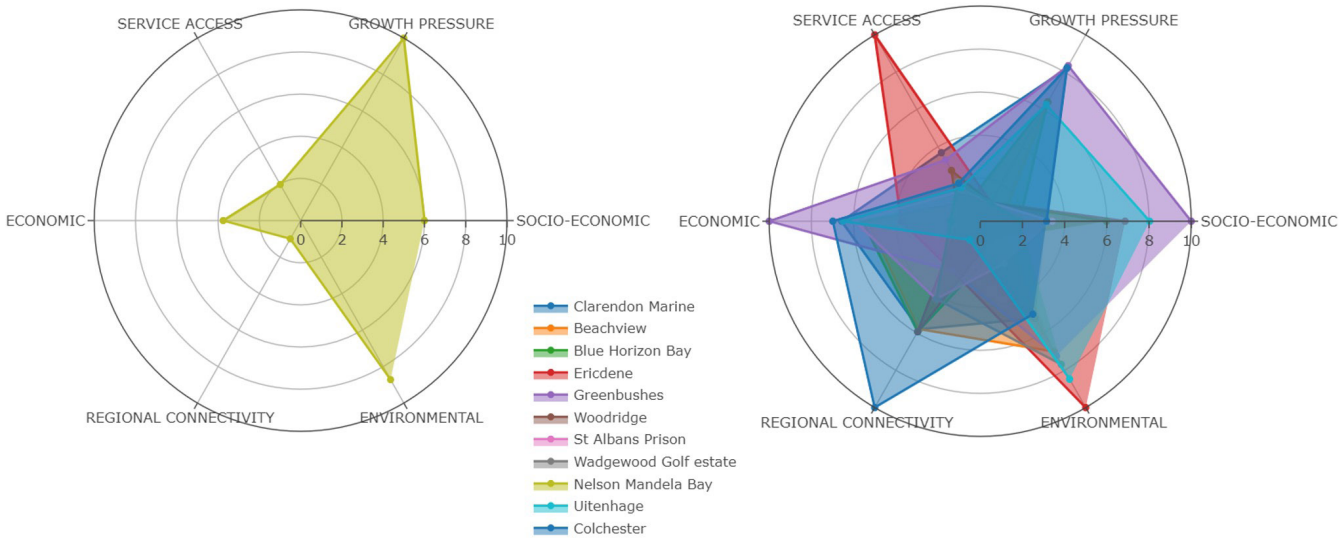


Figure 4-5.
Settlement vulnerability Gqeberha (left) in comparison to other settlements in Nelson Mandela Bay Municipality (right) (Le Roux, et al., 2019)

4.2 KEY SHOCKS AND STRESSES

To attain water resilience, we need to first understand the inherent risks being faced and the associated shocks and stresses. Through the review of existing studies and interviews with key stakeholders, several key shocks and stresses have been identified for the Gqeberha as shown in Table 4-2.

4.2.1 SUMMARY OF KEY SHOCKS

4.2.1.1 WATER SHORTAGES AND DROUGHT

At the time of writing this report in 2022, Gqeberha was experiencing the worst recorded drought since 1979. Since November 2017, the catchments have not had a single rainfall event of greater than 50 mm and as a result the dams are at an all-time low (Figure 4 6). Record high temperatures have exacerbated the situation, with February 2020 having hottest day on record in the past 55 years (NMBM, 2022b). As of January 2022, the combined dam storage was only 18%, and the City has implemented water restrictions of up to 40%. Predictions indicate that drought shocks will likely become more prevalent in the future and will have the greatest impact on poor communities.

Shocks	Stresses
Water Shortages and Drought	Reducing Dam Yields
Failure of Critical Infrastructure	Growth Pressures and Access to Basic Services in informal settlements
Energy Disruption	Declining Groundwater Quality and Reliability
Urban and Coastal Flooding	Environmental Degradation
Riots, Vandalism and Political Unrest	Failure of Spatial Planning
COVID 19 and Other Shocks	Political Instability

Table 4-2.
Key shocks and stresses in NMBM

Figure 4-6.
Kouga Dam spilling (left) and Kouga Dam in 2022 (right) (DWS, 2022)

In response to the drought, some households and business have invested in off-grid water supply sources such as boreholes and rainwater tanks. However, this luxury is only an option for a small percentage of the population, further increasing inequality in Gqeberha.

The response of some industries to the increasing water security risks could also have a direct impact on the financial sustainability of the NMBM. As with other municipalities in South Africa, NMBM generates their income from electricity and water sales. The income derived from the sale of domestic water is small in comparison to the sale of water to industries. The issues associated with intermittent water supply and water restrictions have encouraged some industries to sink their own boreholes and go off-grid. Many of the industries in Gqeberha still purchase their water from the municipality but increasing water uncertainty may force them to also secure their own private sources, thereby cutting off a major revenue source for the municipality.

Another consequence of the uncertainty around water security and drought is a lack of investment in new industries. The Coega Special Economic Zone (SEZ) has not developed as much as anticipated, especially in terms of large foreign investors. Foreign investors have been slow to move to Coega SEZ due to the unsure guarantees of water and energy supply. Many investors have indicated that they will invest once energy and water supply can be assured, and this is the key driving force behind Coega SEZ building a 15 Ml/d desalination plant. The Environmental Impact Assessment for Coega SEZ states that freshwater resources cannot be used for industrial processes and this water must come from desalination or reuse, although a lack of alternative water has prevented the enforcement of this. The Coega SEZ is just one example of the interconnected nature between economics and water availability and the importance of reducing water security risks.

4.2.1.2 COVID-19 AND OTHER SHOCKS

The Covid-19 crisis is a reminder of the impact that global shocks such as pandemics can have, and the accompanying lessons learnt for resilience planning. Gqeberha faced a particularly devastating second wave of Covid-19 in October and November of 2020 when it was the epicentre of the outbreak driven by the Beta variant of the virus[27].

Informal settlements were the least prepared for a global pandemic, due to the inadequate supply of basic services including sufficient water, functioning sanitation and sewer systems, adequate drainage, waste collection services and planned housing (Corburn, et al., 2020). In addition, inhabitants of informal settlements are typically engaged in the informal sector. While workers in the formal sector moved their work to online platforms during the COVID-19 pandemic, those employed in the informal sector immediately lost their employment with no safety nets. The economic impact of COVID-19 in the Eastern Cape Province (of which Gqeberha is the economic centre) is shown in Figure 4-7.

The Covid-19 crisis also highlighted the importance of improved water security for Gqeberha. The city and its surrounding settlements are home to Aspen, the largest generic medicine manufacturer in the southern hemisphere and the leading supplier to both the private and the public sectors in South Africa. Aspen is one of the top twenty generic manufacturers worldwide and South Africa's number one generic brand. In Gqeberha, Aspen produces their own Covid-19 vaccine Aspenovax. Disruptions in energy and water supply will impact the plant's ability to produce vaccines and the water security crisis in Gqeberha was noted as potential risk to the manufacturing of vaccines.

(27) https://www.dailymaverick.co.za/article/2022-05-19-battle-to-save-water-last-straw-for-nelson-mandela-bays-residents/

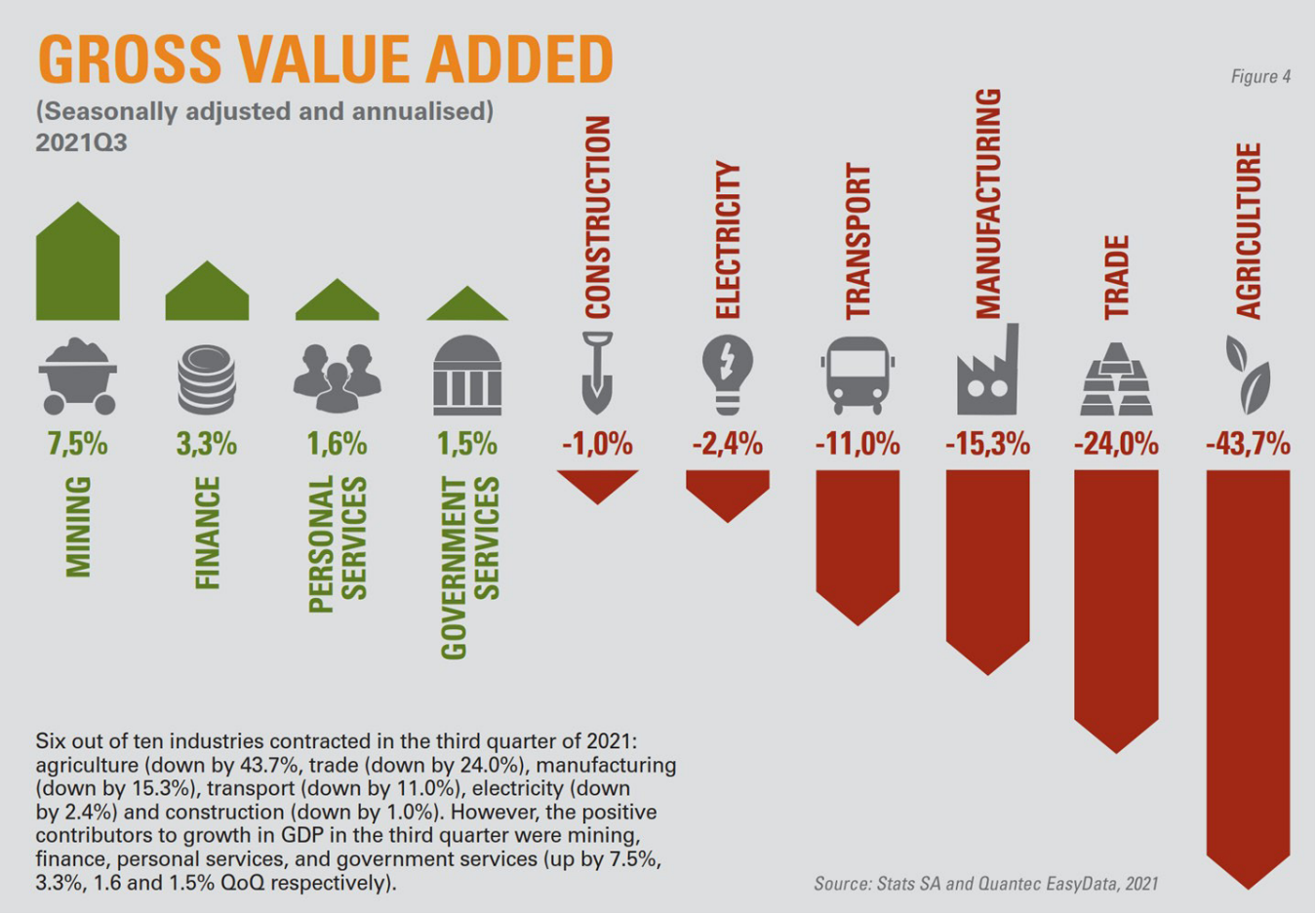


Figure 4-7.
Change in economic activity in the Eastern Cape in mid-2021 (ECSECC, 2017)

4.2.1.3 FAILURE OF CRITICAL INFRASTRUCTURE

Like most other municipalities in South Africa, NMBM faces the challenge of aging infrastructure and a lack of investment towards maintenance, rehabilitation and upgrading of critical infrastructure. Infrastructure failure results in high water loss and disruptions to water supply. Concerns related to the failure of critical infrastructure extends beyond the NMBM and includes other critical components of the Algoa Water Supply System which provides the majority of water to the NMBM.
The Lower Sunday-Fish-Orange River transfer scheme consists of a complicated system of numerous dams, tunnels and canals. Any failure along this system will result in water supply disruption to 52% of the municipality's population, which in most cases results in no water supply. Structural failure of the concrete-lined canals is a potential risk, especially when the age of the system (more than 40 years) is taken into consideration. A landslide damaged the Kirkwood Canal in 2017 and this has not yet been permanently repaired (LSRWUA, 2020) (Figure 4 8). At present the Darlington Dam can only operate at 43% capacity due to dam safety constraints at the Stoney Gates.

The Western sub-system provides 41% of NMBM's water supply, and the Gamtoos canal from Koega Dam has a high risk of failure, as do the aged pipelines from Loerie and Churchill Dams. There have been several occasions in the past where these pipelines have failed or been damaged, resulting in severe water shortages to parts of NMBM.

Figure 4-8.

Damage to the Kirkwood Canal supplying water to the Algoa Water Supply System in 2017, Picture: Riaan Marais[28]

4.2.1.4 ENERGY DISRUPTION - LOAD SHEDDING

South Africa's public electricity utility Eskom is plagued by failing infrastructure and poor maintenance of its coal powered plants. It is forced to initiate load shedding due to a shortage of generation capacity following breakdowns of generating units. Whilst load-shedding is intermittent, it has been regularly increasing over the past 10 years as Eskom has become more unreliable. Energy disruption is critically linked to reliable water supply. The water service providers rely on reliable energy supplies to pump, distribute and treat both the water and wastewater, with the latter contributing to increasing water quality risks. Settlements living in the high lying areas are more vulnerable due to the higher energy demands associated with pumping to high lying reservoirs. This is exacerbated by the drought, where low lying areas are naturally served by the eastern supply system and have an added advantage (NMBM, 2022b).

One of the impressive features of the AWSS is that water is transferred from the Orange River system to NMBM largely under gravity, requiring no additional energy. Energy, however, is required to pump water from Scheepersvlakte Dam and for treatment at Nooitgedacht WTW. Desalination and wastewater reclamation as alternative water sources would require significant energy to operate. The desalination plant currently being developed at Coega SEZ would need to use off-grid energy sources, and Coega SEZ does not currently have alternative energy sources.

(28) https://www.heraldlive.co.za/news/2017-05-19-watch-new-bay-water-disaster/

4.2.1.5 URBAN AND COASTAL FLOODING

Conventional stormwater design is primarily based on principles of conveyance where stormwater is treated as hazardous, and the aim is to rid an area of stormwater as quickly as possible to prevent flooding. However, this design methodology results in an increase in flood peaks and contributes to poor water quality in rivers.

Population growth and urbanisation has resulted in densification and increased impervious areas. Unregulated urban development and sprawl has left communities in NMBM vulnerable to the impacts of flooding. This is particularly true for new developments in disadvantaged and low-income areas due to the limited funding for roads and stormwater construction. Informal houses are often built on natural flood plains or are of poor quality and cannot withstand the impacts of urban flooding. South Africa will likely face increased flooding in the near future due to climate change (Ziervogel, et al., 2014). The scour of gravel from unsurfaced roads and illegal dumping and poor waste removal results in further stormwater blockages (Figure 4 9). Capacity and budget limitations for maintenance of the municipality's stormwater infrastructure results in regular infrastructural failures.

Gqeberha is likely to be impacted by sea level rise as a result of climate change, increasing the risk of flooding particularly during high tide or storm events. It could also increase the risk of flooding from the Swartkops River and other coastal rivers, affecting low lying areas and vulnerable communities. Urban runoff is also a major contributor to poor water quality in the Swartkops River and estuary. Aquatic weeds occur in the lower Swartkops River due to eutrophication of the river from urban runoff (further discussed in Section 4.2.2.4).

Figure 4-9.
Impacts of flooding on an informal settlement in Gqeberha in 2006 (NMBM, n.d.)

4.2.1.6 RIOTS, VANDALISM, AND POLITICAL UNREST

NMBM struggles with frequent vandalism and theft of its water and electrical infrastructure. This vandalism regularly results in water disruptions and outages that last numerous days. Electrical cable thefts from pump stations compromises the distribution of water and vandalism of reservoir electrical control infrastructure results in large water loss. Figure 4 10 shows the effects of vandalism along key pipelines in the NMBM, both of which occurred in March 2022 at the height of the drought. This resulted in parts of Gqeberha being without water for days and the loss of precious water resources. Due to the scale and frequency of the problem and limited government resources, the municipality is often slow to respond to fixing these infrastructure issues. The NMBM has indicated that vandalism is on the increase, likely following the downturned economy during Covid-19.

Inadequate housing, electricity and water supply have been a common feature that triggered violent service delivery protests in Gqeberha (Nomarwayi, et al., 2020). During protest actions, schools and public services such as clinics, and public transport are often closed for days. Protests are more likely to escalate in the informal areas where residents have a greater demand for basic services. Residents in disadvantaged communities have repeatedly turned violent because of poor service delivery, as the municipality or local authorities often only respond to vandalism and destruction of property. While service delivery protests can be traced back many years, the occurrence of this is increasing as the inequality divide grows across the country.

In July 2021 a wave of civil unrest occurred in South Africa, sparked by the imprisonment of former President Jacob Zuma. Over 200 shopping malls were targeted and close to 2,000 retail stores were impacted, mainly in the provinces of Kwa Zulu Natal and Gauteng. The overall impact on the national GDP was estimated to be R50 billion, with far reaching consequences on the economy that can still be felt today[30]. While the same level of civil unrest did not reach NMBM, the economy was still impacted as many stores and businesses closed in fear of the possible looting. Nation-wide riots could occur in the future and will further impact the economy.

Figure 4-10. *A vandalised water beacon outside of Motherwell, March 2022[29], Photo: Joseph Chirume*

(29) https://www.groundup.org.za/article/water-supply-sabotaged-says-nelson-mandela-bay-councillor/
(30) https://pmg.org.za/committee-meeting/33438/

4.2.2 SUMMARY OF KEY STRESSES

4.2.2.1 POPULATION AND ECONOMIC GROWTH PRESSURES

Gqeberha and surrounding areas are expected to experience a high population growth scenario, and the highest levels of population growth in the Eastern Cape Province. The population will likely increase from 1.2 million people in 2020 to 1.55 million people in 2035. This high growth will place extreme pressure on the urban infrastructure and resources.

Informal settlements are expected to have the highest population growth, and already show the highest population densities in NMBM. Increasing population pressures, rural-urban migration, economic vulnerability and low-paid work, marginalisation and displacement caused by conflict, natural disasters and climate change will all accumulate in the decreased resilience of informal settlements and further increase the inequality divide.

4.2.2.2 REDUCING DAM YIELDS

Previous reviews of the hydrology of the major water supply dams have indicated a reduction in the long-term yield of these dams (DWS, 2011). The current low levels of the major water supply dams indicate a potential further reduction in their reliable yield. The DWS is undertaking a study to update the yield of these dams as part of the Algoa West Water Availability Assessment Study. There could be several factors contributing to the declining dam yields:

- **Decrease in long-term rainfall due to climate change.** Global climate change models indicate that the western Kromme and Kouga catchments may experience slightly lower mean annual rainfall and fewer runoff events of 20 mm or more. These models also indicate that the Orange River catchment may experience slightly higher mean annual precipitation and a slight increase in the frequency of rainfall events in excess of 20 mm (WRC, 2011), which together would increase runoff from the catchment of the Orange River that serves the eastern part of the AWSS. This implies that
  - Drought and water shortages in the western part of the AWSS (fed by the Kromme and Kouga catchments) are likely to further increase in the future.
  - The eastern AWSS that is fed by the Orange River will likely remain a reliable source of water for the NMBM (assuming that their allocation remains the same).
- **Sedimentation.** South African dams are losing 0.4% of their original storage capacity every year (Msadala & Basson, 2017), resulting in significant losses over longer planning horizons. Sedimentation is driven by poor land use management and deforestation, and has recently increased in South Africa, likely due to more intense rainfall events or the encroachment of peri-urban settlements into water supply catchments. The impacts of sedimentation are greater in the western part of the AWSS which has experienced higher levels of tree loss and where the dams have smaller capacities.
- **Increase in the spread of Invasive Alien Plants (IAPs).** IAPs are particularly extensive in the Kromme and Gamtoos river catchments in the western AWSS. The Working for Water programme and various local organisations are implementing alien plant control programmes in the Swartkops and Gamtoos River catchments. The Gamtoos Irrigation Board, on behalf of the DFFE, is clearing IAPs in the Kouga, Kromme and Diep river catchments. They currently have 15 projects with 17 fulltime staff, but funding has decreased in recent years. NMBM is also clearing alien vegetation in other catchment areas.

Figure 4-11.
Invasive alien plant clearing by Gamtoos Irrigation Board.[31]

(31) https://gamtooswater.co.za/2019/12/major-project-to-help-alleviate-pe-and-gamtoos-valley-water-supply/

4.2.2.3 GROUNDWATER QUANTITY AND QUALITY

The NMBM's water supply sources are heavily dependent on surface water and several groundwater projects in the region are being explored for diversification. Increasing groundwater utilisation will help support water resilience for the NMBM. However, over-abstraction of groundwater and pollution of groundwater resources are a cause for concern. Groundwater is already being used by private industries, and although all sources should be registered and monitored, this is not always the case. Neighbouring towns, particularly Jeffreys Bay, also rely on groundwater sources and numerous farmers rely on borehole water for irrigation and stock watering. There is uncertainty about whether the groundwater used in NMBM is dynamic groundwater that follows usual rainfall-recharge relationships or is fossil water that could be mined and not replenished (Zutari, 2022). Gqeberha's proximity to the coast also suggests that saltwater intrusion of sea water could occur once groundwater abstraction reaches a certain threshold. Groundwater abstraction would need to be carefully monitored to prevent this.

4.2.2.4 ENVIRONMENTAL DEGRADATION AND WATER QUALITY

Water pollution is a major cause for concern in the NMBM. Sewage pollution from dysfunctional sanitation systems is ranked as the highest and most likely water quality risk in the AWSS (Zutari, 2021). Pesticides and chemicals from upstream crop farms also pose a significant risk. The Sundays River receives substantial irrigation return flows and is battling with salinity issues (Figure 4 12). Urban runoff is a major contributor to poor quality in the Swartkops River and estuary, which is the most polluted river in NMBM (Figure 4 13). Aquatic weeds occur in the lower Swartkops River due to eutrophication of the river from urban runoff. Overloaded and poorly maintained wastewater treatment works, polluted stormwater runoff and solid waste have all contributed to the deterioration in the water quality of the river and estuary. Proper maintenance of sewerage systems, adequate solid waste removal services and increased policing of illegal dumping will all help mitigate this. Industrial wastewater from the Kariega, Despatch and Gqeberha areas all have dangerously high levels of wastewater pollution, which largely discharge into the Coega River. Figure 4 14 also shows the impact that IAPs are having on the local biodiversity. The southern part of the municipality and the Swartkops River are the most threatened ecosystems, due to IAPs and high pollution loads respectively.

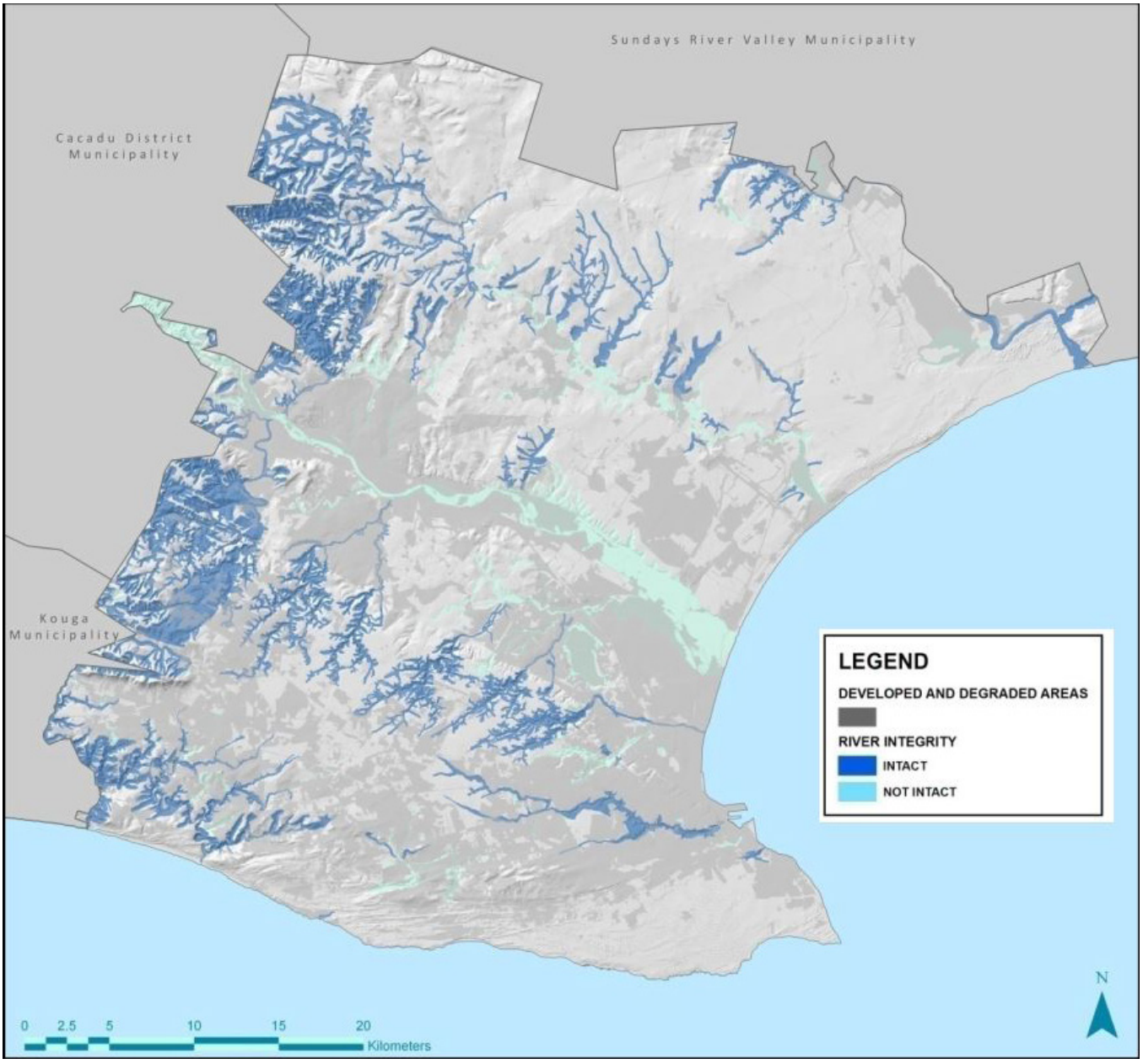


Figure 4-12.
Ecological integrity of riverine systems in NMBM (SRK Consulting, 2010)

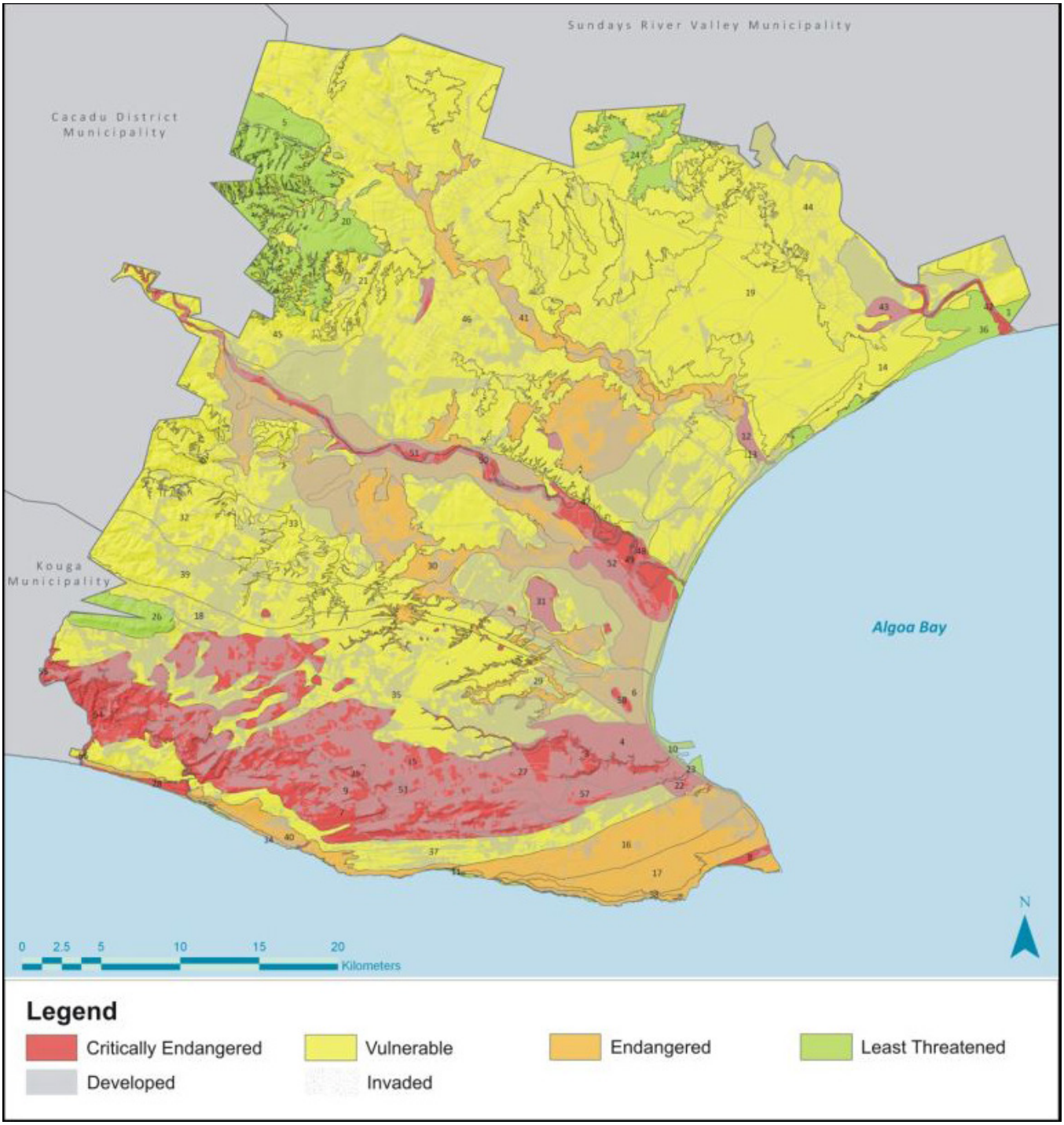


Figure 4-13.
Status of ecosystems (SRK Consulting, 2010)

4.2.2.5 LIMITED SPATIAL PLANNING AND ENFORCEMENT

Zoning and building regulations were enforced during the Apartheid era to regulate urban growth. This resulted in the emergence of informal settlements. While the NMBM has a formal process of urban planning, population pressures and the lack of enforcement has led to unregulated development and informality. This has serious implications for flood vulnerability in urban centres such as the NMBM. Much of the densification and unplanned urbanisation has resulted in an upsurge in development on unstable, steep-sided slopes and floodplains. When flooding occurs, these settlements are the most prone to flooding as they have inadequate or no drainage systems, and the structural integrity of the homes are weak (Figure 4 9). This has consequently led to increasing damage costs and the loss of human lives that is also evident in other developing countries. Increasing evidence supports the better alignment of spatial planning with water resource and climate change planning.

4.2.2.6 POLITICAL INSTABILITY AND GOVERNANCE

The political situation in NMBM is constantly changing, and high levels of wasteful expenditure are causing residents to lose faith in the political establishment. Between 2011 and 2016, the city had three mayors and five municipal managers in five years. Reports in April 2022 suggested that the city had two acting managers, both claiming to be legitimate[32]. This highlights the dysfunctional nature of the governing party. Eugene Johnston was elected at the city mayor in November 2021, and was voted out of office in September 2022, partly due to the repercussions of the severe drought crises and a perceived lack of action.

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https://mg.co.za/opinion/2022-04-27-two-city-managers-one-municipality-why-reforms-are-urgent/

4.3 CLIMATE CHANGE RISK AND VULNERABILITY

The key climate change threats to Gqeberha and its surrounding settlements are summarised in Figure 4-15.

Drought Tendency Risk: Drought tendency risk is aligned with increasing average temperatures and precipitation variability resulting in reduced annual precipitation. This directly impacts water security.

Wild-fires Risk: Wild-fires risk is linked to the drought tendency and heat stress risks. With increasing aridity, hot days are a catalyst for wildfires. This poses a risk to infrastructure, the environment and liveability in cities. A higher wild-fire risk also intensifies the need for readily available fire suppressants, thereby impacting water availability and storage.

Heat Stress Risk: Heat Stress Risk is directly proportional to the number of hot days in a year. As temperatures increase, so does the demand for water.

Extreme rainfall events and urban flooding risk: Intensifying precipitation increases the risk of urban flooding. If not appropriately planned and designed for, this has the potential to cause

Figure 4-15. Climate change predictions for NMBM (NMBM, 2015)

Nelson Mandela Bay's Climage Threats	
Change in temperature patterns	More hot days and heat waves; higher minimum temperatures and fewer cold spells; higher average temperature
Change in rainfall patterns	Decreases in average rainfall and number of rainfall events, BUT increase in rainfall intensity
Change in drought patterns	Increase in frequency (i.e. current 1:10 year drought occurs more often)
Change in flood patterns	Increase in intensity (i.e. 1:100 year flood will increase in magnitude)
Change in fire patterns	More frequent fires
Sea level rise	58cm-75cm rise in sea level
Change in storm surge patterns	Higher probablility of extreme storm surges
Change in wind patterns	Strengthening of easterly winds, weakening of westerly winds

infrastructure damage and loss of life. Business continuity could be interrupted due to people not being mobile and communication breakdowns during intense storms. Due to climate change, NMBM is expected to experience a slight to moderate increase in extreme rainfall days and urban flooding.

Coastal inundation: NMBM is the second largest metro in South Africa in terms of urban sprawl. This presents a particular challenge as much of the city has developed along the coastline. NMBM and Durban are the only settlements along the east coast of South Africa that are at risk of extreme coastal flooding (Lück-Vogel, et al., 2019). Algoa Bay and the Swartkops estuary are particularly at risk of flooding from increased tidal waves and sea water rise. The city is already facing increasing storm surges, and coastal inundation will impact the estuary's backwater. Studies indicate that most of the coastal areas and ports in NMBM will need to establish coastal set-back lines (NMBM, 2012a).

Ocean water quality: Algoa Bay is already experiencing an increase in red tide events, a phenomenon caused by algal blooms that deplete oxygen and release toxins. Warming ocean waters from climate change are likely to increase the upwelling process and occurrence of red tides in the future (Figure 4-16).

Migration and increased urban pressures: Gqeberha's high population growth rate is partly driven by migration from surrounding rural areas in the Eastern Cape. As climate change pressures such as drought impact the rural agricultural sector, migration from rural areas will likely increase.

Figure 4-12.
Ecological integrity of riverine systems in NMBM (SRK Consulting, 2010)[35]

(35) https://www.dailymaverick.co.za/article/2022-01-27-call-to-action-after-devastating-best-case-scenario-for-nelson-mandela-bay/

5

KEY PROJECTS, POLICIES AND PROGRAMMES

5.1 DWS SOUTHERN RECONCILIATION STUDY

DATE: ONGOING

DWS are in the process of developing, updating and reviewing strategies to reconcile water availability and requirements in the Southern Planning Area, up to June 2024. The Southern Planning Area is comprised of the Western Cape, Amatole and Algoa water supply systems, as well as the towns and clusters of villages in the area.

The Algoa Reconciliation Strategy was initially completed in 2010 and was subsequently updated thereafter, up to September 2018. As part of this study the following will be achieved:

- Profiling of the various water use sectors in the project focus area in order to establish the socio-economic baseline that can be used to project future economic developments under the various water demand and supply scenarios.
  - Metropolitan areas – Industrial, Commercial and Households;
  - Large Towns that will be identified with the rest of the project team;
  - Potential electricity generation;
  - Potential Mining activities;
  - Irrigation Agriculture with its sub-sectors subdivided into the relevant sub-areas.
- A partial general socio-economic equilibrium analysis will used to quantify the social and economic impacts of the specific region or activities.
- The socio-economic loss impacts resulting from restrictions imposed on the catchment area users due to a climate event or the system being over-allocated will be modelled for different scenarios.
- An analysis will be performed to estimate the future projected economic growth of the specific area.

Several other ongoing studies have significant synergy with this study, namely:

- Study for the National Water Resource Balances Perspectives for South Africa, being undertaken by JG Afrika (national study);
- Update the Climate Change Status Quo Analysis for Water Resource and the Development of the Climate Change Response Strategy for the Water and Sanitation Sector (Emanti, Zutari & UCT/ CSAG) (national study);
- Development of Operating Rules for Water Supply and Drought Management of Stand-alone Dams, Schemes, and Integrated Systems in the Southern Water Planning Area (WP11251), being undertaken by Mariswe (Pty) Ltd. for DWS (Integrated Systems & Stand Alone Dams AORs South);
- General Modelling and Water Resource Evaluation Services for Allocable Water Quantification and to Support Integrated Water Resource Planning (Kouga, Baviaans, Gamtoos and Kromme Rivers) (WP11336), being undertaken by Mariswe (Pty) Ltd. for DWS (Algoa West Water Availability Assessment Study (WAAS));
- Determination of Water Resource Classes, Reserve and the Resource Quality Objectives in the Keiskamma and Fish to Tsitsikamma Catchments within the Mzimvubu-Tsitsikamma Water Management Area (WP11354), being undertaken by Groundtruth.

5.2 DROUGHT MITIGATION PLAN

DATE: 2022

The NMBM released an updated Drought Mitigation Plan in March 2022 to tackle the present drought. The purpose of this Plan is to document an action plan to fast track interventions and measures to diversify its water supply and further reduce the current water demand. The NMBM is currently at severe risk of depleting its water resources and it is imperative that measures are put in place to mitigate and address the drought disaster. The two main drought mitigation actions include:

Measures to reduce water demand:

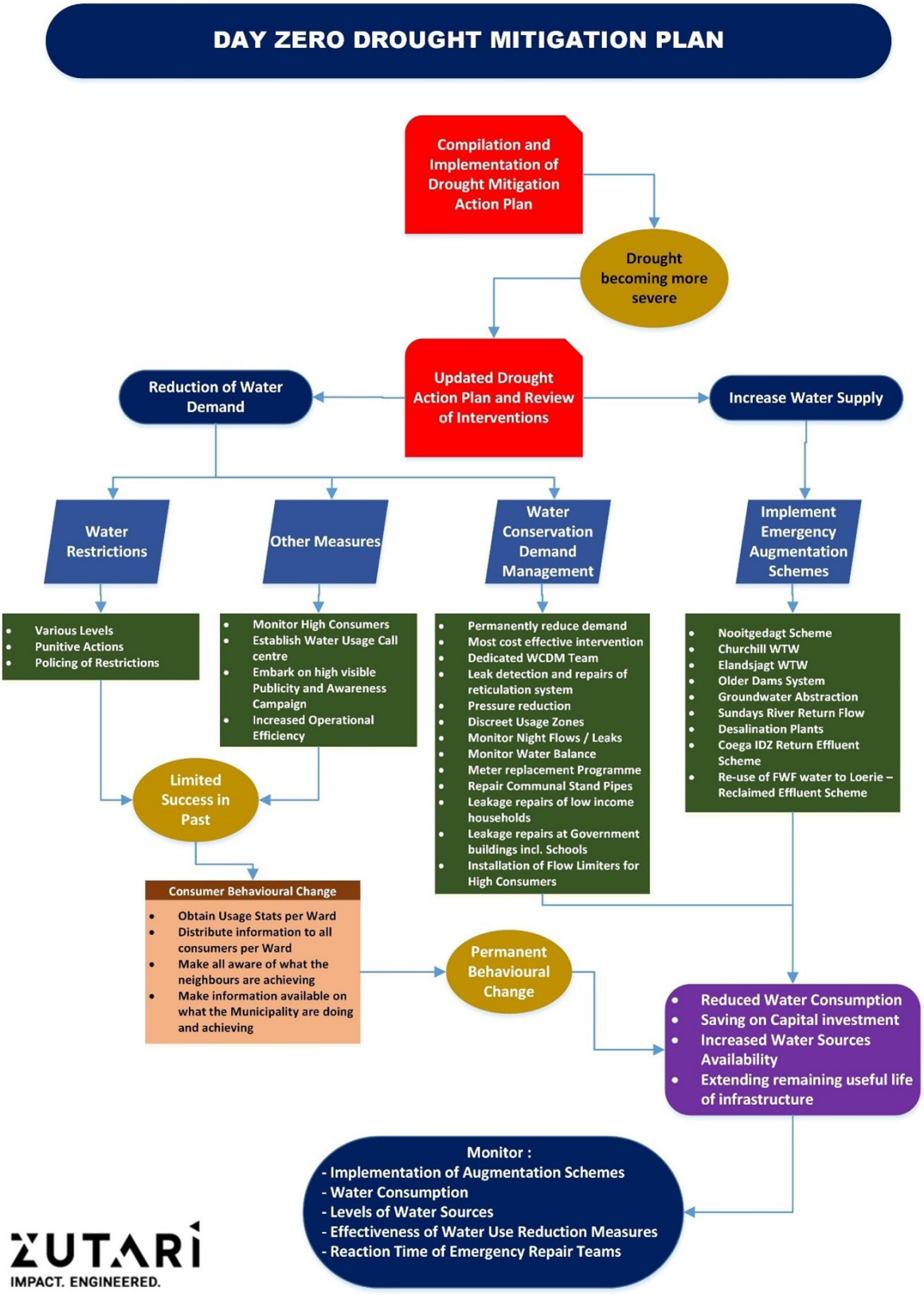
- Implementation of water restrictions
- Public awareness and improved operations & maintenance
- Water conservation and demand management
- Consumer behavioral change

Measures to increase/augment water supply:

- Implementation of emergency augmentation schemes

Figure 5-1 illustrates the drought implementation strategy that is being implemented. Details regarding the projects are included in Appendix A: Drought Augmentation options.

Figure 5-1:
Drought mitigation plan for NMBM (NMBM, 2022a)



5.3 INTEGRATED DEVELOPMENT PLAN

DATE: 2018-2022

In fulfilling their developmental mandate, municipalities are required by the Constitution of the Republic of South Africa to prepare five-year Integrated Development Plans (IDPs). These serve as strategic plans that indicate where and how cities should allocate their resources in line with their vision and mission, which are embodied in their long-term plans inclusive of provincial and national government strategies. The fourth edition of the NMBM IDP is for 2017/18 – 2021/22 and is renewed annually. The focus of 2020/2021 IDP review has been on aligning municipal programmes, projects, strategies and budgets within the context of COVID-19 with community needs and priorities, prioritisation of health, safety, the economy and poverty eradication as well as integrated approaches to municipal planning and development. Water & Sanitation Capital Budget part of the Integrated Development Plan.

The 2020 Vision and Mission of NMBM are as follows:

Vision: 'To be a globally competitive and preferred Metropole that works collectively with the people to improve lives, boost the economy, advocating zero corruption, and to have a transformed administration aimed at enhancing service delivery.'

Mission Statement: 'Nelson Mandela Bay Municipality is a global city that is governed by an inclusive and innovative administration, focused on sustainable service delivery, socio-economic development, infrastructure development, local and regional integration through comprehensive initiatives.'

5.4 METROPOLITAN SPATIAL DEVELOPMENT FRAMEWORK

DATE: 2018-2022

The Metropolitan Spatial Development Framework (MSDF) is the primary spatial plan of the city and represents the spatial manifestation of the IDP. All matters of a spatial nature concerning the Municipality are encapsulated in the MSDF. The initial MSDF for NMBM was approved by Council in 2009 and a second version was approved in December 2015. The Spatial Planning and Land Use Management Act 2013 (SPLUMA) sets the legal framework for the SDFs of South African municipalities. A major review of the MSDF is scheduled for completion during 2021/22 in order to align with the new IDP.

The plan guides the overall spatial form of the municipality and identifies current and future desirable land uses within the Municipality in order to give physical effect to the vision, goals and objectives of the IDP. The MSDF identifies major transport routes, future transport links, environmentally important areas and key development opportunities and constraints. The MSDF also aims to sequence future development areas in a manner that makes the best use of infrastructure services and limits the leapfrogging of development and the unnecessary expansion of infrastructure networks.

5.5 WATER SERVICES DEVELOPMENT PLAN

DATE: 2018-2019

Water Services Development Plan (WSDP) are compiled in accordance with the requirements of the Water Services Act. The WSDP Report consists of eight (8) topics, the information is captured via an Integrated Regulatory Information System via the Department of Water and Sanitation.

The purpose of the WSDP lies in the need to plan for water services whereby key targets of the NMBM are set for a 5-year period. Furthermore, it is a mechanism used to identify and address water service priorities, in terms of Basic Water Services, High Level of Services, Water Resources, Environmental Impacts, Effective Management, and Transfers within the NMBM's area of jurisdiction. Finally, the WSDP forms the basis on which the Water and Sanitation Master Plans are based that in turn provides more detail for planning purposes.

The NMBM is required to compile a new WSDP every five years. Whilst the last time that council approved the document was the WSDP 2003 (Council resolution 55 of 18 August 2003), the NMBM has submitted updated versions to the DWS with the last being WSDP Revision 2: 2018 (2018 - 2019).

5.6 WATER MASTER PLAN

DATE: 2011-2035

The main objective of the water master planning process is to ensure that all communities can be supplied with services that meet acceptable standards.

The Water Master Plan (WMP) mainly deals with water services planning (as opposed to water resource planning) and focuses on the optimal analyses, planning and management of water distribution and sewer reticulation systems through the application of fit-for-purpose software applications such as:

- SWIFT that performs advanced statistical analyses of data from utility billing databases
- Wadiso the analyses and optimally design water disctribution systems
- Sewsan to simulate, analyse and design sewer reticulation systems; etc.

The WMP thus analyses the (i) existing system (as-built information) as well as (ii) present and future land use and water demand to advise on future distribution zones and required works (i.e. potable infrastructure) as well as associated cost estimates of these.

The analyses of all bulk water infrastructure upstream of the Water Treatment Plant (viz. abstraction infrastructure, raw bulk storage, raw water pump stations and raw water mains) is thus beyond the scope of a WMP.

WMPs is not a regulatory requirement of any national or local government legislation. However, it is advisable that a WMP is updated by a WSA on a five-year-basis (back-to-back with a WSDP) to sufficiently inform both water and sewer projects to be incorporated in a WSDP.

The 2011-2035 WMP for NMBM reviews the proposals and infrastructure recommendations of the 2006 WMP through an analysis and evaluation of historical, present and estimated future water usage by the NMBM for the period 2011 to 2035, taking into account the water needs and the impacts on water supply that may follow from the following:

- The NMBM 10 year Housing Development Plan
- The NMBM SDF (approved March 2009) with proposed Urban Fence Line
- IDP projects as prioritised for implementation
- NMBM Vision 2020 projects
- NMBM Rural Development Policy - 2010
- Water Services Development Plan 2006 – proposed projects for a 5 years horizon

5.7 CLIMATE CHANGE AND GREEN ECONOMY ACTION PLAN

DATE: 2015

The NMBM adopted an Integrated Environmental Policy with sector specific commitments (in 2012) and have a Disaster Management Policy as well as Enterprise Risk Management Policy. These formed the basis of the Climate Change and Green Economy Action Plan that was published in 2015.

The Climate Change & Green Economy Action Plan consequently speaks to the ultimate goal of ensuring a climate resilient Nelson Mandela Bay through the achievement of eight objectives and targets that correspond to the four overarching capitals, as depicted in Figure 5-2. The objectives and targets are to be achieved through a range of specific intervention programmes that each correspond to a set of specific tasks. The targets set for each high-level objective or outcome are to be used as a 'dashboard' to show how NMBM is doing in terms of the overall goal of becoming more resilient, but also to flash warning signals when one of the dimensions of resilience is being neglected or not fully realised as intended. The 15 climate change programmes identified are shown in Figure 5-3.

The Action Plan includes a Measurement, Reporting and Verification Plan, although the status of this is unknown.

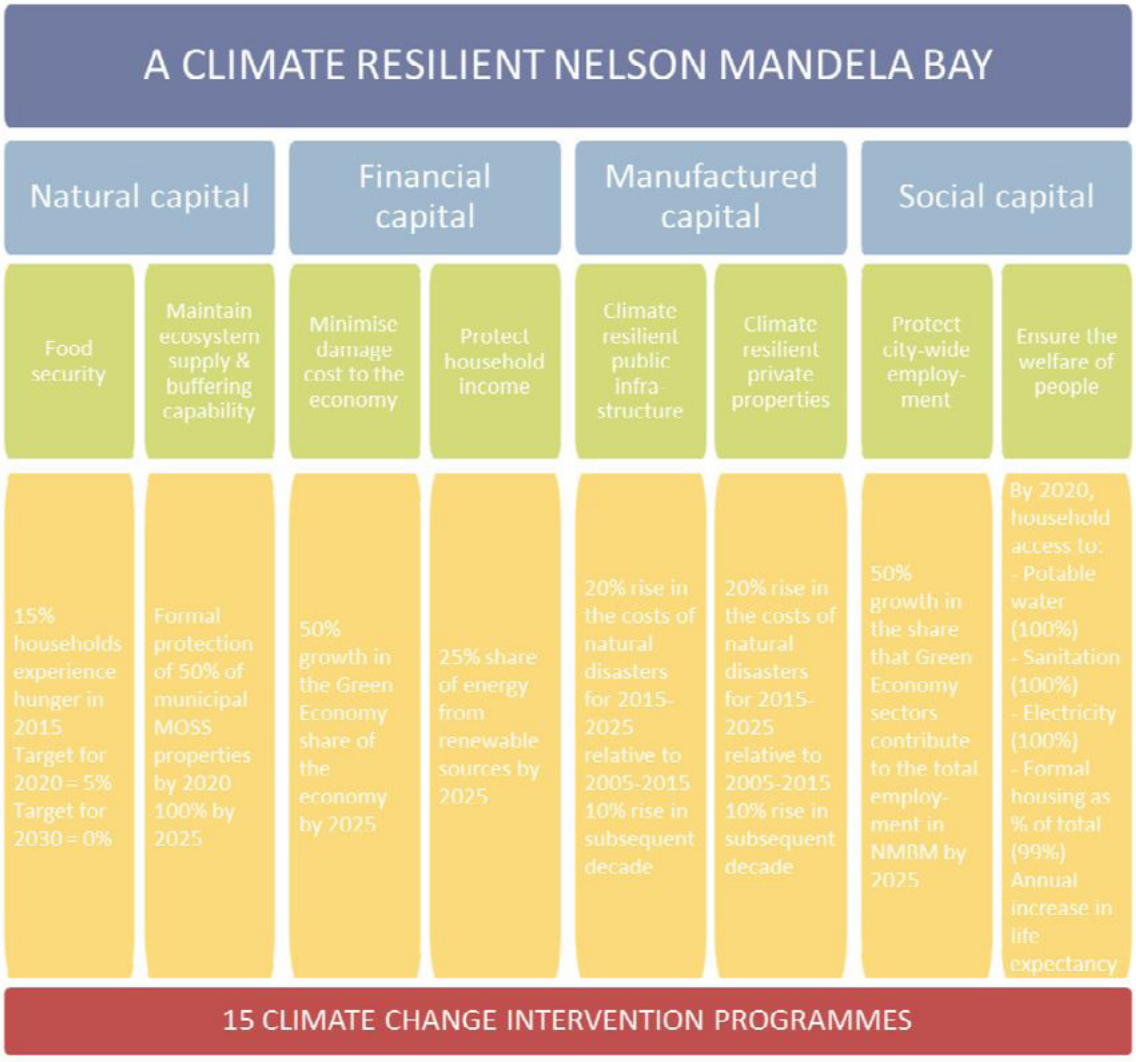


Figure 5-2: *Structure of the Climate Change and Green Economy Action Plan (NMBM, 2015)*

Figure 5-3: *The 15 intervention programmes (NMBM, 2015)*

6

NEXT STEPS WITH THE URBAN WATER RESILIENCE ASSESSMENT IN GQEBERHA

The key findings of the Gqeberha City Characterization Report support that Gqeberha and the water system it depends upon, Algoa Water Supply System, are vulnerable and impacted by many types of shocks and stresses, including change in weather patterns affecting rainfall, extreme growth pressures, environment degradation, energy disruptions, aging water and sanitation infrastructure, limited investments towards the water sector, and political and governance instability. At the time of writing this report (June 2022), the Gqeberha, the NMBM, and the surrounding regions are experiencing a severe drought and water supply crisis due to below average rainfall (likely caused by climate change), increasing demands and infrastructure capacity limitations. The main water supply dams have been declining since November 2015 and the local dam levels are sitting at 14% as of 29 June 20221, the lowest storage volume recorded for this time of year since 1979. Should no significant changes occur soon, Gqeberha will likely run out of water and become South Africa's first major city to reach a 'day zero' scenario.

Considering the current water crisis the NMBM is facing and the government's focus on short-term drought mitigation measures, the Urban Water Resilience initiative will follow an approach that is sensitive to the local context. This sensitivity will be considered when engaging with the Municipal officials and other stakeholders. We will balance the critical need to ensure future urban water resilience with the Municipality's own pressing concerns during this period of disaster. The remaining steps for the project therefore include the following:

Stakeholder resilience and visioning workshops:
WRI and partners will continue to work collaboratively with NMBM towards initiating and advancing a city water resilience agenda using the City Water Resilience Approach. The City Water Resilience Framework will be populated with data gathered through interactive workshops with the stakeholders in NMBM that offer a range of resilience perspectives. Given the current drought, the format of these workshops will need to be reassessed on an ongoing basis. Currently the approach for the resilience workshops is smaller focus group discussions, taking place online over the months of July to September 2022 (dependent on development of the water crisis). The outcome of these workshops will be a scored CWRF wheel, such as the one developed for Johannesburg (see Figure 6-1). The resilience workshops will be followed by a visioning workshop that will develop a water resilience vision for Gqeberha's future. The visioning workshop is set to take place in September to November 2022. The visioning workshop will also aid in identifying key areas for action.

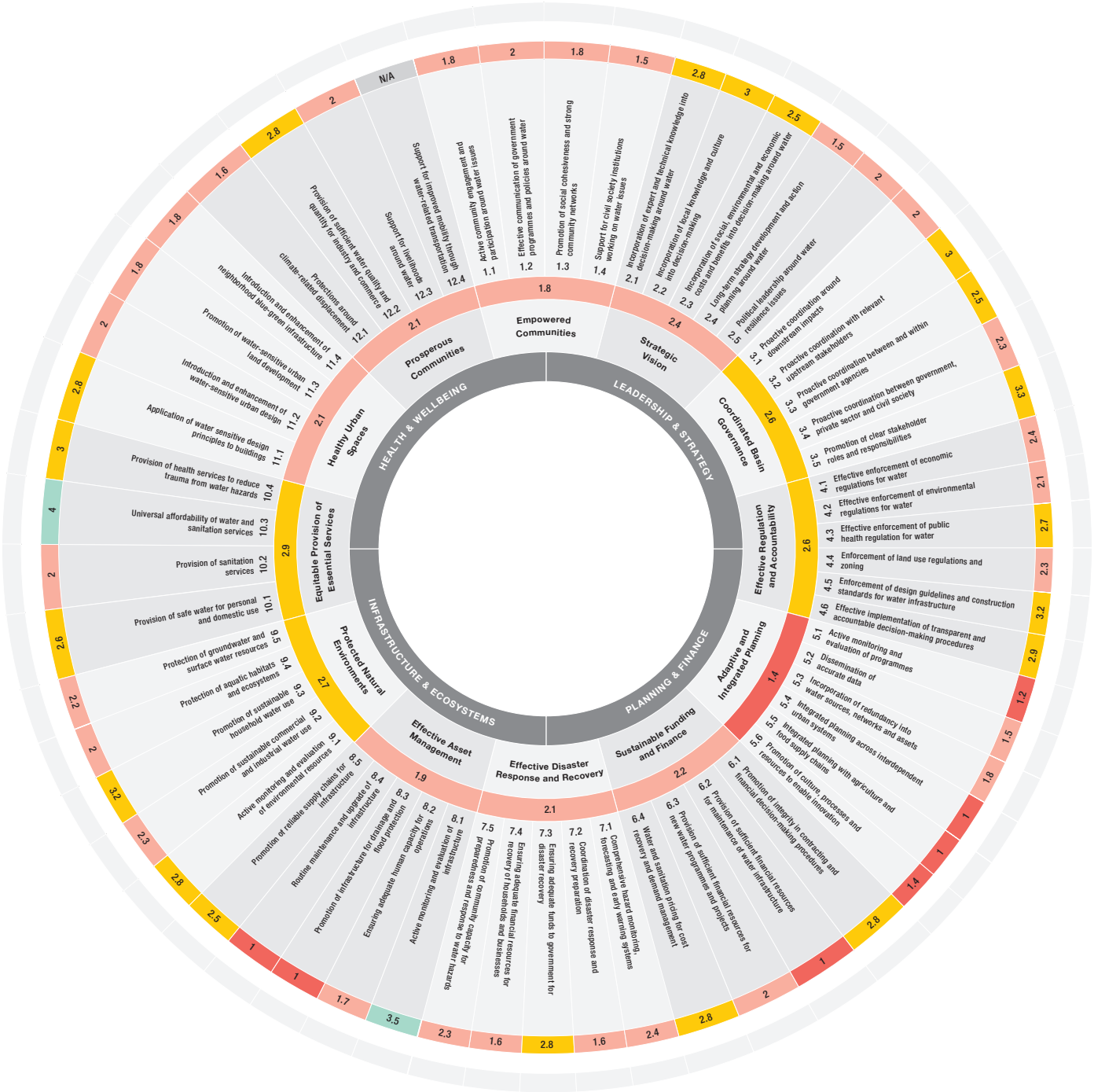
City water resilience profile and action plan:
Based on the key action areas identified in the visioning workshop, a Resilience Profile and Action Plan for Gqeberha will be developed that will contribute to tackling the shocks and stresses that directly and indirectly impact the urban water system. This action plan will be finalised in December 2022.

Technical assistance plan: Parallel to the development of the City water resilience profile and action plan, the task team will continue engaging with the Municipality, WRI and other key partners to develop a technical assistance plan for one or two priority areas. Based on conversations had with the NMBM water lead outlined in Section 3.8, it is apparent that high non-revenue water remains a critical area of concern for the Municipality. Reducing non revenue water will not only ensure urban water resilience in the short and long term, but will also enable NMBM to unlock additional government funding, as many grants are dependent on municipalities showing a clear reduction in non-revenue water. In line with this, engagements have been initiated with Castalia to develop a concept note for a non-revenue water Performance Based Contract. This concept note will continue to be strengthened during the remainder of the project.

Continued support for the DWS southern reconciliation study: The southern reconciliation study (see Section 5.1) is key to ensuring long-term water supply and availability for Gqeberha and the greater Algoa Water Supply System. The project team is already actively engaging with the Department of Water and Sanitation and service provider Zutari, and is a key partner in the Project Steering Committee for the Algoa Water Supply System. Continued engagement will ensure the alignment of long-term water reconciliation and urban water resilience planning for the City and surrounding settlements.

Figure 6.1:

Example of a scored City Water Resilience Framework wheel for Johannesburg, South Africa. The resilience workshops took place in May 2022. The objective of the next phase of the implementation of the UWRA is to do a similar resilience scoring for Gqeberha.



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APPENDIX A: DROUGHT AUGMENTATION OPTIONS

The NMBM is exploring several water supply augmentation options to be implemented both as emergency drought response plans, but also to improve the long-term water security situation for Gqeberha. These planned projects and their status are discussed below (NMBM, 2022a) .

A.1 IMPROVING/UPGRADING OF LOCAL SOURCES

Upgrading of the Impofu Barges: When the water storage level drops below 17%, the Impofu Dam reaches dead storage capacity and the pumps in the intake tower are not able to function. Following the upgrade of the abstraction capacity and the commissioning of the second barge in August 2021, with an additional maximum abstraction capacity of 33.5 Ml/day, a combined maximum capacity of 67.25 Ml/day can now be abstracted from the Impofu Dam (Figure 8-1).

Churchill WTW Backwash recovery: The Churchill WTW uses gravity filters which blocks up after a period of time. The filters are therefore regularly backwashed with water which is abstracted from the dam. During the backwashing cycle, the water is currently being discharged into the river downstream of the WTW, effectively resulting in a 5 – 25% water loss depending on the daily treated water volume. The design for recycling of the backwash water has already been completed and approved by the NMBM. The construction phase will commence in due course once the NMBM has accepted quotations and appointed a contractor to proceed accordingly. The NMBM estimates that an additional R 2 million is required for the construction phase of this project and aims to have the backwash recovery intervention commissioned by the end of August 2022.

Refurbishment of the Linton WTW: The WTW receives water from our older dams via Central WSS. Historically only less than 3 Ml/day has been treated and supplied. The recent rehabilitation carried out to this 80-year-old plant resulted in an increase of the plant's treatment capacity to 7 Ml/day. Further operational improvements are carried out to boost the treatment capacity even further

Lower and Upper Van Stadens dams: The total permissible abstraction allocation of approximately 3 Ml/day from the Lower Van Stadens and Upper Van Stadens Gorge Dams are not being utilized at this stage. This is mainly due to old and outdated infrastructure/pumping equipment that must urgently be upgraded/refurbished so that the entire allocation from this source can be fully utilized in order to offset some of the volume of water currently being abstracted from the Kouga Dam, via the Loerie Balancing Dam. The NMBM investigated the requirements to upgrade/refurbish the infrastructure in order to re-instate the abstraction from these dams to supply the Linton WTW accordingly. Although the electrical supply was sufficient, a new pump set will be required together with minor modifications to existing pipework to accommodate the new pump set. The NMBM recently procured the new pump set as indicated by the figure below and is in the process of modifying the existing pipework accordingly.

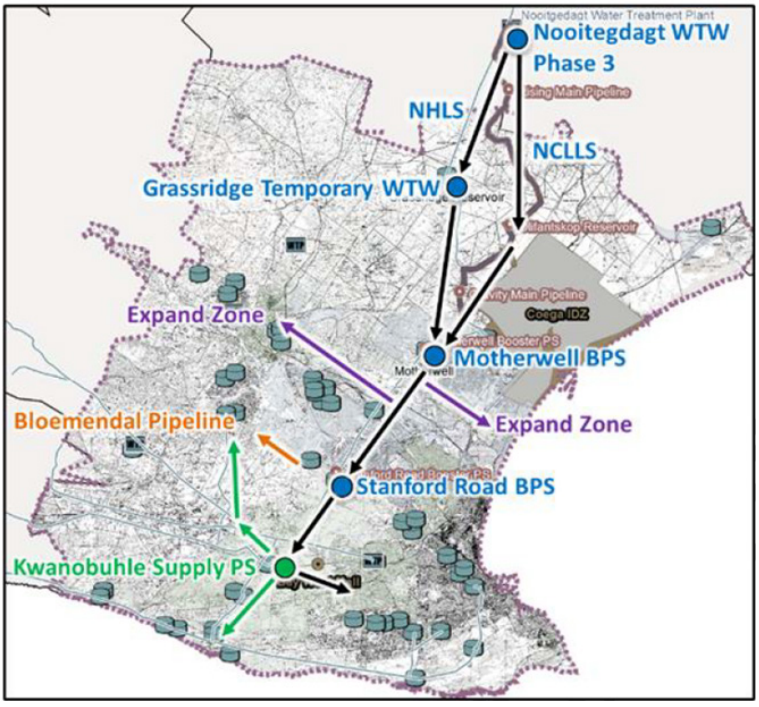
Figure 8-1: *Upgrading barges in Impofu Dam (NMBM, 2022a)*

A.2 MAXIMISING NOOITGEDACHT WTW

To meet the continuing growth in water demand, the Nooitgedagt High Level Scheme project commenced in 1993. This scheme linked the then drought stricken Eastern Cape metropolitan area to the Orange River Supply source. This forms part of the Eastern Water Supply System of the Algoa WSS and is a crucial link in the chain of various schemes that supply water to the NMB. Figure 60 provides an overview of the Nooitgedagt schemes.

- **Nooitgedacht WTW Phase 3**: Once completed, the water treatment works will be able to supply a total capacity of 210 Ml/day. This intervention is due for completion in September 2022.
- **Grassridge temporary WTW:** The temporary WTW was commissioned in July 2019, and produces an additional volume of around 55 Ml/day.
- **Motherwell and Stanford Road Booster Pump Stations:** the Motherwell & Stanford Road pump stations will be upgraded to a transfer capacity of 120 Ml/day and 135 Ml/day, respectively. This tender for upgrading the pump stations is currently in the evaluation stage and the intervention is due for completion in 2023.
- **Kwanobuhle Supply Pump Station:** It is possible to supply Kwanobuhle with water from Orange-Fish River Water Transfer Scheme (Gariep Dam), treated at Nooitgedagt WTW. The upgrade of this pump station will make first water available in April 2022, with final completion due in August 2022.
- **Bloemendal to Kwanobuhle pipeline:** Construction is completed with minor snags that remains to be rectified by the Contractor. The first water from the pipeline was officially supplied on 26 October 2021.
- **Additional expansion of the Nooitgedagt Water Supply Zone:** The NMBM is also constantly investigating the further expansion of the Nooitgedagt Water Supply zone in specific zones/areas, which is normally supplied by water from the Western WSS.
- **Motherwell/Bethelsdorp – East to West Pipeline Upgrade:** An environmental directive in terms of Section 30A has already been obtained from DEDEAT for the implementation of the majority of the NMBM's drought mitigation projects. The estimated implementation timeframe to complete this project is 35 months
- **Chatty Reservoir Offtake Repair**
- **Construction of the Chatty Pumpstation to supply the Despatch Tower**
- **Construction of the proposed Coerney Dam:** In order ensure a constant reliable water supply from the Gariep Dam / Orange River Transfer Scheme, the construction of the proposed Coerney Dam has been identified as one of the long-term drought mitigation interventions which will be implemented and owned by DWS. Once constructed, the Coerney Dam will have an estimated capacity of 4690 Ml and will be able to supply 210 Ml/day. The technical feasibility study for the construction of the dam was completed in July 2020. Subsequent to the latter, Professional Service providers have been appointed to proceed with the detail design and EIA process, which are to be completed by December 2022. DWS indicated that the construction of the project will then commence in April 2023 and will carry on until March 2026.

Figure 8-2:
Upgrading barges in Impofu Dam (NMBM, 2022a)



A.3 GROUNDWATER AUGMENTATION

Approximately 200 boreholes were drilled within the region to locate suitable sites (Figure 8-3). The potential sites identified for groundwater development is summarised in Table 8 1.

- **Coega Kop Groundwater Scheme:** The drilling of production boreholes has been completed. The designs of the permanent Water Treatment Works have been completed. A contractor has been appointed and construction on the permanent Water Treatment Works is underway – estimated completion time is August 2022.
- **Churchill Wellfields:** High potential groundwater sites were identified on NMBM property around Churchill dam. 73 boreholes were drilled, 19 marked for production. Groundwater from these boreholes will augment the raw water supply from the drought-stricken dam and treated at the WTW. Conceptual designs have been completed and commencement is imminent.
- **Fort Nottingham Boreholes:** Water from the boreholes will be disinfected and blended into the existing water supply system. Project is currently at tender stage.
- **Glendenning Boreholes:**Water from the boreholes will be disinfected and blended into the existing water supply system. Project is currently at tender stage.
- **Fairview Boreholes:** Water from the boreholes will be disinfected and blended into the existing water supply system. Project is currently at tender stage.
- **St Georges Boreholes:** Water from the boreholes will be treated, disinfected and blended into the existing water supply system. St. Georges is currently at tender stage.
- **Bushy Park Wellfield:** High potential groundwater sites were identified at Bushy Park. 18 boreholes were drilled, 10 marked for production. Groundwater from these boreholes will be disinfected and blended into the Churchill pipeline running in close proximity to the wellfield, augmenting the drought stricken western sources. Conceptual designs have been completed and commencement is imminent. Bushy Park is currently at tender stage.

Figure 8-3:
Borehole sites in NMBM (NMBM, 2022a)

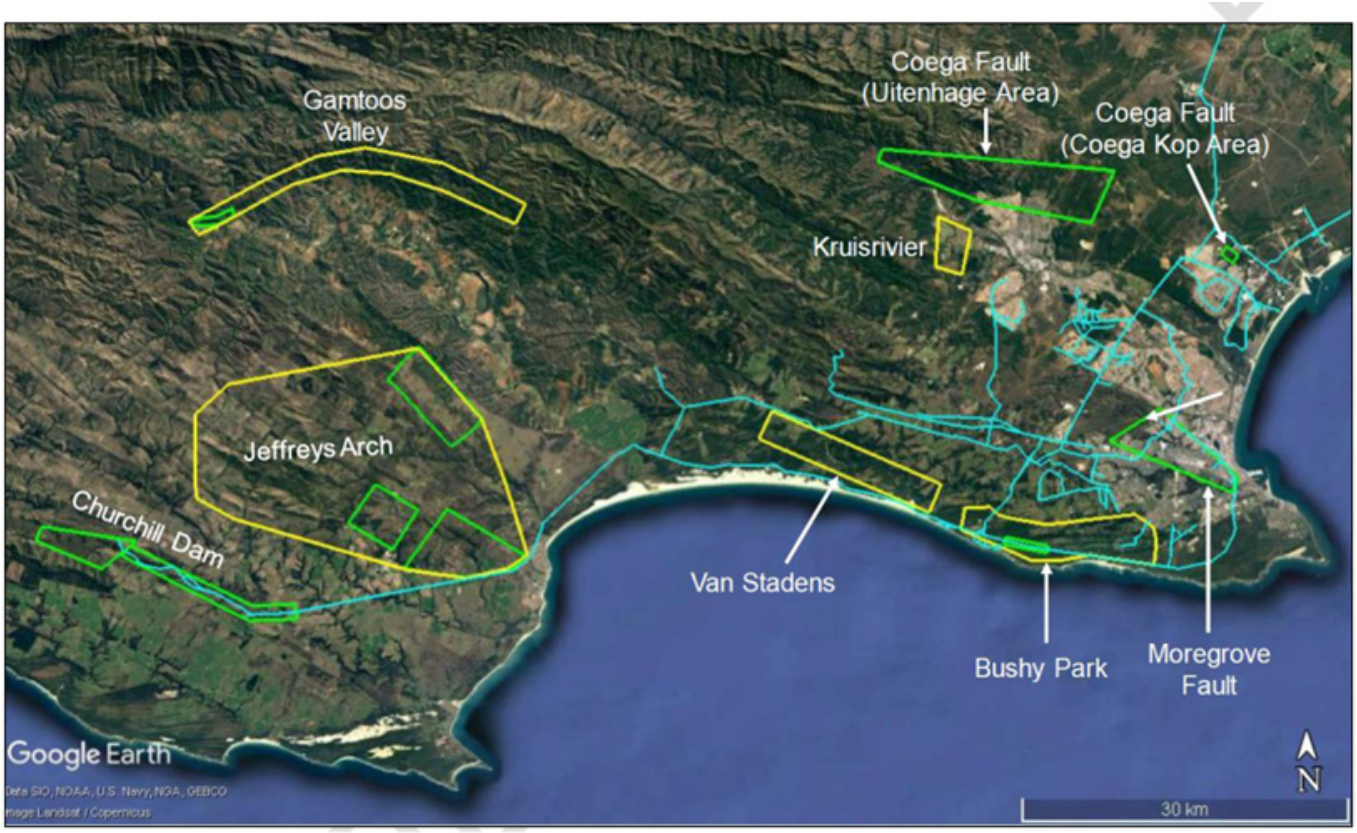


Table 8-1: *Potential sites for groundwater development (NMBM, 2022a)*

LOCATION	YIELD LOW (Mℓ/day)	YIELD MEDIUM (Mℓ/day)	YIELD HIGH (Mℓ/day)
Coegakop	10.0	12.5	15.0
St Georges Park	2.1	2.9	3.6
Glendinning	1.6	2.3	2.9
Fort Nottingham	0.8	1.0	1.8
Fairview	0.9	1.5	2.2
Bushy Park	7.0	10.2	13.3
Churchill (Future)	1.7	3.0	4.3
Total	**24.1**	**33.4**	**43.1**

A.4 DESALINATION

Desalination remains the most expensive source of water augmentation, although it is the only water source which is not impacted by climate change and is virtually unlimited in potential. Desalination is included in the National Water Strategy as well as the Algoa WSS reconciliation strategy and will form part of the long-term future water supply. Small scale temporary plants are especially expensive, and yields are too low to provide water supply assurance to a region such as NMB. Desalination is not a silver bullet solution during drought.

Coega Desalination Plant: The NMBM is busy finalising an agreement with Coega Development Corporation (CDC) for the implementation of desalination plants. The CDC has already received funding from National Treasury for the establishment of a desalination plant within the CDC, and tenders have been called for the design and build as well as an owners engineer for a 15M Ml/d plant (60Ml/d ultimate). The NMBM have already signed a memorandum of understanding with the CDC, and currently an offtake agreement is being finalised for the NMBM to utilise 11Ml/d within the metro, while 4 Ml/d will be utilised by the Coega SEZ themselves.

Western Desalination Plant: A Feasibility Investigation was undertaken in two phases, being a Site Selection and a Detailed Feasibility Investigation. Potential plant locations for a 60 Ml/d desalination plant for the NMBM have been investigated. The siting was concluded with the Schoemakerskop inland site at the western side of the City recommended as the preferred site. The feasibility study got underway, with its components being a comprehensive water quality monitoring programme, marine bathymetry and geophysical surveys, brine dispersion modelling, and preliminary design considerations for the marine intakes and outfall, the desalination plant, and the delivery pipeline. The preferred potential plant location would then also be subject to a full EIA. The Feasibility Investigation was stopped early in 2017, with the pre-feasibility investigations, site selections and marine bathymetry having been completed, and with the water quality monitoring evaluation done at desktop level.

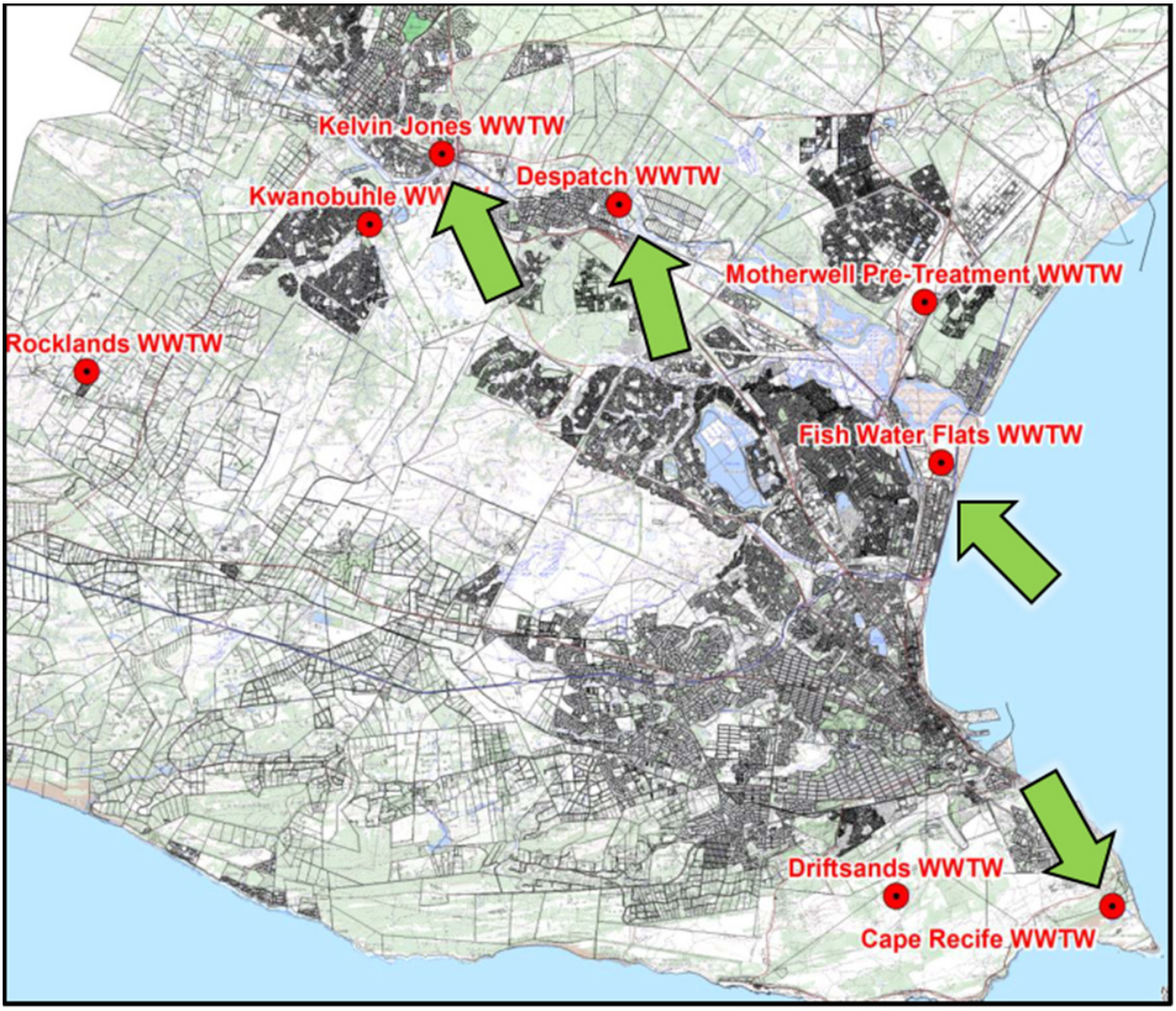
A.5 REUSE OF TREATED EFFLUENT

There are currently eight existing wastewater treatment works located throughout the NMB. These facilities have a total treatment capacity of 205.04 Ml/day. The volume of treated effluent currently being re-used amounts to just under 8 Ml/day, which represents ≈4% of the total treatment capacity of all the WWTWs. Treated effluent is currently being re-used/collected at the following four existing WWTW's (and as indicated by the green arrows in Figure 8 4).

Fish Water Flats (FWF) WWTW: The use of reclaimed effluent from the Fishwater Flats WWTW as a source for industrial water use was a condition of the EIA approval for the development of the Coega SEZ. The continuation and implementation of this project is very much dependant on the availability of budget. This project is currently on hold due to budget constraints.

Direct Re-Use of treated effluent: A pilot project this is planned for implementation for the direct re-use of treated effluent from the Cape Recife WWTW, and there is possible future direct re-use of the treated effluent from Driftsands WWTW.

Table 8-4:
Location of WWTW's throughout the NMBM (NMBM, 2022a)



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