

**UNIVERSITY OF KWAZULU-NATAL**

**Assessment and enhancement of beach water quality management strategies in eThekweni**

**Municipality**

**By**

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**in the**

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## DECLARATION

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## **DEDICATIONS**

This dissertation is dedicated to my beloved mother, Ms. Sibongile Madondo, whose unwavering support, guidance, and unconditional love have shaped me into the man I am today. Her commitment to instilling in me the values of diligence and perseverance has been an endless source of inspiration.

I am profoundly grateful for her constant encouragement and belief in my abilities, which have propelled me to strive for excellence in all endeavours.

Thank you, Mamzo, for being my guiding light and for always encouraging me to reach for the stars.

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## ABSTRACT

Beaches are key tourist attractions in Durban and KwaZulu-Natal, offering diverse recreational activities along approximately 2,800 km of coastline. Managed by eThekweni Municipality, these beaches are vital for swimming, surfing, fishing, and other water sports. Effective management of beach water quality, influenced by inland activities and river discharges, is essential for both tourism and environmental health. This study aimed to assess and enhance beach water quality management strategies in eThekweni Municipality. It assessed current practices, evaluated their effectiveness, identified primary pollution sources, and proposed improvements. Using purposive sampling, insights were gathered from decision-makers in water quality management across seven key municipal sectors from the eThekweni Municipality and three non-profit organisations: Adopt-A-River, Green Corridor, and Duzi Umgeni Conservation Trust. Primary data were collected through in-depth semi-structured interviews via Microsoft Teams, which were recorded, transcribed, and analysed with NVivo software to identify critical themes in water quality management strategies. Findings revealed that the eThekweni Municipality lacks a formal beach water management strategy despite conducting periodic water quality monitoring of beaches and rivers. The study further reveals that the current monitoring system is ineffective in ensuring compliance with both international and local water quality standards for safe recreational use. This is evident from the frequent failure to meet the required levels of  $\leq 200$  cfu/100 ml for *Enterococci* and  $\leq 500$  cfu/100 ml for *Escherichia coli* (E. coli), particularly during 2022, leading to numerous intermittent beach closures, a problem that continues to persist. The study identified sewer infrastructure as the primary source of pollution, exacerbated by the April 2022 floods, although issues existed prior to this event. The study recommends developing an integrated beach water quality management strategy, improving the current water quality monitoring plan, increasing the sanitation budget, implementing education and awareness campaigns, aligning organisational functions, investing in ICT and innovations, as well as fostering partnerships with private stakeholders to enhance waste management practices.

Keywords: Beach, Water Quality, Management, Strategies, eThekweni Municipality

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## LIST OF USED ABBREVIATIONS AND ACRONYMS

BOD: Biochemical Oxygen Demand

CAQDAS: Computer-Assisted Qualitative Data Analysis Software

CFU: Colony Forming Units

COVID-19: Coronavirus Disease 2019

CSIR: Council for Scientific and Industrial Research

CZM: Coastal Zone Management

DEA: Department of Environmental Affairs

DFFE: Department of Forestry, Fisheries and the Environment

DO: Dissolved Oxygen

DUCT: Duzi Umgeni Conservation Trust

DUT: Durban University of Technology

DWAF: Department of Water Affairs and Forestry

DWS: Department of Water and Sanitation

EC: Environmental Commission

*E. coli*: *Escherichia coli*

ECA: Environmental Conservation Act

EDTEA: Economic Development, Tourism and Environmental Affairs

EMA: eThekweni Municipality Academy

FEE: Foundation for Environmental Education

FOG: Fats, Oils, and Grease

GA: General Authorisation

GDP: Gross Domestic Product

GI: Gastrointestinal Illness

HSSREC: Humanities and Social Sciences Research Ethics Committee

ICM: Integrated Catchment Management

ICMA: Integrated Coastal Management Act

ICT: Information and Communication Technology

ICZM: Integrated Coastal Zone Management

ISO: International Organization for Standardization

KZN: KwaZulu-Natal

LIMS: Laboratory Information Management System

MS Teams: Microsoft Teams

MSDFs: Municipal Spatial Development Frameworks

NEMA: National Environmental Management Act

NPOs: Non-Profit Organizations

NTU: Nephelometric Turbidity Units

NWA: National Water Act

pH: Potential Hydrogen

PPP: Public-Private Partnership

PRC: Parks, Recreation and Culture Unit

RSA: Republic of South Africa

SANBI: South African National Biodiversity Institute

SANParks: South African National Parks

SANS: South African National Standards

SAWS: South African Weather Service

SCM: Supply Chain Management

SDGs: Sustainable Development Goals

SEMA: Spatial Environmental Management Act

SLAs: Service Level Agreements

STATS SA: Statistics South Africa

SWPPP: Stormwater Pollution Prevention Plan

TCTA: Trans-Caledon Tunnel Authority

UK: United Kingdom

UKZN: University of KwaZulu-Natal

UN: United Nations

US EPA: United States Environmental Protection Agency

US: United States

WHO: World Health Organization

WQI: Water Quality Index

WQMS: Water Quality Management System

WRC: Water Research Commission

WSA: Water Services Act

WULA: Water Use License Application

WRC: Water Research Commission

WWTWs: Wastewater Treatment Works

# CHAPTER ONE

## INTRODUCTION

### 1.1 Introduction and background

The eThekweni Municipality, as the sole metropolitan municipality in the KwaZulu-Natal (KZN) province, occupies a prominent position along South Africa's East Coast. Its expansive 98-kilometre coastline encompasses a total of 44 beaches, of which 23 cater to contact activities such as swimming, diving, water skiing, surfing, and paddling, while 21 are designated for non-contact activities such as fishing, sightseeing, camping, horse riding, and hiking, making Durban a popular destination for travellers (eThekweni Municipality, 2023a).

The most vital features when assessing a beach are the sand, cleanliness, and water quality (Villacampa et al., 2017). However, recent attention has been drawn to the beach water quality within eThekweni Municipality, sparking concerns over its compliance with local and international standards for governing marine recreational activities. Various media outlets and non-profit organisations (NPOs), notably Adopt-A-River, have raised the alarm on the issue, with the latest contribution coming from a higher education institution, the Durban University of Technology (DUT) (Khan, 2023).

The start of beach water pollution often stems from various factors, exacerbated by extreme hydro-meteorological events such as the April and May 2022 floods in KZN, significantly damaging sewer reticulation infrastructure (Chikodzi, Dube & Ngcobo, 2021). The prolonged infrastructural repairs further contributed to beach water pollution, leading to intermittent beach closures and negative ramifications for the tourism sector and associated revenue streams. Verma et al. (2020) state that although there are three types of marine pollution, which include the pollution caused by land, air, and transportation, eighty per cent of marine pollution comes from land. Prior studies indicate that marine pollution through land predominantly results from raw sewage, industrial and wastewater treatment works (WWTWs) effluents, oil spillages, and global climate change (Vikas & Dwarakish, 2015). The various forms of marine pollution have proven detrimental to marine life and its habitats. Several local and international policies have been promulgated to mitigate beach water pollution, recognising its detrimental impact on aquatic system, public health, and economic growth, particularly within the tourism sector.

To realise its vision of becoming Africa's most caring and liveable City by 2030, the eThekweni Municipality must confront the critical task of safeguarding the environmental integrity and sustaining the tourism sector (eThekweni Municipality, 2023a). The city has also introduced various departments and developed numerous policies in line with local and international guidelines to mitigate water pollution and

prevent its negative impact on aquatic life, human health, and the city's economy. Hence, this study will assess the city's current beach water quality management strategies and evaluate their effectiveness. It also investigates the factors contributing to the pollution of the receiving water environment and proposes measures to enhance the current water management strategy. Chapter one of the study provides the problem statement and stipulates the research objectives and questions as well as the significance of the study. Additionally, it outlines the research methodology, limitations, and the dissertation chapter organisation.

## **1.2 Problem statement**

Water is the fundamental basis of life and holds unparalleled value and significance. The surrounding environmental conditions influence the quality of the watercourse (Villacampa et al., 2017). The degradation of beach water quality carries multifaceted social, environmental, and financial repercussions within the eThekweni Municipality, hence necessitating the establishment of dedicated and robust legislation in beach water quality management aligned with global standards for coastal management (Mazibuko, 2019). Previous research predominantly concentrated on drinking water quality management. Investigations by Gumbi and Rangongo (2018) unveiled that infrastructural deterioration, the impacts of global climate change, financial constraints, and operational inefficiencies significantly hamper the management and provision of potable water within eThekweni Municipality. Other studies focused on river water quality management, as rivers are essential and play a crucial role in shaping beach water quality. Naidoo (2013) revealed that non-compliant effluent discharges from most wastewater treatment works (WWTWs) in the eThekweni Municipality detrimentally affect river water quality, negatively impacting beach water quality. Therefore, this study will focus on beach water quality management, recognising that the same factors may affect it.

eThekweni beaches constitute a cornerstone of Durban and KwaZulu-Natal tourism appeal, with the Tourism KZN statistical report (2019, 2021) indicating that beach visits rank as the number one activity undertaken by domestic visitors, with 79% and 66% of the visitors partaking in 2019 and 2021, respectively, underscoring their crucial role in tourism growth and economic development. Notably, the tourism industry globally is still recovering from the adverse effects of the coronavirus (COVID-19) pandemic. However, as of 2024, the eThekweni Municipality beach quality report indicates ongoing beach closures due to non-compliance issues (eThekweni Municipality, 2023b). The eThekweni Municipality, as the local government, must uphold the Constitution of the Republic of South Africa (1996, p.9), Chapter 2 Section 24 of the Environmental Law, which mandates the protection of citizens' "right to an environment that is not harmful to their health or well-being". It further emphasises the obligation to safeguard the environment for the

benefit of present and future generations through appropriate legislative and regulatory measures (Republic of South Africa, 1996). Accordingly, the eThekweni Municipality conducts beach water quality assessments every two weeks, ensuring compliance with international beach quality standards and promptly updating results online on relevant beach areas.

### **Research objectives**

- 1) To assess the current beach water quality management strategies in the eThekweni Municipality.
- 2) To evaluate the effectiveness of these strategies in improving beach water quality standards in the eThekweni Municipality.
- 3) To identify the primary sources of beach water pollution.
- 4) To propose recommendations for enhancing beach water quality management strategies in the eThekweni Municipality.

### **1.3 Research questions**

- 1) What current beach water quality management strategies are implemented in the eThekweni Municipality?
- 2) How effective are these strategies in improving beach water quality in the eThekweni Municipality?
- 3) What are the primary sources of beach water pollution?
- 4) What pollution prevention strategies are employed to address these factors in the eThekweni Municipality?

### **1.4 Research methodology**

A comprehensive examination of the existing literature pertaining to beach water quality management strategies was conducted, drawing from reputable sources such as academic journals and books. The review encompassed studies on pollution sources, regulatory frameworks in beach water quality management, and recognised best practices locally and internationally. This process identified significant gaps in beach water quality knowledge and opportunities for potential enhancement in current strategies. Ethical clearance for this research was successfully obtained from the University of KwaZulu-Natal's Humanities and Social Sciences Research Ethics Committee (HSSREC), with the protocol number HSSREC/00007273/2024 (see Appendix 1). Additionally, a gatekeeper's letter was secured from the eThekweni Municipality, granting

permission to conduct research and utilise its resources through the eThekweni Municipality Academy (EMA). Furthermore, authorisation to carry out the research was acquired from the relevant non-profit organisations (NPOs), as their consent did not necessitate a formal gatekeeper's letter.

A qualitative approach was chosen for this study to gather in-depth information from the interviewees, enabling them to share their perspectives and provide a comprehensive understanding of their lived experiences in beach water quality management. Primary data was collected through interviews with ten (10) interviewees, selected using purposive sampling. The sample was intentionally chosen to meaningfully address the research questions and effectively achieve the research objectives, meaning saturation was not anticipated. Seven (7) of the ten interviewees were key decision-makers within the eThekweni Municipality. Their selection was based on their authority, expertise, and role in managing beach water quality within their respective departments or branches. Each interviewee represented one section, branch, or department, and represented were the Water and Sanitation Unit (represented by the Scientific Services department; and the Sanitations Operations Department represented by three branches: the Mechanical and Engineering branch, the Sewer Networks branch, and the Wastewater Treatment Works branch); the eThekweni Parks, Recreation and Culture Unit; the eThekweni Environmental Health Unit and the eThekweni Biodiversity Management Unit. Additionally, insights were gathered from environmental agencies and stakeholders, including non-profit organisations (NPOs). Therefore, the remaining three (3) interviewees were individuals representing each of the following organisations: Adopt-A-River, Durban Green Corridor, and DUCT (Duzi Umgeni Conservation Trust). The deliberate selection of these organisations was due to their involvement in water quality and environmental protection within the eThekweni Municipality, and the selection of all interviewees followed a purposeful approach aiming to only interview individuals with the necessary expertise, experience, and who hold suitable positions in the organisations, making them the most valuable interviewees to contribute to this study.

The interviews were conducted online via Microsoft Teams between August 5th and September 4th, 2024, with each session lasting no longer than 30 minutes, and these interviews were meticulously recorded, transcribed, and analysed using NVivo, a specialised qualitative data analysis software. This approach facilitated an in-depth exploration, allowing for the identification of underlying patterns and themes in the beach water quality management strategies of the eThekweni Municipality. To ensure that interviewees were thoroughly prepared, interviewees were provided with interview questions twenty-four (24) hours prior to the interviews, given the comprehensive nature of the questions. Furthermore, all interviewees were required to provide informed consent. Informed consent forms were distributed and signed via email twenty-four (24) hours prior to the scheduled interview date to ensure adherence to ethical standards and the protection of interviewees' rights during and after the research process.

## **1.5 Limitations of the study**

As with any research, this study has several limitations that must be acknowledged. Firstly, it is essential to note that the researcher is employed within the eThekweni Municipality, Pollution and Environment Branch, one of the critical sections responsible for the beach water quality management within the municipality. Due to this affiliation, the researcher excluded this department from the interview process, as familiarity with their scope of work could potentially introduce biasness. Consequently, insights on beach water quality management from this section were covered under the Scientific Services Department interview in the study. Secondly, it is imperative to acknowledge that the omission of crucial government stakeholders beyond the municipality, such as the National Department of Water and Sanitation (DWS) and the KwaZulu-Natal Provincial Department of Economic Development, Tourism, and Environmental Affairs (EDTEA), stemmed from procedural challenges associated with acquiring separate gatekeeper's letters which may have included distinct conditions compared to those of the eThekweni Municipality. Consequently, these entities were excluded from the scope of the study. However, insights from three non-profit organisations (Adopt-A-River, Durban Green Corridor, and DUCT) were gathered to provide an external perspective. While the limitations mentioned above may have influenced the comprehensiveness and outcomes of the study, diligent efforts were made to mitigate them to the extent feasible within the research context.

## **1.6 Significance of the study**

Firstly, eThekweni beaches are one of KwaZulu-Natal's main tourist attractions. Hence, they are essential for the province and country's economic development. Secondly, the eThekweni beaches have been having compliance issues due to sewage pollution of the rivers, which has led to beach closures and endangerment of the public and aquatic life at large. eThekweni Municipality, as the local government, must uphold the South African Constitution, Chapter 2 Section 24 of the Environmental Law, as it stipulates the environmental right that "everyone has the right to an environment which is not harmful to their health or well-being." Furthermore, it expresses that "everyone has a right to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures" (Constitution of the Republic of South Africa, 1996, p.23). Therefore, this report will assess the current beach water management strategies and propose measures to enhance beach water quality in the eThekweni Municipality.

## **1.7 Dissertation chapter organisation**

### **CHAPTER ONE: INTRODUCTION**

This introductory chapter provides an overview of the study's scope. The background of the study and the research problem are outlined, as well as the research objectives and questions. Additionally, the significance of the study, a brief research methodology, and the research limitations are provided.

### **CHAPTER TWO: LITERATURE REVIEW**

This chapter offers a comprehensive literature review pertaining to beach water quality management strategies, presenting an in-depth analysis of current approaches and methodologies that are utilised locally and internationally.

### **CHAPTER THREE: RESEARCH METHODOLOGY**

This chapter explains the research design and methodology, detailing the qualitative data collection techniques employed and the analysis procedures.

### **CHAPTER FOUR: FINDINGS AND DISCUSSIONS**

This chapter presents the comprehensive research findings and thoroughly discusses the data and their implications.

### **CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS**

This final chapter synthesises the key insights and conclusions drawn from the study and offers actionable recommendations to inform future beach water quality management strategies.

## **1.8 Chapter summary**

This chapter provides an overview of the research, outlining the overarching objectives to assess and enhance the current beach water quality management strategies in the eThekweni Municipality. Key research components such as the historical context, problem statement, and purpose statement are presented to contextualise the study. Additionally, the methodology employed for qualitative data collection and analysis from critical decision-makers from the eThekweni Municipality and NPOs is detailed. Furthermore, the chapter addresses the research and the respective mitigation measures. Lastly, the chapter overview of the research is outlined. The following chapter delves into the existing literature review pertaining to beach water quality management strategies.

# **CHAPTER TWO:**

## **LITERATURE REVIEW**

### **2.1 Introduction**

Water is a precious and increasingly scarce resource, particularly in South Africa, where irregular rainfall patterns and prolonged unpredictable drought periods pose significant risks. The fast-growing population exacerbates this scarcity, as it is the most significant contributor to climate change and the pollution of this vital ecosystem (Dotaniya et al., 2022; Imbert et al., 2020). Recognising the crucial role of water resources in socio-economic development, municipalities, particularly those along the coastal areas, are tasked with the sustainable and efficient management of these resources to foster urban growth for the prosperity of cities and benefit the residents and the country. The primary objective of this study is to assess the current beach water quality management strategies (WQMS) in the eThekweni Municipality and to propose enhancements to improve these strategies. This chapter begins with an extensive review of relevant literature, establishing a theoretical framework crucial for developing the conceptual and analytical tools necessary to address research questions.

Against this backdrop, an interpretive, qualitative approach has been employed in this research to assess the existing beach water quality management strategies that are currently utilised in the eThekweni Municipality and suggest enhancements that can be implemented for their improvement. In providing such, extensive literature on beach water quality management strategies is reviewed at local, national, and international levels. The chapter delves into the coastal water regulatory frameworks, policies, legislation, standards, and guidelines governing beach water quality management, shedding light on worldwide approaches adopted to safeguard coastal ecosystems. Furthermore, the chapter explores various monitoring and assessment techniques utilised to evaluate beach water quality and the best management practices tailored to mitigate water pollution and enhance beach water quality. In addition, this chapter focuses on the South African water guidelines for recreational use and the beach water quality monitoring program employed by eThekweni Municipality. It also assesses the water quality data from the past decade for all beaches, highlighting compliance and non-compliance with the guidelines for recreational waters. Moreover, the chapter identifies the primary sources of beach water pollution that contribute the most locally and internationally. Finally, this chapter concludes by outlining the mitigation actions aimed at protecting and managing these pollution sources, which are vital for sustainability and aligning with the United Nations (UN) sustainable development goals (SDGs), precisely SDG six (6) objective, which declares clean water and sanitation for all (UN, 2023).

Section 2.2 explores the regulatory frameworks and policies governing coastal zone management (CZM), looking at international approaches and strategies to preserve and enhance coastal water quality. The section also scrutinises the network of South African government laws and institutions dedicated to water quality management, clarifying their roles in safeguarding coastal ecosystems. Section 2.3 presents an exhaustive examination of tools, techniques, and assessment methodologies used in coastal water quality monitoring. The section describes monitored sites and monitoring instruments ranging from field sampling, assessment, and laboratory analysis. In Section 2.4, an enquiry is undertaken into the sources of pollution that affect the quality of beach water. Drawing upon research and empirical evidence, this section identifies and categorises the primary sources of contamination. Section 2.5 details a comprehensive array of pollution prevention strategies utilised at local, national, and international levels to mitigate the degradation of beach water quality. This section showcases diverse interventions to reduce pollutant loads, enhance ecosystem resilience and promote sustainable coastal development. Finally, Section 2.6 synthesises the findings and offers concluding remarks on local and international beach water quality management strategies. The section reflects upon the evolving landscape of coastal water governance and the importance of addressing emerging challenges.

In summary, this chapter consolidates literature on beach water quality management strategies, provides a comprehensive overview of the current approaches, and offers insights into associated challenges.

## **2.2 Coastal water regulatory frameworks and policies**

South Africa boasts a sprawling coastline spanning about 2800 kilometres (km), stretching from Namibia along the South Atlantic Coast to the border of Mozambique on the Indian Ocean (Warne, 2021; Mafumbu, Zhou & Kalumba., 2022). Within this coastline lies the eThekweni municipality, encompassing nearly 98 km of shoreline comprising 16 estuaries, extending from the north to the South Coast (Forbes & Demetriades, 2008). The dynamics of these estuaries, whether they remain open or experience periodic closures, along with the activities within their associated catchment areas, significantly influence the composition of water reaching the beaches and consequently impact beach water quality (Forbes & Demetriades, 2008). The quality of beach water depends on catchment management practices and the overall water quality within these catchments. As such, understanding and implementing practical approaches and strategies for beach water quality management is paramount. By examining international best practices and strategies employed in other countries and by other South African coastal municipalities, valuable insights can be drawn to enhance beach water quality management efforts within the eThekweni Municipality.

## **2.2.1 International approaches and strategies**

### **2.2.1.1 Integrated coastal zone management: Spain, Portugal, Ireland and the United Kingdom (UK)**

Coastal management in Spain recognises the value and complexity required to safeguard coastal areas amidst the many natural factors and human activities at play, such as construction, effluent discharges, coastal erosion, flooding, pollution, and sand mining, which all contribute to the challenges faced by coastal regions (Ariza, 2010; Martorell, Rodríguez-Rodríguez & García-Millán, 2023). Spain, with its extensive 9300 km of coastline, has witnessed massive development over the past three decades, which has caused numerous sustainability challenges despite protection under the Shore Act, which aims to define, conserve, and sustainably manage usage of coastal areas in the country (Martorell, Rodríguez-Rodríguez & García-Millán., 2023). Balancing development and environmental conservation remains a pressing issue for coastal management in Spain. To address these complexities, Spain employs the Integrated Coastal Zone Management (ICZM), a holistic approach encompassing coordination, planning, and management of marine, land, human and economic activities in the coastal areas (Ariza, 2010). ICZM, established in 1992 by the Commission of the European Communities (EC) during the Earth Summit in Rio de Janeiro, seeks to balance coastal protection with human and economic interests (EC, 2000). ICZM is defined as a “dynamic, multidisciplinary process to promote sustainable management of coastal zones” through “informed participation and cooperation of stakeholders” (EC, 2000, p.2; Haines-Young & Potschin, 2011, p.4).

However, despite its noble objectives, ICZM implementation has faced significant challenges in Spain and Portugal due to various issues, including inadequate public awareness, insufficient funding, gaps in monitoring efforts, climate change considerations, shortages in expertise, and varying levels of political commitment (Alves et al., 2013). Responding to these challenges, the Portuguese government has embraced European tools and frameworks, integrating directives and policies from the national to municipal levels, which has contributed to achieving sustainable outcomes; however, concerns remain regarding the effectiveness of management instruments, inadequate mitigation of sea level rise due to climate change risks, and delays in the implementation process (Oliveira, Moura & Boski, 2020; Aqel et al., 2024). The ICZM implementation has encountered challenges in various regions worldwide. In the United Kingdom (UK), the absence of a specific legal framework has posed significant hurdles, similarly in South Africa, despite having perhaps the model legislation for Integrated Coastal Management (ICM) compared to other countries, owing to concerns about the government’s ability to effectively implement these measures (Bradshaw, 2021). In Ireland, the implementation of ICZM has highlighted the inadequacy of relying solely on mitigation measures in the face of climate change impacts; this has stressed the need for ICZM strategies

to emphasise adaptation, which is a trend observed in several European nations that have adopted a National Adaptation Strategies (O'Mahony et al., 2020).

### **2.2.1.2 Integrated coastal zone management: Xiamen in China and Bangladesh**

Although the implementation of ICZM in Spain and Portugal has faced numerous challenges, successful projects have been established in other countries, including the city of Xiamen in China and Bangladesh. Xiamen, situated on the southeast coast of China with a 64 km long coastline, initiated the ICZM project in the mid-90s, which has since been replicated successfully in other coastal cities within China and abroad (Hong & Xue, 2006; Islam, Xue & Rahman, 2009). Similarly, Bangladesh, with its 710 km long coastline, has implemented a successful ICZM project despite its vulnerability to natural disasters such as tropical cyclones, storms, and flooding. Islam, Xue, and Rahman (2009) outline that the ICZM process consists of three primary components such as:

- A coastal zone policy encompasses eight objectives addressing vulnerabilities, opportunities, industrial activities, and sustainability of natural resources in coastal zones.
- A development strategy aimed at developing sustainable livelihoods and integrating the coastal zones.
- An investment program utilised to implement ICZM policy aims and objectives.

Despite their successes, ICZM programs in China and Bangladesh encounter challenges such as poor management, lack of information, policy conflicts, governance issues and political support; however, these initiatives have introduced solutions and mitigation measures to address marine pollution problems, which include the implementation of ocean use licensing, pollutant discharge limits, pollution control from ships, and establishment of environmental law enforcement groups within key relevant departments (Islam, Xue & Rahman, 2009; Shampa et al., 2023).

### **2.2.1.3 Blue Flag programme**

The Blue Flag is widely regarded as the most prestigious and internationally recognised beach management programme. Established by the Foundation for Environmental Education (FEE), it provides a comprehensive framework to assess and improve various aspects of beach management, including environmental protection, safety, accessibility, education, and sustainability (Blue Flag, 2025; Lucrezi, Saayman & Van der Merwe, 2015). The programme was first launched in France in 1987, but it was only in 2001 that the Blue Flag became global, with South Africa being the first country outside of Europe to join (Blue Flag, 2025). Since then, 51 countries across five continents have joined the programme, where beaches must meet 33 stringent criteria, which are grouped into four main categories to receive the Blue Flag status (Blue Flag, 2025; Bañuls, 2024).

In South Africa, a total of 48 beaches earned the Blue Flag status in the 2024/25 season, including nine beaches from the KwaZulu-Natal province; however, the eThekweni Municipality has not participated in the voluntary programme since the 2020/21 season, when twelve of its beaches were awarded the Blue Flag status (Southern and East African Tourism Update, 2024; Blue Flag, 2025). The absence of eThekweni participation is notable, as the Blue Flag programme is widely seen as a valuable tool for attracting tourists, especially domestic visitors who often travel in large numbers and are likely to choose the Blue Flag beaches due to their perceived cleanliness, safety, and high-quality infrastructure (Saayman & Saayman, 2017).

Despite its recognition as an effective marketing tool to promote tourism, the programme has faced criticism, particularly regarding sustainability. The costs of maintaining Blue Flag status are significant, as it requires substantial investments in infrastructure and continuous monitoring to ensure compliance with its rigorous standards, which has led some to question whether the long-term sustainability of the programme is viable, particularly in municipalities with limited resources (Mthiyane, Nojiyeza & Mofokeng, 2024). Nevertheless, the programme has proven to be invaluable in improving beach water quality. Under the Blue Flag's water quality criteria, beaches are required to meet strict standards for faecal coliform counts, with guidelines in place for controlling sewage discharge and preventing pollution (Lucrezi, Saayman & Van der Merwe, 2015). This focus on water quality helps to safeguard public health and protect marine ecosystems, ensuring that beaches remain clean and safe for both tourists and local communities.

### **2.2.2 South African national coastal management approaches and strategies**

South Africa occupies most of the southern tip of the African continent, encompassing nearly 3,000 km of coastal zones spanning four of the nine South African provinces: KZN, Eastern Cape, Western Cape, and Northern Cape. The country has an area of 1.22 million square kilometres (km<sup>2</sup>) and is home to a population of 62 million as of 2024, with approximately one-third residing within this coastal zone, equating to around 20 million individuals (DFFE, 2024; Stats SA, 2024). Given its considerable size, strategic location, and dynamic nature, South Africa's coastal region holds significant economic value, contributing substantially to its Gross Domestic Product (GDP). Consequently, this coastal zone's effective and dedicated management necessitates an integrated and comprehensive approach. The importance of ICM in South Africa became apparent in the 1970s due to mounting concerns regarding severe environmental degradation along the coast; issues such as the exploitation of fisheries, oil pollution, and infrastructure failures garnered negative media attention, prompting government intervention, subsequently, several government departments, multilevel acts, and regulations were introduced to govern the environment and the coastal

zones (Mohamed & Francis, 2005). In this context, several laws, legislations, and government institutions play pivotal roles in the country's beach water quality management and water resources management.

### **2.2.2.1 Government laws**

#### **The constitution**

The South African Constitution, the country's supreme law, defines citizens' and authorities' rights and responsibilities. Under Section 24, the Constitution declares the right to access clean water and a healthy environment, emphasising the importance of safeguarding "the environment for present and future generations" through "legislative and other measures" (The Constitution of the Republic of South Africa, 1996, p.9).

#### **National Environmental Management Act (Act no. 107 of 1998) (NEMA)**

NEMA serves as South Africa's primary environmental law, which places the environmental duty and responsibility on all stakeholders, not solely on the government. NEMA aims to establish a clear environmental framework for entities to conduct their businesses in an environmentally friendly manner, ensuring the protection of the receiving environment, biodiversity, air, ground, water, and the ecosystem (NEMA, 1998). Complementary to NEMA are various Specific Environmental Management Acts (SEMA) that are used to govern specific environmental aspects, including but not limited to the National Water Act (NWA) 36 of 1998, Water Services Act (WSA) 108 of 1998, Environment Conservation Act (ECA) 73 of 1989, National Environmental Management: Air Quality Act 39 of 2004, National Environmental Management: Waste Act 59 of 2008, National Environmental Management: Integrated Coastal Management Act, 24 of 2008, and National Environmental Management: Protected Areas Act, 57 of 2003. Among SEMAs, the Integrated Coastal Management Act (Act No. 24 of 2008) (ICM Act) is crucial to beach water quality and coastal management in South Africa. Sowman and Malan (2018, p.121) state that "the promulgation of the Coastal White Paper in 2000, and the Integrated Coastal Management (ICM) Act of 2008, signalled a significant paradigm shift in coastal management and governance" in South Africa, acknowledging coastal environments as complex systems that require urgent and delicate management approaches. The White Paper reflected a shared vision by coastal stakeholders on systematic coast management and the optimal utilisation of the opportunities and benefits the coast presents (DFFE, 1999; Celliers et al., 2009).

The ICM Act was a progressive step in coastal management and groundbreaking in the promotion of coordinated, integrated, sustainable management of coastal resources, with objectives to set out a new approach to providing equal access to the coastline and to promote the use of the coastal resources in an ecological, social, and economically sustainable manner (DFFE, 1999; Celliers et al., 2009). Aligned with

the ICZM, the ICM Act principles emphasise the incorporation of all stakeholders and the regulation of human activities within coastal zones. The act further places the responsibility on municipalities to control and manage coastal waters, such as waters in bays, estuaries, and harbours, in a manner that benefits the communities and is lawful.

#### **2.2.2.2 Government institutions**

##### **Department of Forestry, Fisheries, and the Environment (DFFE)**

The DFFE is a national government department that is tasked with managing, protecting, and conserving South Africa's environment and natural resources in accordance with Section 24 of the Constitution of the Republic of South Africa through the development of regulatory frameworks, environmental educational and awareness, capacity building in the sector, and fostering public-private partnerships that address environmental challenges faced by the country (DFFE, 2024). Therefore, DFFE ensures that citizens' rights to a healthy environment that benefits the present and future generations are upheld. The four entities reporting to DFFE include the iSimangaliso Wetland Park, the South African National Biodiversity Institute (SANBI), the South African National Parks (SANParks), and the South African Weather Service (SAWS).

##### **Department of Water and Sanitation (DWS)**

As custodians of water and sanitation resources, the DWS is mandated to ensure that all South African citizens have access to clean water and dignified sanitation, as informed by Section 27 of the Constitution of the Republic of South Africa. By promoting effective and efficient water resources management strategies that are economically sustainable and foster social development, the DWS facilitates the realisation of all citizens' rights to access clean water. Various entities reporting to the DWS include all fifteen (15) South African water boards, nine (9) Catchment Management Agencies (CMAs), the Trans-Caledon Tunnel Authority (TCTA), and the Water Research Commission (WRC) (DWS, 2024).

##### **Department of Economic Development, Tourism and Environmental Affairs (EDTEA)**

The EDTEA, a provincial department in KwaZulu-Natal, is mandated to oversee socio-economic transformation and environmental management through initiatives promoting sustainable development, climate change resilience, and various environmental management programmes; the department facilitates economic growth, transformation, development, and environmental conservation. The departments' key responsibilities include "environmental planning, climate change management, environmental compliance monitoring and enforcement, environmental quality management, and coastal and biodiversity management" (EDTEA, 2024, p.1).

### **2.2.3 South African local government coastal management approaches and strategies**

Coastal municipalities are responsible for managing the coastal zones at the local level, empowered by the South African Constitution's Section 156 and Section 11 of the Local Government Municipal Systems Act, 2000 (Act No. 32 of 2000). These municipalities utilise a variety of municipal laws tailored to their specific needs. In the Metropolitan Municipalities such as the eThekweni Municipality and the City of Cape Town, several by-laws play crucial roles in regulating and managing coastal zones and implementing coastal management strategies:

#### **Beaches by-law**

This by-law focuses on managing, controlling, and regulating public access and behaviour at beaches. The by-laws specifically address protecting the natural environment of the coastal zones within the municipality's jurisdiction by prohibiting any means of pollution to the sea or the coastal area and their surroundings (eThekweni Municipality, 2015a).

#### **Recreational water-use by-law**

The by-law aims to control the use of recreational water within the city, control the use of vessels, and provide for safe and environmentally sensitive recreation (City of Cape Town, 2018).

#### **Stormwater management by-law**

The by-law aims to regulate stormwater management systems and activities that may negatively affect the development and maintenance of the stormwater system. This by-law also includes provisions for adapting to climate change and densification of built-up areas. The by-law emphasises the protection and preservation of the natural environment. It promotes safe and sustainable development practices regarding rainfall and stormwater while balancing economic development in an environmentally sustainable manner in the city (City of Cape Town, 2005; eThekweni Municipality, 2020).

#### **Sewage disposal by-law**

This by-law is designed to ensure the provision of efficient, affordable, economical, and sustainable access to a dignified sanitation system and proper sewage services. It establishes different mechanisms for sanitation and regulates sewage management within the city (eThekweni Municipality, 2015b).

### **Wastewater and industrial/trade effluent by-law/policy**

This by-law is aimed at protecting the municipal sewers and the receiving environment by detailing the duties of property owners and requirements for the discharge of trade effluent to ensure that it is disposed of safely and in an environmentally friendly manner (City of Cape Town, 2013; eThekweni Municipality, 2021).

### **Treated effluent by-law**

This by-law is aimed at controlling and regulating treated effluent in the city (City of Cape Town, 2015). The by-law was established to safeguard the public health and the receiving environment by regulating the discharged treated effluent.

### **Municipal planning and land use management by-law**

Addressing Municipal Spatial Development Frameworks (MSDFs) and the land use schemes, this by-law regulates special land use planning and development within the city. The by-law aims to guide the development in alignment with the municipality's package of plans as well as to regulate and manage urban growth in the city (eThekweni Municipality, 2016; City of Cape Town, 2019)

### **Coastal management by-law**

This by-law focuses on managing and protecting the coastal areas by the National Environmental Management: Integrated Coastal Management Act. The by-law establishes measures for aligning development within the coastal zone, protecting the natural environment, managing public access, and establishing the Municipal Coastal Committee and Municipal Coastal Management Programme (eThekweni Municipality, 2019; City of Cape Town, 2020).

All these by-laws outline prohibitions, expected standards, operating procedures, and municipal measures for dealing with offences, including penalties for the transgressors, thereby ensuring effective coastal management within the municipality that benefits the current and future generations.

## **2.3 Water quality monitoring and assessment**

Water quality monitoring plays a crucial role in evaluating the suitability of water for recreational activities, particularly during peak holiday seasons when coastal areas attract many local and international visitors for leisure and recreational purposes. The quality of beach water is negatively impacted by various pollutants originating from inland activities entering via the stormwater drains and river discharges as well as directly

from oceanic activities; such pollution poses numerous risks to public health, aquatic life, the tourism sector, and the country's economy (Johnson, 2016; Olisah, Adams & Rubidge, 2021). According to Vijay et al. (2011), sewage discharges, often partially or inadequately treated, and wastewater from multiple sources such as sewer blockages, sewer breakages, sewer overflows, illegal sewer connections, and cross-connections between sewer and stormwater lines along the sewerage system, contribute substantially to the pressure and deterioration of the water quality along the beachfront and beaches. Olisah, Adams and Rubidge (2021) add that many South African estuaries are negatively impacted by pollutants from industrial effluents, agricultural runoffs, and sewage overflows, especially from informal settlements. Consequently, due to the various sources of pollution that the coastal zones are subject to, comprehensive monitoring and assessment of not only beach water but also the contributing estuaries and rivers are essential to mitigate pollution levels and ensure water quality compliance in line with international and South African Water Quality (SAWQ) Guidelines, initially published in 1996.

Water quality assessment, often analysed through water quality index (WQI), is a comprehensive approach process that examines a spectrum of water variables, which includes physical properties such as temperature, electrical conductivity, turbidity, salinity, colour, taste, and odour; chemical properties including pH, chlorine levels, hardness, dissolved oxygen (DO), and biological oxygen demand (BOD); and biological properties like nutrients, bacteria, algae and viruses as well as sediments analysis for marine water (Mazibuko, 2019; Aqel et al., 2024). WQI evaluates water characteristics about its intended use, recognising that a mere and simplistic classification of “good quality” and “bad quality” water alone is not sufficient, even though it may be a helpful approach when communicating the water quality results to non-scientific audiences (Lee, 1999; Malan & Day, 2012). The WQI holistic approach ensures a thorough understanding of water quality dynamics and informs effective management strategies to safeguard coastal environments and promote sustainable use of coastal resources. Water quality is defined as the “physical, chemical, biological and aesthetic properties of water that determine its fitness for a variety of uses and for the protection of aquatic ecosystems” (Department of Water Affairs and Forestry, 1996, p.2). Ritchie and Schiebe (2000, p.287) further emphasise that while water quality is described using its “physical, chemical, thermal, and biological properties”, its suitability and desirability for one purpose may render it completely unsuitable for another, hence cannot be standardised across all water uses. Water serves many uses, including but not limited to consumption, domestic, irrigation, industrial processes, and medicinal applications; however, for this research, the discussion primarily focuses on standards and parameters relevant to water used for recreational purposes. Beach water quality is badly affected by a multitude of pollutants, predominantly pathogenic pollution, which constitutes 80% of the pollutants, infiltrating coastal waters through stormwater and river discharges (Johnson, 2016; Lin, Yang & Xu, 2022).

The substances that negatively impact water quality are distinguished as originating from either point or nonpoint sources. Point sources suggest that substances can be detected in a single source, such as a sewer pipe; however, once the point has been traced, the effluent emanating from the source can be easily managed; conversely, nonpoint sources suggest that substances are more diffuse, such as those associated with the landscape, for example, human and natural activities, therefore presenting more significant challenges due to their diffuse nature, making identification and management costly, complex, and prone to causing significant pollution on the receiving environment (Ritchie & Schiebe, 2000; Verma, 2021). To develop effective water quality management strategies for reducing and mitigating pollutants, international and local standards have been established to safeguard water quality parameters affecting aquatic life. Achievement of these standards promotes healthy aquatic habitats and mitigates water pollution, which is a global concern documented within the 17 United Nations (UN) Sustainable Development Goals (SDGs), particularly SDG 6, which mainly “focuses on ensuring the availability and sustainable management of water and sanitation for all”, as part of the UN 2030 target for Sustainable Development, (Ritchie & Schiebe, 2000; UN, 2023, p.1).

### **2.3.1 South African guidelines for recreational use**

The South African Water Quality Guidelines for Coastal Marine Water, Volume 2, reintroduced by the Department of Environmental Affairs (DEA) in 2012, aimed at recreational use, seeks to address the limitations identified in the original issue released in 1995. Aligned with the international guidelines for recreational water, these guidelines offer authorities background information and guidance on the target range for recreational water (DEA, 2012). However, it is imperative to note that these guidelines are not assumed to be standards; professional judgement and knowledge of the surroundings and local environment must guide their application to avoid misinterpretation (Mazibuko, 2019). Hence, their utilisation should complement other local and international guidelines for a comprehensive assessment and monitoring of recreational water quality.

### **2.3.2 Beach water quality monitoring**

South African coastal cities have a comprehensive water quality monitoring programme encompassing various water bodies, including potable water, rivers, estuaries, trade effluent, beaches, and the deep ocean (eThekweni Municipality, 2021). The water monitoring programmes are structured to ensure coverage and effective management of water resources. Key components of the monitoring include the systematic collection of water samples, laboratory analysis of pertinent parameters tailored to the specific type of water being analysed, and the utilisation of data management systems like Laboratory Information Management System (LIMS). Water quality monitoring is a fundamental practice adopted worldwide, with a rich history and evolution spanning many years. It involves meticulously sampling water bodies and analysing their

constituents and prevailing conditions. The rationale behind this practice is multifaceted; however, the specifications and objectives depend on the purpose or intended use of the monitored water. Environmental Protection Department (2024) and United States Environmental Protection Agency (US EPA) (2012) state that beach water quality monitoring serves as a valuable tool for achieving the following objectives:

- Identify whether waters meet designated uses and comply with the water quality standards.
- Detection of sudden changes in water quality, indicative of potential issues.
- Screening for potential pollution problems, enabling proactive intervention.
- Determining pollutants and their respective sources facilitates targeted remedial action.
- Determination of pollution trends and formulation of effective management strategies.
- Provision of insights for decision-making regarding the opening or closure of water bodies to the public.
- Circulation of information regarding water quality status to the public and relevant authorities.

### **2.3.3 Coastal water quality testing**

South African coastal cities adhere to the South African Water Quality Guidelines for Coastal Marine Waters Volume 2: Guidelines for Recreational Use as a framework for beach water quality monitoring practices. Consequently, the parameters and the thresholds adhere strictly to this framework. In this study, the terms "beach" and "coast" are defined as follows: "beach" refers to the sandy area along the water's edge, while "coast" encompasses the entire area along the shoreline. This study focuses exclusively on the water quality monitoring programs of the eThekweni Municipality and the City of Cape Town. Microbiological testing for beach water quality primarily involves testing for two biological analyses, namely, the *Enterococcus* and the *Escherichia coli* (E. coli), which are recognised as reliable indicators for faecal pollution levels in water (De Giglio et al., 2022; Rodrigues & Cunha, 2017). *Enterococcus* and E. coli are chosen due to their prevalence in the intestinal tracts of mammals, including human beings and other warm-blooded animals. Their abundance, ease of cultivation and established correlation with faecal contamination make them critical in gauging the safety of recreational waters (Dungan & Bjorneberg, 2021). The guidelines specify limits in alignment with international standards for coastal water quality. As per the international standards and the guidelines outlined by the Department of Water Affairs and Forestry (DWAF) (1996), these limits classify recreational water quality levels accordingly. The international and local guidelines for safe recreational water use set the limit for Enterococci at  $\leq 200$  cfu/100 ml and *Escherichia coli* (E. coli) at  $\leq 500$  cfu/100 ml (DWAF, 1996; U.S. EPA, 2022). Elevated readings can lead to significant ecosystem degradation and pose serious public health risks to individuals who come into contact with the contaminated water, as exposure can lead to a range of waterborne illnesses (Verma et al., 2020). Table 2.1 shows the estimated risk of gastrointestinal illness per exposure for *Enterococcus* and E. coli.

Table 2.1: Risk ranges for *Enterococcus* and *E. coli* used for beach water quality monitoring.

Range	Estimated risk of illness per exposure*	<i>Enterococcus</i> count per 100 ml	<i>Escherichia coli</i> count per 100 ml
Excellent	<2,9% GI illness risk	< 100 (95th percentile)	< 250 (95th percentile)
Good	<5% GI illness risk	< 200 (95th percentile)	< 500 (95th percentile)
Sufficient	<8,5 % GI illness risk	< 185 (90th percentile)	< 500 (90th percentile)
Poor	>8,5% GI illness risk	> 185 (90th percentile)	> 500 (90th percentile)

\* Exposures are defined as 10 minutes of swimming with three head immersions.

Counts = number of colonies ; CFU = colony-forming-units ; GI = gastrointestinal

Source: (DEA, 2012, p.18; City of Cape Town, 2023b, p.3)

Table 2.2: Recommended targets for objectionable matter and physico-chemical indicators.

Indicator	Recommended Target
Objectionable matter	“Water should not contain litter, floating particulate matter, debris, oil, grease, wax, scum, foam or any similar floating materials and residues from land-based sources in concentrations that may cause nuisance. Water should not contain materials from non-natural land-based sources, which will settle to form objectionable deposits. Water should not contain submerged objects and other surface hazards that arise from non-natural origins, which would be a danger, cause nuisance, or interfere with any designated/recognised use. Water should not contain substances producing objectionable colour, odour, taste, or turbidity.”
pH	5.0 – 9.0
Turbidity	5.0 Nephelometric Turbidity Units (NTU)
Temperature	15 – 35 °C

Source: DEA (2012, p.11)

The South African Water Quality Guidelines recommend additional parameters beyond microbiological indicators for beach water quality monitoring. These include the assessment of objectionable matter and physicochemical parameters as per Table 2.2. Consequently, South African coastal cities monitor the presence of any floatable litter by testing pH, salinity, and turbidity.

#### **2.3.4 Beach water quality monitoring – City of Cape Town**

According to the City of Cape Town 2023 water quality report, water quality monitoring is a regular practice, with tests conducted every fortnight at 90 sites spanning along the coastline from Atlantic to False Bay, covering a distance exceeding 300 kilometres (City of Cape Town, 2023a). These tests include “water samples collected in the surf zone and tidal swimming pools, which the internal Scientific Services unit laboratory analyses” (City of Cape Town, 2023a, p.1). These samples undergo a variety of tests following guidelines for recreational use. Water quality results are categorised annually as excellent, good, sufficient, or poor. With just over 4.7 million residents, the City of Cape Town deals with water quality challenges common to many coastal cities, including sewage pollution, overpopulation, surface water runoffs, industrial effluent and global climate change (City of Cape Town, 2023a). Notably, sewage pollution is particularly higher during drought periods, as noticed in 2017, when sewage released into Camps Bay alone exceeded the rainfall recorded at least nine-fold (Ojemaye et al., 2021). Using marine/sea outfalls for sewage disposal is a recurring concern among Cape Town residents, as it negatively impacts the coastal water quality (Zackon, 2021). Despite these concerns, sewage disposal via sea outfalls is a common practice worldwide and, in the country, with 14 such outfalls currently in operation along the coast of South Africa, with the City of Cape Town alone boasting three (3) outfalls, located at Green Point, Camps Bay, and Hout Bay, while eThekweni Municipality operates two outfalls, both located off the Bluff coast (Bailey, 2000; City of Cape Town, 2023a).

#### **2.3.5 Beach water quality monitoring – eThekweni Municipality**

The eThekweni municipality has established several sampling points along its coastline that are strategically positioned to comprehensively monitor the entire coastline for compliance with guidelines for recreational use (eThekweni Municipality, 2023b). Figure 2.1 provides a map of eThekweni beaches. Table 2.3 provides a detailed list of all beaches, including their names, designated use classification (swimming or non-swimming), and specific locations and coordinates. The beaches are strategically located along the coastline, where consistent and thorough monitoring is ensured by carefully selecting beach water sampling locations that effectively represent and reflect water quality across the recreational zone under scrutiny (Van Heerden, 2015).

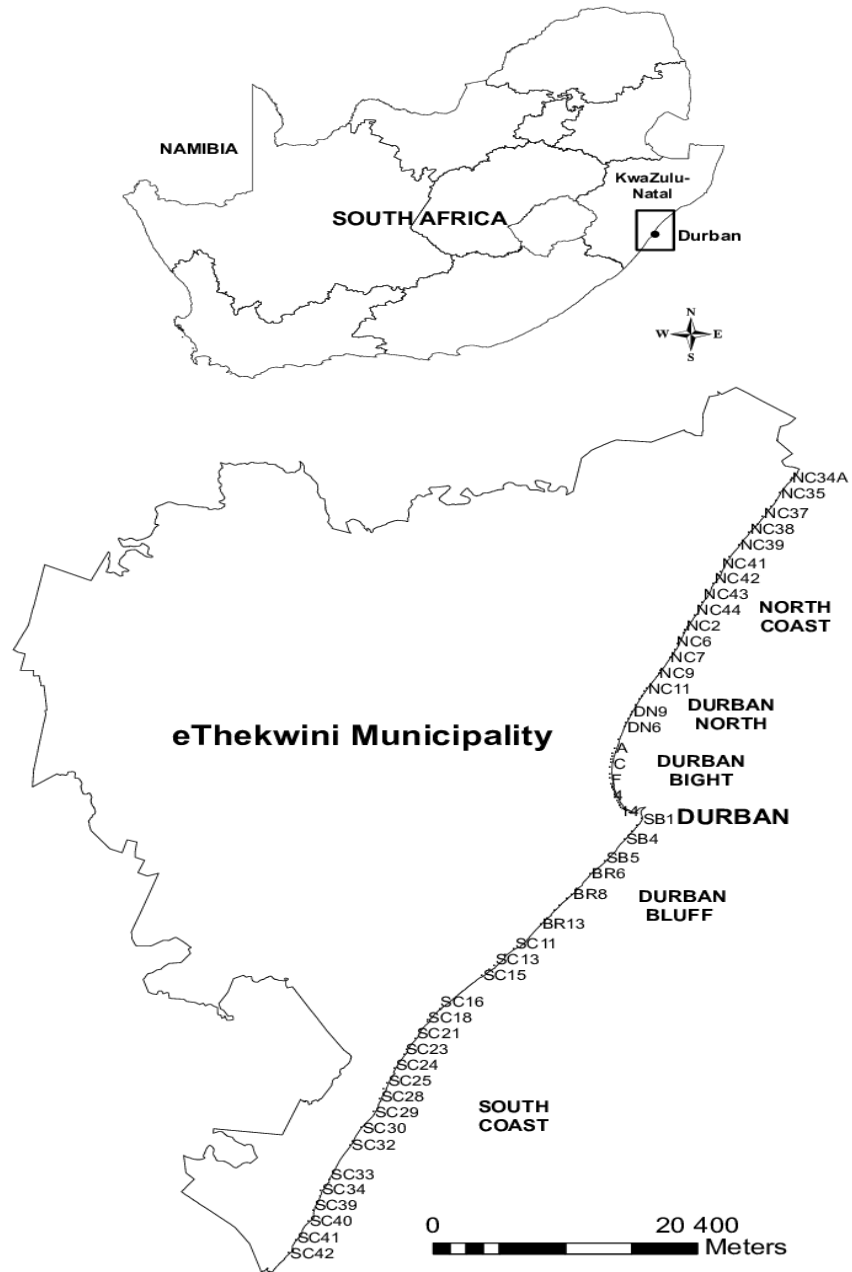


Figure 2.1: A map of the eThekweni Municipality beaches along the coastline.

Source: Corbella and Stretch (2012, p.13).

Table 2.3: eThekweni Municipality list and locations of all beaches along the coastline.

Name of the Beach	Region	Swimming	Non-swimming	Coordinates
Westbrook	North	*		-29.59206447220 31.17114640570
Casuarina	North		*	-29.60287096150 31.16499698340
La Mercy	North		*	-29.64811278380 31.13075453930
Mdloti Main Beach	North	*		-29.67160866690 31.11782043350
Mdloti South	North		*	-29.68096849480 31.11296574400
Mdloti Tidal	North		*	-29.66661849430 31.12200062800
Umhlanga Main Beach	North	*		-29.72337252240 31.08968249960
Umhlanga Bronze Beach	North	*		-29.71787694450 31.09225114450
Umhlanga Granny's Pool	North		*	-29.72484617250 31.08931703380
Umhlanga Lighthouse	North		*	-29.72874101140 31.08798069490
Beachwood Mangroves	North		*	-29.78295852760 31.05310031630
Virginia	North		*	-29.77461136170 31.05762357760
Glenashley	North		*	-29.76570418860 31.06299418360
Country Club Beach	Central	*		-29.82842296650 31.03733587790
eThekweni Beach	Central	*		-29.82340658930 31.03774043850
Laguna Beach	Central	*		-29.82080326660 31.03818994440
Beach South of Mgeni	Central		*	-29.81294307260 31.04045426670
Wedge Beach	Central	*		-29.85388657230 31.04036679430
North Beach	Central	*		-29.84908948890 31.03870944410
Bay of Plenty	Central	*		-29.84642245570 31.03780152820
Battery Beach	Central	*		-29.83795433920 31.03705717180
Dunes at Suncoast	Central		*	-29.83653789470 31.03709803290
Point Beach (Vetches)	Central	*		-29.86713202800 31.04768112750
Ushaka Beach	Central	*		-29.86660345000 31.04700925530
Addington Beach	Central	*		-29.86347449420 31.04474394970
South Beach	Central	*		-29.85825413890 31.04146989480
Garvies	Bluff		*	-29.91267278340 31.03165413870
Treasure	Bluff		*	-29.95252489480 30.99392168350
Anstey_R	Bluff		*	-29.92592434470 31.01801772240
Umlaas	Bluff		*	-29.96834812780 30.97923778330
Reunion	Bluff	*		-29.99326052250 30.95314546070
Isipingo	Bluff		*	-29.99462486690 30.95174649990
Ezimbokodweni	Bluff		*	-30.01167786150 30.93337807820
Beach at CWWTW	Bluff		*	Lat: -29.871465 Lon: 31.060362.
Ansteys	Bluff	*		-29.92325449980 31.02032222800
Brighton	Bluff	*		-29.93338297250 31.01277276110
Karridene	Southern	*		-30.12460153870 30.84944406160
Toti Main	Southern	*		-30.04990157810 30.89115683910
Toti Pipeline	Southern	*		-30.04074513930 30.89939687220
Winkelspruit	Southern	*		-30.09504373310 30.86225168850
Umgababa	Southern	*		-30.14325255570 30.83749153870
Umkomaas	Southern		*	-30.19988483330 30.80362983320
Warner Baggies	Southern		*	-30.07889074500 30.87206801160
Warner	Southern	*		-30.07531215000 30.87366731130

Source: The author compiled this table using information from the eThekweni Municipality (2024).

### **2.3.5.1 Beach water sampling**

The eThekweni Municipality 46 beaches include a diverse array of beaches, including swimming, non-swimming, and seasonal beaches – those open for swimming exclusively during the December festive season (eThekweni Municipality, 2023b). The eThekweni Water and Sanitation Unit, Scientific Services Departments’ biomonitors utilise a meticulous approach to water sampling, adhering to a predetermined schedule and using bacteriological sampling bottles to collect numerous “grab” samples from designated spots, which are verified by precise coordinates. DEA (2012, p.16) outlines essential recommendations for beach water sampling:

- A structured random sampling routine must be followed.
- Beach water samples must be collected fortnightly.
- Important information must be recorded on sampling at each sampling point.
- Sampling points must accurately represent the water quality of the sampled area.
- Water samples must be collected at 15 to 30 centimetres (cm) underneath the water surface.
- Sample analysis must follow the methods stipulated by the South African National Standards (SANS).

Upon completion of the sampling route, international sampling guidelines are followed, and all collected samples are promptly transported to the eThekweni laboratory in Pinetown, New Germany (eThekweni Municipality, 2023b). During transportation, samples are carefully stored at controlled temperatures using coolers and ice packs to preserve and maintain sample integrity while in transit until arrival at the laboratory, ensuring that they remain in their original condition for accurate analysis (DEA, 2012; DWAF, 1996). Given the significant impact of inland activities on beach water quality, the municipality employs a comprehensive river water sampling program to monitor river water quality within the eThekweni region, ultimately influencing beach water quality. Rivers are the primary route from land to coastal zones, making their pollution critical in determining coastal water quality. Factors such as river size, vegetation, geomorphology, climate, and surrounding developments along the river, including informal settlements, contribute to river pollution dynamics (Johnsons, 2016). Consequently, rivers are sampled monthly at various sampling points, with analyses conducted for multiple parameters aligned with established river water quality assessment guidelines.

### **2.3.5.2 Sampling frequency**

The sampling frequency for each beach occurs every fortnight (twice a month), aligning with the international and local water quality recommendations for coastal waters (DEA, 2012; DWAF, 1996). However, the sampling frequency may increase under certain circumstances, such as peak seasons, heavy

floods, or known pollution incidents affecting beach water quality. Throughout the water sampling process, water samples are collected for laboratory analysis, and the litter information is registered to ascertain the status of the beaches (eThekweni Municipality, 2023b).

### **2.3.5.3 Beach water testing**

Rigorous testing for various parameters is conducted in line with the South African National Standards (SANS) and International Organization of Standardization (ISO) 17025 accreditation laboratory standards. Laboratory analysts and scientists based at the eThekweni Municipality Scientific Services Laboratory conduct and oversee these analyses, ensuring thorough examination of various parameters (eThekweni Municipality, 2023b).

### **2.3.5.4 Beach water quality results**

Testing for all pathogens present is ideal to conduct a comprehensive assessment of water quality. However, this approach is often impractical, challenging, and costly. As a practical and affordable alternative, routine monitoring using indicator organisms is used; these indicators are chosen for their ability to reliably symbolise the presence of waterborne pathogens (Johnson, 2015). According to the South African Water Quality Guidelines (1996) (DEA, 2012; DWAF, 1996), microbiological indicators are the most preferred method for assessing beach water quality globally, and they are favoured based on several factors:

- a) They serve as a reliable indicator of the presence of waterborne pathogens.
- b) Microbiological indicators are consistently present in sewage-polluted water bodies.
- c) Their quantities correlate with the levels and duration of faecal pollution.

Although several microbiological indicators exist, each with advantages and disadvantages, eThekweni municipality focuses its monitoring efforts on two key indicators, the *Enterococcus* and the *E. coli*. However, to evaluate the past decade of eThekweni beach water quality, only *E. coli* indicator results were focused on. This decision was made to streamline the assessment process and avoid repetition of information in indicator monitoring as both *Enterococcus* and *E. coli* symbolise the same pollutant (DEA, 2012; DWAF, 1996).

It is worth noting that research conducted by the World Health Organization (WHO) suggests that *Enterococcus* is a preferred microbiological indicator for assessing pathogenic pollution in coastal recreational waters. The preference stems from the direct link between *Enterococcus* bacterium with gastrointestinal illness (GI) levels, its resistance to various environmental stressors such as beach salinity, and its prolonged survival ability compared to *E. coli* and other microbiological indicators (WHO, 2004; Health Canada, 2020).

Table 2.4: eThekweni Municipality water quality ratings 2014 to 2024.

Name of the Beach	Region	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Westbrook	North	EXCELLENT	SUFFICIENT	SUFFICIENT	SUFFICIENT	GOOD	SUFFICIENT	POOR	POOR	POOR	POOR	POOR
Casuarina	North	EXCELLENT	SUFFICIENT	SUFFICIENT	GOOD	EXCELLENT	POOR	POOR	POOR	POOR	POOR	POOR
La Mercy	North	EXCELLENT	EXCELLENT	POOR	SUFFICIENT	EXCELLENT	SUFFICIENT	EXCELLENT	GOOD	POOR	POOR	POOR
Mdloti Main Beach	North	EXCELLENT	GOOD	SUFFICIENT	GOOD	EXCELLENT	POOR	EXCELLENT	POOR	POOR	POOR	POOR
Mdloti South	North	EXCELLENT	GOOD	EXCELLENT	EXCELLENT	EXCELLENT	SUFFICIENT	EXCELLENT	GOOD	POOR	POOR	SUFFICIENT
Mdloti Tidal	North	EXCELLENT	EXCELLENT	SUFFICIENT	EXCELLENT	EXCELLENT	GOOD	EXCELLENT	SUFFICIENT	POOR	SUFFICIENT	SUFFICIENT
Umhlanga Main Beach	North	EXCELLENT	GOOD	POOR	SUFFICIENT	GOOD	POOR	EXCELLENT	POOR	POOR	POOR	POOR
Umhlanga Bronze Beach	North	EXCELLENT	GOOD	SUFFICIENT	SUFFICIENT	GOOD	GOOD	EXCELLENT	POOR	POOR	POOR	POOR
Umhlanga Granny's Pool	North	GOOD	GOOD	POOR	SUFFICIENT	GOOD	POOR	SUFFICIENT	POOR	POOR	POOR	POOR
Umhlanga Lighthouse	North	EXCELLENT	GOOD	POOR	SUFFICIENT	POOR	POOR	EXCELLENT	POOR	POOR	POOR	POOR
Beachwood Mangroves	North	GOOD	SUFFICIENT	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR
Virginia	North	GOOD	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR
Glenashley	North	GOOD	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR
Country Club Beach	Central	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR
eThekweni Beach	Central	POOR	SUFFICIENT	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR
Laguna Beach	Central	POOR	SUFFICIENT	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR
Beach South of Mgeni	Central	POOR	SUFFICIENT	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR
Wedge Beach	Central	GOOD	GOOD	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR
North Beach	Central	POOR	GOOD	POOR	GOOD	SUFFICIENT	POOR	POOR	POOR	POOR	POOR	POOR
Bay of Plenty	Central	SUFFICIENT	GOOD	POOR	GOOD	POOR	POOR	POOR	POOR	POOR	POOR	POOR
Battery Beach	Central	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR
Dunes at Suncoast	Central	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR
Point Beach (Vetches)	Central	EXCELLENT	POOR	POOR	SUFFICIENT	POOR	POOR	POOR	POOR	POOR	POOR	POOR
Ushaka Beach	Central	SUFFICIENT	POOR	POOR	SUFFICIENT	POOR	POOR	POOR	POOR	POOR	POOR	POOR
Addington Beach	Central	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR
South Beach	Central	SUFFICIENT	GOOD	POOR	SUFFICIENT	POOR	POOR	POOR	POOR	POOR	POOR	POOR
Garvies	Bluff	POOR	SUFFICIENT	POOR	POOR	SUFFICIENT	POOR	POOR	POOR	POOR	POOR	POOR
Treasure	Bluff	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR
Anstey_R	Bluff	GOOD	SUFFICIENT	POOR	POOR	POOR	POOR	SUFFICIENT	POOR	POOR	POOR	POOR
Umlaas	Bluff	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR
Reunion	Bluff	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR
Isipingo	Bluff	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR
Ezimbokodweni	Bluff	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR
Beach at CWWTW	Bluff	POOR	SUFFICIENT	GOOD	POOR	POOR	POOR	POOR	EXCELLENT	POOR	POOR	POOR
Ansteys	Bluff	EXCELLENT	EXCELLENT	POOR	SUFFICIENT	POOR	POOR	POOR	POOR	POOR	POOR	POOR
Brighton	Bluff	SUFFICIENT	POOR	POOR	POOR	POOR	POOR	POOR	SUFFICIENT	POOR	POOR	POOR
Karridene	Southern	POOR	EXCELLENT	POOR	POOR	POOR	SUFFICIENT	POOR	SUFFICIENT	POOR	POOR	POOR
Toti Main	Southern	SUFFICIENT	SUFFICIENT	POOR	POOR	POOR	GOOD	POOR	GOOD	POOR	POOR	POOR
Toti Pipeline	Southern	POOR	SUFFICIENT	POOR	POOR	POOR	GOOD	POOR	SUFFICIENT	POOR	POOR	POOR
Winkelspruit	Southern	SUFFICIENT	GOOD	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR
Umgababa	Southern	EXCELLENT	EXCELLENT	POOR	POOR	GOOD	SUFFICIENT	EXCELLENT	SUFFICIENT	POOR	SUFFICIENT	POOR
Umkomaas	Southern	POOR	POOR	POOR	POOR	POOR	POOR	POOR	SUFFICIENT	POOR	POOR	POOR
Warner Baggies	Southern	GOOD	SUFFICIENT	POOR	SUFFICIENT	POOR	POOR	POOR	POOR	POOR	POOR	POOR
Warner	Southern	POOR	SUFFICIENT	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR	POOR

Source: eThekweni Municipality (2024, p.1).

To evaluate the effectiveness of its beach water quality management system (WQMS), the City of Cape Town utilises a water quality rating system that is based on the South African Water Quality Guidelines for Coastal Marine Waters Volume 2: Guidelines for Recreational Use (City of Cape Town, 2023b). This rating system evaluates water quality by analysing *Enterococci* and *Escherichia coli* in water samples collected periodically throughout the year. For each beach, the 90<sup>th</sup> and 95<sup>th</sup> percentiles of these biological indicators are calculated annually, and based on these results, the beaches are assigned a grade and corresponding

colour code: excellent (low risk and safe for use), good (low to moderate risk and safe for most users), sufficient (moderate risk and must be used with caution) or poor (high risk and unsafe for use), as detailed in Table 2.1 (City of Cape Town, 2023b). In order to assess the performance of the eThekweni Municipality beach monitoring system, a similar rating approach was applied to all eThekweni beaches, exclusively focusing on E. coli, as presented in Table 2.4. While the report has never been published, it is available through the Scientific Services department. The findings, as shown in Table 2.4, reveal a consistently poor water quality status across most monitored beaches, indicating a chronic issue with sewage pollution, as evidenced by the frequent presence of faecal coliforms. Notably, the data from 2022 shows that all beaches in the region were rated as poor, highlighting the increased persistent nature of the sewage contamination.

## **2.4 Sources of beach water pollution and pollution prevention measures**

The ocean is the ultimate final destination for all surface water, which renders it vulnerable to significant pollution from various sources. Efforts to mitigate ocean pollution involve monitoring, regulation and cooperation. Below are the familiar sources of coastal pollution and potential mitigation measures:

### **2.4.1 Stormwater system**

Stormwater includes all the rainwater runoffs and water flows from any surface following rainfall events or floods. Kotecha et al. (2023) defines stormwater as any water that originates from natural precipitation. The stormwater contamination varies depending on the geographic location of the catchment area. Therefore, the pollution of stormwater and, thus, of the coastal water depends on the activities from inland. In urban areas, all surface runoff collects in stormwater drains, discharging directly into rivers, canals, or the ocean without any treatment. Pathogenic pollutants may also accompany water runoff if present on catchment surfaces, thereby polluting the coastal waters; however, the extent of pathogenic pollution in coastal waters is affected by the rainfall duration and intensity (Johnson, 2015). Additionally, the duration and quantity of sewage pollution from its source determine the pathogenic pollution of the ocean, as pollutants sediments on the surface are washed away into the ocean during rainfall or floods. Several stormwater pollution prevention plans (SWPPP) have been implemented to address diverse forms of pollution prevention. These SWPPPs typically include measures such as sediment and erosion control, particularly for construction sites, as well as strategies for turf management to mitigate fertiliser and pesticide runoff; additional components include street and parking clean-up, effective vehicle management practices, sewer and stormwater system maintenance, and public education initiatives aimed at preventing illegal dumping into stormwater drains, which can lead to sewer blockages (Clampitt, 2023; Foster, 2023).

### **2.4.2 Floods**

Floods result from prolonged rainfall or intense rainfall over a short period, exacerbated by climate change or failures of large water control structures such as dams or retaining walls. Regardless of the cause, flood events can significantly damage sewer infrastructure, contaminating water bodies, including oceans, with sewage, pesticides, industrial effluents, and debris (National Geographic Society, 2022). The Council for Scientific and Industrial Research (CSIR) reports that flood events are increasingly frequent globally, impacting South Africa similarly with devastating consequences such as severe water pollution, loss of lives and livelihoods, and extensive infrastructural damage affecting businesses (CSIR, 2019). Uncertainties surround future rainfall patterns under future climates, but projections indicate that rainfall intensities will increase, particularly in South Africa, where flooding is a recurring phenomenon (CSIR, 2019). Grab and Nash (2023) highlight that flooding frequency in eThekweni Municipality has doubled over the past century, with the April 2022 floods standing as one of KZN's most catastrophic flood disasters to be recorded. Therefore, comprehensive mitigation measures are crucial to minimise flood impacts. Municipalities in urban areas can play a pivotal role in flood prevention or mitigation and addressing oceanic pathogenic pollution caused by flooding by restoring ecological infrastructure, implementing flood-proof infrastructure, and maintaining existing infrastructure (US EPA, 2015).

### **2.4.3 First flush rains**

During heavy rainfall, surface water runoff, particularly during the first flush rains, acts as the main transport mechanism for various pollutants into the receiving environment, which negatively impacts the physical and chemical constituents of water bodies, leading to pollution and severe environmental degradation (Mamoon et al., 2019). "First flush" refers to the initial surface runoffs after precipitation, which carries concentrated pollutants accumulated since the last rainfall event into stormwater drains or nearby water bodies. The quantity of pathogenic pollution during the first flush is determined by factors such as inland activities, duration and intensity of the rainfall (Soller et al., 2005). Consequently, local activities, rainfall duration, and intensity are critical in determining the severity of first-flush rain pollution. Lee et al. (2011) note that the highest concentration of contaminants in the receiving environment and water bodies occurs during the initial runoff stages, known as the first flush. Wang, Feng and Min (2023) and Lay et al. (2024) propose that urban areas invest in first flush diverter designs as part of stormwater pollution management strategies, which can help reduce pollution loads for rainwater harvesting and be adapted for managing industrial and surface runoff pollution.

#### **2.4.4 Rivers**

Rivers serve as conduits for all surface waters to reach the ocean, accumulating several pollutants from catchments and associated inland activities, particularly industrial and agricultural practices (van Emmerik et al., 2022). The quality of effluent discharged from wastewater treatment plants significantly affects river health and, ultimately, the beaches as they directly discharge treated or partially treated effluents into waterways. During heavy rains, sewer overflows, illegal or cross-connections, and sewer pump station malfunctions exacerbate beach pollution with sewage (Forbes & Demetriades, 2008). Van Emmerik et al. (2022) highlight that rivers are major contributors to ocean litter, transporting substantial amounts of land-based plastic waste into the ocean. Consequently, rivers are instrumental in accumulating and transporting inland pollutants into coastal waters. In addition to domestic, industrial, and agricultural wastes, harmful materials disposed of directly or indirectly further contribute to river pollution; however, addressing river pollution necessitates identifying pollution sources and understanding their causes and impacts (Mat Saad et al., 2022). Although resolving river pollution is a complex challenge, steps can be taken to mitigate it, including safe disposal of hazardous waste, preventing illegal dumping, reducing the use of fertilisers and pesticides, raising public awareness, continuous monitoring, enforcing strict regulations, and participating in river clean-up initiatives; once pollution sources have been mitigated, various “water treatment technologies including ozonation, chlorination, and aerobic granulation can be applied to remediate the pollutant residues” in severely polluted rivers (Mat Saad et al., 2022, p.139).

#### **2.5 Chapter summary**

In summary, the South African coastline offers significant opportunities for economic development, but its sustainability is threatened by inland human activities that adversely affect this invaluable resource. Both government and private institutions must collaborate to ensure sustainable development of the coastal areas, adhering to their respective mandates outlined in relevant legislation. Local beach water quality management strategies should be revamped to align international standards employed in coastal cities that experience similar climates, aiming to curb marine pollution and safeguard aquatic and human life. South African coastal cities must prioritise mitigating water pollution to unlock the economic potential of their coastal areas. Implementing climate-resilient infrastructure is crucial to combat harsh weather patterns, especially floods, alongside regulating human activities inland to prevent coastal water pollution. Enforcing existing legislation while promoting sustainable development in alignment with the Sustainable Development Goals is essential for maximising the country’s coastal advantages. The following chapter will explore the research methodology used in this research.

# **CHAPTER THREE**

## **RESEARCH METHODOLOGY**

### **3.1 Introduction**

This chapter presents the methodology employed in this research. Chapter two presented a comprehensive literature review of the study focusing on key topics such as international and local coastal water regulatory frameworks and policies, water quality monitoring and assessment, as well as sources of beach water pollution and their respective prevention measures. Given the vast scope of water quality management and its multifaceted dynamics, the literature review only focuses on selected studies from both local and international contexts.

The research methodology chosen for this qualitative study aims to comprehensively address eThekwin beach water quality management, drawing insights from interviewees who are knowledgeable in the domain of beach water quality management. This chapter describes the research purpose, offers the research design and methodology utilised in the study, describes the sampling techniques employed, outlines the data analysis instruments, and discusses the validity, reliability, limitations and ethical considerations of the research.

This chapter is structured as follows. Section 3.1 introduces the topics that will be explored in the current chapter. Section 3.2 delves into the research purpose, providing the primary objective for conducting the research. Section 3.3 elaborates on the research design and methodology, detailing the overall plan chosen to achieve the research objectives. This section includes discussions on research philosophy, research approach, research strategy, research design and data collection methods. Section 3.4 provides an in-depth account of the sampling techniques used, outlining the methods employed to select the target population from a larger population and profiling the selected interviewees in the study. Section 3.5 clarifies the data analysis process, which involves systematically examining and interpreting the data collected during the study to filter the themes relevant to the research objectives. Section 3.6 outlines the procedure undertaken to ensure the validity and reliability of the data, assessing its quality and trustworthiness. Section 3.7 addresses the research limitations, detailing the constraints or restrictions that may affect the study's findings. Section 3.8 discusses the ethical considerations integral to the research, emphasising the principles and guidelines undertaken to ensure the protection of interviewees' rights, integrity, and confidentiality throughout the research process. Finally, Section 3.9 offers a chapter summary, providing a general overview of the key points presented within the research methodology chapter of this study.

### **3.2 Research purpose**

Research is defined as “the creation of new knowledge or the use of existing knowledge in a new and creative way so as to generate new concepts, methodologies and understandings” (Song, 2021, p.408). There are many other definitions of research by various scholars; however, the bottom line is that research is vital for both scientific and nonscientific fields; it starts by asking the relevant questions and then choosing a relevant method to investigate the problem. Research involves a systematic series of actions necessary for conducting a study effectively, encompassing posing questions, gathering relevant information, and presenting findings; it also promotes scientific and logical thinking (Singh, 2021). The research purpose is to collect, analyse, and interpret data so the researcher can gain a deeper understanding of a phenomenon that interests them (Leedy & Ormrod, 2021; Mlamula, 2022). Therefore, the research purpose is simply a statement that explains why the research is undertaken and gives answers to the research questions. There are a number of primary purposes for conducting research. Beckingham (1974) aligns with Singh (2019), both stating that the purpose might vary between identifying a concept, explaining a situation or finding a solution to a situation.

The purpose of this research is to evaluate the existing strategies for maintaining the beach water quality that the eThekweni Municipality implements and to recommend comprehensive measures aimed at improving these strategies. The study aims to analyse the effectiveness of the current strategies, identify shortcomings or areas of improvement, and propose actionable steps to enhance the management of beach water quality within the city. The ultimate goal is to contribute to the protection of the environment and the safety of the beaches through informed and targeted recommendations.

### **3.3 Research design and methodology**

The research design purpose is to establish a suitable framework for the study that guides critical decisions regarding the research approach and dictates how relevant information will be gathered (Sileyew, 2019). According to Thakur (2021), research design serves as an overall plan that integrates the different elements of the research cohesively and pragmatically to address the research problem effectively. The strategy includes systematic gathering, measurement, and examination of data. The researcher in this study utilised the six-layer research onion model by Saunders, Lewis and Thornhill (2019), initially introduced in 2012, to guide the selection of appropriate methods for gathering pertinent information. The model, as detailed in Figure 3.1, presents the six layers of research design that comprise the research process. The research onion begins with the outer layer, the research philosophy, followed by the research approach to theory development. Subsequently, it digs into the methodological choice, strategy selection, and time horizon,

then in the sixth innermost layer – the research procedures and techniques (Saunders, Lewis & Thornhill, 2019). The layers of the research onion are discussed below, with a focus on the specific aspects relevant to this study.

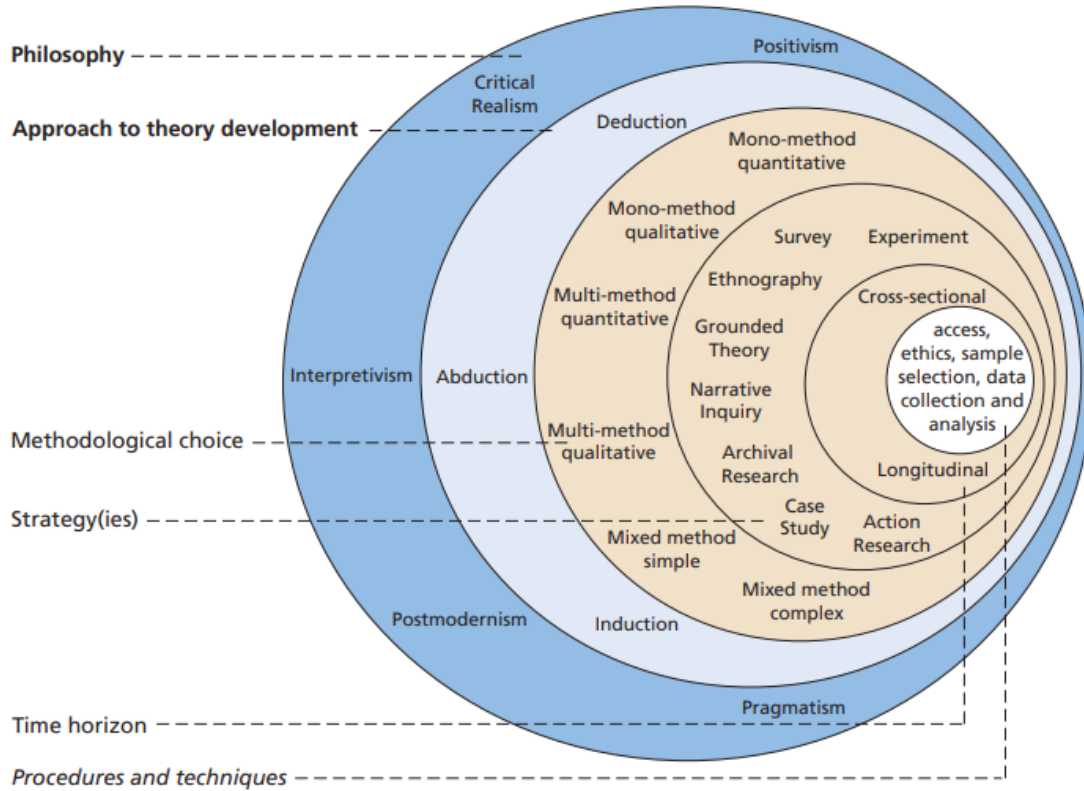


Figure 3.1: The ‘Research Onion’.

Source: Saunders, Lewis and Thornhill, (2019, p.108).

### 3.3.1 Research philosophy

Saunders, Lewis and Thornhill (2019, p.130) define research philosophy as “a system of beliefs and assumptions about the development of knowledge” within a particular field. Žukauskas et al. (2018) describe it as the researcher’s worldview through which new insights or knowledge are obtained. Regardless of the magnitude of the research, whether the researcher is aware or not, there are a number of assumptions that will be made throughout the process, which include ontological, epistemological, and axiological assumptions which shape how research questions are framed, methods are chosen, and data are interpreted (Saunders, Lewis & Thornhill, 2019; 2023). Ontology pertains to the assumptions about the nature of reality or knowledge, epistemology refers to assumptions about how knowledge is acquired and what can be

known, whereas axiology concerns the assumptions about what is valuable (Saunders, Lewis & Thornhill, 2023). Qualitative research is typically aligned with interpretive philosophy, where researchers seek to understand the context and meanings associated with the situation under study (Poggenpoel, Myburgh & Van Der Linde, 2001). Hence, this study adopts an interpretive philosophy to gain insights into the management strategies of beach water quality in the eThekweni Municipality.

### **3.3.2 Research approach**

A research approach refers to the systematic procedure that a researcher uses to gather, analyse, and interpret data of a particular study. Philosophically, research approaches are often categorised as inductive and deductive reasoning, where inductive reasoning involves deriving a general principle or creating theories from specific observations, whereas deductive reasoning involves testing or analysing existing theories through empirical research (Okilu, 2022; Saunders, Lewis & Thornhill, 2019). Additionally, abductive reasoning is another form where researchers form an explanatory hypothesis or introduce new ideas based on observed phenomena; however, in practice, researchers commonly classify their approach as either inductive or deductive depending on whether they are generating theories or testing them (Okoli, 2022).

This research follows an inductive research approach, where data is collected and analysed to formulate or develop theories. By identifying patterns in the data, the inductive approach facilitates the exploration of the phenomena under study, which is evaluating the effectiveness of beach water quality management strategies in eThekweni Municipality.

### **3.3.3 Research design**

The research design is a strategy for responding to research questions, encompassing clear objectives and specific sources of data to be analysed, including the data collection and analysis method (Saunders, Lewis & Thornhill, 2019). The plan also includes the methodological choice to examine and explain the research and its final results, which may involve using numbers, a descriptive style, or a benefit of using both; these three research methodologies are quantitative, qualitative, and mixed methods, respectively, and are widely used by researchers (Taherdoost, 2022; Saunders, Lewis & Thornhill, 2019). This study aims to evaluate the effectiveness of the beach water quality management strategies currently employed by eThekweni Municipality and to propose enhancements to these strategies. Evaluative research assists in assessing how well something works or the effectiveness of existing practices, while exploratory research is flexible and adaptable, offering opportunities for new insights (Saunders, Lewis & Thornhill, 2019). Given the dual evaluative and exploratory nature of this study, a qualitative methodology was chosen as the researcher seeks to gain deeper insights and understanding of the subject matter.

Qualitative methodology encompasses various definitions by a number of scholars. However, they all highlight its role in exploring and understanding social human problems. Qualitative methods are characterised by their approach to uncovering the meanings that individuals or groups ascribe to such issues (Creswell & Creswell, 2018; Lima & Newell-McLymont, 2021). Leavy (2017) supports this perspective, suggesting that qualitative research is particularly suitable when the primary purpose of the research is to explore, describe or explain a particular phenomenon, thereby fostering a comprehensive understanding among all involved parties. Furthermore, Aspers and Corte (2019, p.2), after synthesising approximately ninety sources, define qualitative research as an “iterative process in which improved understanding to the scientific community is achieved by making new significant distinctions resulting from getting closer to the phenomenon studied”. In essence, qualitative research addresses the ‘how’, ‘what’, and ‘why’ questions within the study, making it the advantageous choice of research method and crucial for educational research as this approach offers detailed insights and allows a thorough understanding of experiences, phenomena and context of the study (Gill & Baillie, 2018; Cleland, 2017). Qualitative research, therefore, is particularly well-suited to address research questions that cannot be quantified to understand the phenomenon; hence, it may be used in conjunction with quantitative research in mixed method research (MMR) when numerical data alone is insufficient to extend knowledge and understanding of a phenomenon (Cleland, 2017).

### **3.3.4 Research strategy**

Malhotra (2017) defines research strategy as the systematic plan of action through which information is sought and assessed. Similarly, Saunders, Lewis and Thornhill (2009) describe it as a comprehensive plan that guides the researchers in addressing their research questions. Qualitative research encompasses a number of research strategies, each chosen based on the study’s primary aim and objectives, outlining how the research will proceed and determining whether methods such as “experiments, surveys, ethnography, grounded theory, narrative inquiry, archival research, case studies, interviews, or action research” will be employed to collect the data (Saunders, Lewis & Thornhill, 2019, p.190). In qualitative research, the non-numeric nature of the data often leads to multiple interpretations and ambiguous or unclear meanings, necessitating further clarity with the interviewees (Saunders, Lewis & Thornhill, 2019). For this study, data will be collected using a qualitative interview research strategy, which is characterised by various types, including structured, semi-structured, and unstructured qualitative interviews. However, semi-structured qualitative interviews will specifically be used for this study, with the aim of eliciting comprehensive information and detailed insights from the interviewees.

### **3.3.5 Data collection**

Data collection represents a crucial phase in any research, as any possible errors at this stage can significantly overshadow the quality and reliability of the achieved results (Taherdoost, 2021). Therefore,

meticulous attention and sufficient time allocation are essential to ensure that the collected data is appropriate and accurate. However, while effective data collection is crucial, it is not the sole determinant of the overall success of a study, as numerous other factors also influence the research outcomes (Olsen, 2012).

In qualitative studies, the nature of the data collected is often non-standardized and requires careful classification and interpretation (Saunders, Lewis & Thornhill, 2019). For this particular research, a mono-method qualitative design has been employed, utilising semi-structured interviews with seven decision-makers from the eThekweni Municipality involved in beach water quality management, along with representatives from three NPOs focused on environmental conservation. This approach is recognised for its depth and richness in gathering interviewees' perspectives.

The data collected will be subjected to classification using thematic analysis, a methodological approach aimed at identifying and interpreting patterns and themes within qualitative data to make sense of the data (Saunders, Lewis & Thornhill, 2019). Given the inductive nature of this research, where theories and themes emerge from the data itself, the thematic analysis will allow data to drive the identification and development of key research themes (Taherdoost, 2021). This methodological choice ensures that the findings are grounded in the interviewee's perspectives, providing an understanding of the research topic.

Data collection methods vary based on whether a study is quantitative or qualitative and can be categorised into primary and secondary data (Sharma, 2022; Saunders, Lewis & Thornhill, 2019). Primary data constitutes original information collected firsthand by the researcher, while secondary data is derived from primary data sources. Sharma (2022) asserts that primary data is more reliable and trustworthy due to the direct interaction between the researcher and individuals who have experience with the subject matter.

For this study, primary data will be obtained through semi-structured interviews conducted via Microsoft (MS) Teams between August 5<sup>th</sup> and September 4<sup>th</sup>, 2024, with each session lasting no longer than 30 minutes. These interviews will be recorded and subsequently transcribed, as this method is a dominant form of data collection in qualitative research (Mazibuko, 2019). Saunders, Lewis and Thornhill (2019) describe research interviews as purposeful conversations where interviewers pose concise, unambiguous questions and actively listen to responses. In this study, semi-structured interviews will commence with a predetermined list of themes and key questions that align with the philosophical assumptions of the research.

Adopting an interpretive approach allows flexibility within the predetermined themes, permitting adjustments based on individual interviewee dynamics and the flow of the conversation. The advantage of employing non-standardized qualitative research interviews is that they facilitate the emergence of new

themes while omitting others. To guide the discussion and gather comprehensive insights, the study utilised the following six key questions formulated in alignment with the research objectives:

- What are the current beach water quality management strategies implemented in the eThekweni Municipality?
- How are these strategies monitored and evaluated for effectiveness in improving beach water quality?
- What are the primary challenges encountered in implementing beach water quality management strategies in the eThekweni Municipality?
- What are the main factors contributing to beach water pollution in the eThekweni Municipality, and how are they addressed in current strategies?
- Can you describe recent developments or innovations in beach water quality management strategies in the eThekweni Municipality?
- In your opinion, what measures or improvements could enhance beach water quality management strategies in the eThekweni Municipality?

Elton Mayo's interviewing method was employed to maximise the value of the interviews. This approach emphasised giving full attention to the interviewees, actively listening to their responses without interrupting or offering advice, and summarising their answers (Kvale & Brinkmann, 2009). The order of the questions was flexible and adapted according to the flow of the interview. To ensure security and confidentiality, data collected were stored on a password-protected (secured) shared drive account that was accessible only to the author and the supervisor. Data will be securely retained for five years, maintaining the anonymity of the interviewees. After five years, in line with the university guidelines, the collected data will be disposed of by secure deleting or wiping.

### **3.4 Sampling**

Every research study, regardless of its goals, requires some form of sampling. Ideally, a comprehensive study would involve the collection and analysis of data from every single case, group or individual under investigation, a method known as a census; however, constraints such as time, finances, ethical considerations, or accessibility often make this impractical; therefore, researchers often rely on sampling, which involves selecting a subset of the population from which data will be gathered (Saunders, Lewis & Thornhill, 2019; Mesa, 2016). Sampling is defined as the “process through which individuals or sampling units are selected from the sample frame” (Mesa, 2016, p.327). In research, two primary types of sampling are recognised, namely, probability sampling and non-probability sampling. Probability sampling, or random sampling, ensures that each case, group, or individual selected has an equal selection chance, thus providing a representative sample (Saunders, Lewis & Thornhill, 2019).

In contrast, non-probability sampling does not guarantee equal chances of selection for all elements, making the sample less representative. Qualitative research often employs non-probability sampling due to its focus on specific research questions, objectives, and chosen methodologies. In non-probability sampling, the sample size selection is flexible and typically based on logical considerations, with some researchers recommending data collection until data saturation is reached (Saunders, Lewis & Thornhill, 2019). Data saturation refers to the point in data collection where collected data is the repetition of existing data or “the point at which no further data can be found” (Saunders, Lewis & Thornhill, 2019; Naeem et al., 2024, p.3). Choosing the appropriate non-probability sampling technique is crucial; options include quota sampling, purposive sampling (or judgmental sampling), volunteer sampling, haphazard sampling, convenient sampling, expert sampling, and snowballing sampling (Saunders, Lewis & Thornhill, 2019; Vehovar et al., 2016). This study employs the purposive or judgmental sampling technique, where the researcher uses judgment to select individuals and organisations deemed most suitable for addressing the research questions and objectives. Purposive sampling is particularly valued for its ability to ensure diversity in the sample, a key consideration highlighted by Vehovar et al. (2016). The details of the target population and interviewees in the study are discussed below.

### **3.4.1 Target population**

Saunders, Lewis and Thornhill (2019, p.294) define the “population as the full set of cases or elements” from which samples are drawn, and they define a target population as a specific subset of the population. This distinction is echoed by Willie (2023), who describes the population as the entire group or collection of individuals sharing a common characteristic, while the target population is a representation of a specific subgroup within the population that is the focus of the study. Whether a study chooses to focus on the broader population or a targeted subset depends on its ability to meaningfully and justifiably address the research questions and achieve objectives (Becker, 1998).

In the assessment and enhancement of beach water quality management strategies in the eThekweni Municipality, the researcher targeted a population consisting of seven sections of the eThekweni Municipality and three NPOs involved in water quality management, with each section or organisation represented by a single person/individual. This approach ensures that the chosen sample reflects relevant stakeholders whose insights are critical to addressing the study's objectives effectively.

### **3.4.2 Interviewees in the study**

In every research, whether quantitative or qualitative, the interviewees in the study hold a critical role. According to Saunders, Lewis and Thornhill (2019), effective judgment is essential in purposive sampling, especially considering the typically smaller sample sizes involved. Those selected must be sufficiently

informative to give insights necessary for addressing the research questions and fulfilling the research objectives. The success of purposive sampling depends upon the ability to choose interviewees who possess the knowledge, perspectives, and experiences that can contribute meaningfully to the study (Saunders, Lewis & Thornhill, 2019). In this study, interviewees were chosen based on their profound insights, extensive knowledge, and deep understanding of beach water quality management, as well as their suitability in addressing the research questions and achieving the study’s objectives effectively. The choice of the eThekweni Municipality sections was deliberate, considering their significant roles in water quality management. Similarly, the organisations involved were chosen due to their active engagement in water quality monitoring and environmental conservation involvement. Table 3.1 below provides detailed information about the interviewees in the study, the organisations represented, the sections included, and the number of interviewees from each organisation are provided.

Table 3.1: Interviewees in the study.

<b>Organisation</b>	<b>Interviewee #</b>	<b>Date &amp; Time</b>	<b>Duration</b>
EWS – Mechanical and Electrical	1	13/08/2024 at 12h00	00:28:45
Biodiversity Management Unit	2	13/08/2024 at 14h00	00:23:53
EWS – Scientific Services	3	05/08/2024 at 13h00	00:29:03
Parks, Recreation and Culture Unit	4	14/08/2024 at 18h00	00:21:01
EWS – Treatment Works	5	08/08/2024 at 11h00	00:24:13
Environmental Health Unit	6	26/08/2024 at 11h00	00:20:36
EWS – Sewer Networks	7	06/09/2024 at 08h30	00:22:15
Green Corridor	8	22/08/2024 at 15h00	00:29:47
Adopt A River	9	27/08/2024 at 11h00	00:28:07
DUCT (Duzi Umgeni Conservation Trust)	10	04/09/2024 at 09h00	00:27:53

*EWS – eThekweni Water and Sanitation*

Source: Compiled by the author from eThekweni Municipality departments and NPOs (2024).

### **3.5 Data analysis**

Dawit (2020) defines data analysis as a comprehensive process encompassing the gathering, transformation, simplification, and modelling of data with the aim of discovering the required information. This analytical

process, as Dawit (2020) notes, supports researchers in making informed decisions across both qualitative and quantitative research domains. Kothari (2004) further characterises data analysis as the critical assessment and comparison of the collected data outcomes, which is crucial for determining the achievement of the research goals. In essence, the process of data analysis involves arranging the collected raw data into meaningful information, rendering it just as crucial as data collection in enhancing the effectiveness of the research outcomes. Subsequently, the chosen methods for data collection and analysis in this study are elaborated upon in the following sections.

### **3.5.1 Data analysis method**

In research, the process of gathering information represents merely the tip of the iceberg; the true essence lies in careful organisation and the insightful interpretation of this gathered information (Mezmir, 2020). Qualitative research results in vast amounts of data, mostly in textual format or verbal format, that require transcription. The primary goal of data analysis in such research is to derive meaningful insights from this textual data (Creswell, 2021). Qualitative research offers a range of methods for data analysis, including “content analysis, thematic analysis, narrative analysis, grounded theory analysis, discourse analysis, and qualitative data analysis”. The selection of an appropriate method is based on a combination of factors, including the research questions, theoretical framework, and methodological fit for the study (Kawulich, 2004). For this study, thematic analysis (TA) was selected as the data analysis method.

According to Saunders, Lewis, and Thornhill (2019), thematic analysis includes identifying and interpreting patterns and themes within qualitative data to make sense of the data. Similarly, Clarke and Braun (2016, p.297) define thematic analysis as “a method for identifying, analysing, and interpreting patterns of meaning (‘themes’) within qualitative data”. The thematic analysis approach has evolved into two main types: codebook thematic analysis, which uses predefined codes as well as structured codebooks to analyse from a deductive outlook, and reflective thematic analysis, which uses methods for qualitative research in all disciplines due to its flexibility, and responsiveness to the data (Terry et al., 2017; Braun & Clarke, 2019). This study uses reflexive thematic analysis to afford the researcher reflexivity, theoretical independence and alignment with the research question (Terry & Hayfield, 2020).

Computer-aided qualitative analysis software (CAQDAS) such as NVivo is commonly utilised to facilitate data management and analysis. NVivo aids in organising and managing qualitative data effectively, thereby streamlining the analysis process. Mezmir (2020, p.15) outlines the steps involved in qualitative data analysis, including “transforming raw data, evaluating, recognising, coding, mapping, exploring and describing patterns, trends, themes, and categories in the raw data.” These steps are crucial in uncovering

the underlying meaning of the data. However, there are no universal stages of qualitative data analysis; different authors use different stages to analyse data (Mezmir, 2020).

For this study, the interview data source was imported into NVivo and organised into folders. The process of identifying themes involves several key steps: first, the data was thoroughly reviewed to gain a comprehensive understanding of its content; then, meaningful elements were identified and assigned descriptive codes; to search for emerging themes, NVivo's text search query was used to find specific words and word frequency query helped highlight the most commonly used words in the data set; the identified these were reviewed and refined to ensure coherence and accuracy; and finally, the themes were defined and named with clear, descriptive labels (Braun & Clarke, 2019). Additionally, NVivo mind maps were used to visualise the themes and illustrate the relationships between them. The interpreted themes were subsequently presented as the study's findings, providing valuable insights into the topic.

### **3.6 Reliability and validity of data**

Reliability and validity are critical concepts in research methodology, each addressing essential aspects of study quality. Reliability pertains to consistency, ensuring that the research process can yield consistent results when repeated under similar conditions, while validity, on the other hand, pertains to accuracy, ensuring that the methods used accurately measure what they are intended to measure (Mazibuko, 2019). Reliability and validity play important roles in both quantitative and qualitative research by strengthening the credibility of the study. In qualitative research, particularly where scientific rigour is sometimes questioned compared to quantitative approaches, ensuring both reliability and validity becomes even more crucial (Noble & Smith, 2015).

Validity in qualitative research signifies the integrity of the methods used and the accuracy of the data collected, while reliability indicates the consistency of the research process (Noble & Smith, 2015; Creswell, 2021). Ahmed (2024) emphasises that maintaining trustworthiness is paramount in qualitative research, which involves elements such as credibility, transferability, dependability, and confirmability, as highlighted by Forero et al. (2018) in their four-dimension criteria for assessing research rigour of qualitative research. Dobakhti (2020) further stresses the importance of validity throughout the research process, as it directly influences the trustworthiness and authenticity of the study outcomes. Therefore, researchers must uphold validity across all phases of their research endeavours.

In this study, interviewees from the eThekweni Municipality were purposively selected based on their authority, position, and experience in water quality management strategies. Similarly, interviewees from NPOs, Adopt-A-River, DUCT, and Durban Green Corridor were chosen based on their seniority within

their organisations and involvement in environmental conservation, specifically in water quality management. These deliberate selections were made to enhance the credibility and relevance of the study's findings.

### **3.7 Research limitations**

As with any research, this study encountered limitations that must be acknowledged. Firstly, it is important to note that the researcher is employed within the eThekweni Municipality, Pollution and Environment Branch, which is one of the critical sections responsible for the beach water quality management within the municipality. Due to this affiliation, the researcher excluded this branch from the interview process, as familiarity with their scope of work could potentially introduce biasness. However, insights on beach water quality management from this section were sought from the department under which this branch falls.

Secondly, while efforts were made only to engage senior personnel across identified sections within the municipality, not all senior personnel were available for interviews. However, this limitation was mitigated by ensuring that interviews were conducted with other key personnel within these sections.

Furthermore, it is imperative to acknowledge that the omission of crucial government stakeholders beyond the municipality, such as the National Department of Water and Sanitation (DWS), the National Department of Forestry, Fisheries and the Environment (DFFE) and the Provincial Department of KZN Department of Economic Development, Tourism and Environmental Affairs (EDTEA), stemmed from procedural challenges associated with acquiring separate gatekeeper's letters which may have included distinct conditions compared to those of the eThekweni Municipality. Consequently, these entities were excluded from the scope of the study. However, insights from three non-profit organisations were gathered to provide an external perspective. While the limitations mentioned above may have influenced the comprehensiveness and outcomes of the study, diligent efforts were made to mitigate them to the extent feasible within the research context.

### **3.8 Ethical considerations**

Ethics involves questioning what is right and what is wrong, a crucial consideration in research where decisions inevitably affect others. Researchers must thoroughly evaluate which options are most suitable for them to ensure ethical conduct (Bos, 2020). Saunders, Lewis and Thornhill (2019) describe ethics as the behavioural standards that guide researchers in respecting the rights of interviewees and others affected by the study.

To uphold ethical standards in this study, all materials were diligently recognised, cited, and referenced to uphold academic integrity and ensure compliance with ethical guidelines. Formal permission was obtained through a gatekeeper's letter from the eThekweni Municipality, granting authorisation to use the municipality's name, facilitate interviews with relevant personnel, and access beach water quality data. Although the three NPOs involved indicated that a gatekeeper's letter was not required for interviews with the relevant senior personnel, written authorisation was still sought from them.

Subsequent to receiving the gatekeepers' letter from the eThekweni Municipality and authorisation from the NPOs, the researcher sought ethical clearance from the University of KwaZulu-Natal (UKZN) Human and Social Sciences Research Ethics Committee (HSSREC), which was granted with protocol number HSSREC/00007273/2024 (See Appendix 1). This step was taken to confirm a commitment to ethical conduct throughout the research process. Upon obtaining the ethical clearance, informed consent (See Appendix 2) was requested from all interviewees. Each interviewee was provided with a consent form detailing the study's topic, aims, objectives, and questions, thereby ensuring transparency and informed decision-making. The consent form clearly outlined the interviewees' rights, affirming their voluntary participation and the option to refuse to participate or withdraw from the research at any point without repercussions. Interviewees were assured of confidentiality and anonymity, which protected their privacy and minimised any potential risks associated with their participation.

### **3.9 Chapter summary**

This chapter provides a comprehensive overview of the research methodology employed to assess and enhance the beach water quality management strategies at eThekweni Municipality. The chapter begins by clearly stating the study's objectives and aims, setting the foundation for a detailed exploration of the research design and methodology. The discussion follows a thorough examination of the layers of the 'research onion', especially the philosophical assumptions, approaches, methodology, and strategies relevant to the study. The chapter delves into specific methods used for sampling and data analysis, offering clarity on how these techniques were applied. The chapter further addresses the issues of data validity and reliability, highlighting the measures taken to maintain the integrity of the findings. Additionally, the chapter outlines the limitations encountered throughout the research process, providing insights into the challenges faced and their potential impact on the study's outcome. Lastly, the ethical considerations are discussed, detailing the steps taken to uphold ethical standards and ensure the protection of interviewees' rights. The following chapter presents the data analysis of the study, offering insights into the findings and their implications for the beach water quality management strategies at the eThekweni Municipality.

# **CHAPTER FOUR**

## **FINDINGS AND DISCUSSION**

### **4.1 Introduction**

The previous chapter presents a comprehensive research methodology employed in this purposive qualitative study, detailing the research design, sampling techniques, and data analysis instruments used. In addition, the chapter addresses the validity, reliability, limitations and ethical considerations that underpin the research process.

This chapter presents a thorough analysis of the findings and a discussion of the data collected between the 5<sup>th</sup> of August and the 4<sup>th</sup> of September 2024 for the study, which aims to assess and enhance beach water quality management strategies (WQMS) at the eThekweni Municipality. The research findings are contextualised within the existing literature on beach water quality management, as presented in Chapter Two. Data collection was conducted through online interviews with ten purposefully selected interviewees, including key decision-makers from the eThekweni Municipality and representatives from environmental non-profit organisations (NPOs), using the Microsoft Teams platform. The interviews were recorded, transcribed, and analysed using the NVivo software.

The structure of this chapter is organised as follows: Section 4.2 explores themes related to the current beach water management strategies. Section 4.3 examines themes of monitoring and evaluation processes used to assess the effectiveness of these strategies. Section 4.4 identifies themes on the challenges encountered in implementing the strategies. Section 4.5 provides themes on the primary sources of beach water pollution and the strategies employed to prevent it. Section 4.6 highlights themes of recent developments and innovations in the current beach WQMS. Section 4.7 presents themes on recommended measures for enhancing the existing strategies. Lastly, section 4.8 summarises the chapter's key points.

### **4.2 Current beach WQMS**

Interviewees were asked to describe, based on their knowledge, the current beach WQMS in place at the eThekweni Municipality. The study identified that these strategies fall into three main categories, and the themes that emerged are summarised in the figure below.



Figure 4.1. Identified themes of current beach WQMS.

Source: Created by the author using NVivo and information from interviews (2024)

#### 4.2.1 Water quality monitoring

All interviewees from the eThekweni Municipality acknowledged that, to their knowledge, there is no formally documented beach WQMS. However, they confirmed that water quality monitoring is an integral component of the existing approach. This monitoring involves monthly sampling and testing of rivers and fortnightly testing of beaches. As noted by interviewee 5 (personal communication, August 08, 2024), “*I have not seen a clear strategy per se that is formalised, but it is directly maintaining the quality of the beach water*”. Interviewees also stated that test results are communicated to relevant stakeholders and the public through various channels, including notices displayed on beach boards.

The primary goal of water quality monitoring is to assess the suitability of water for its intended uses, and the program includes physical inspections and efforts to identify pollution sources if test results are non-compliant (DWAF, 1996). Ritchie and Schebie (2000) further emphasise that monitoring and assessing the quality of water is critical for improving the overall quality of the environment. Interviewees also stated that in instances where the water quality is deemed unsuitable, beach closures are implemented as part of the strategy. The eThekweni Municipality water monitoring programme aligns with standards in the United States (US); the monitoring period and frequency for both the eThekweni Municipality and the United States (US) vary depending on factors such as beach popularity, usage, water quality history, and accessibility (US EPA, 2012). The sampling every two to three weeks complies with the international and local water quality guidelines for coastal marine waters (DEA, 2012; Hannides et al., 2021).

#### **4.2.2 Infrastructure maintenance and management**

Interviewees underscored the importance of sanitation infrastructure in preventing untreated sewage from contaminating rivers and beaches. To support beach water quality management, the maintenance of sewer infrastructure is a key component of the monitoring strategy. This includes regular physical inspections of essential infrastructure, such as sewer pump stations, sewer lines, rising mains, sewer manholes, and wastewater treatment works. Interviewees also highlighted the crucial role stormwater infrastructure plays in water management, particularly in controlling and directing rainwater runoff to prevent contamination and protect water quality. Interviewee 5 (personal communication, August 08, 2024) stated, “*We have got programmes to clear lines and make sure that the stormwater system is fully functional and reduces blockages as well*”. Verma et al. (2020) estimate that at least eighty percent of marine pollution originates from inland sources via stormwater infrastructure, rivers, and WWTWs; thus, effective management of these systems is crucial. This proactive approach ensures that any emerging issues are addressed promptly.

#### **4.2.3 Cross-sectoral collaboration**

The research highlighted that effective water quality management requires a collaborative effort involving both interdepartmental and intergovernmental cooperation. Internally, this collaboration includes the eThekweni Municipality’s Water and Sanitation, Health, Parks, Recreation and Cemeteries Units. Externally, it encompasses national and provincial departments such as the Department of Forestry, Fisheries and the Environment (DFFE), Department of Cooperative Governance and Traditional Affairs (COGTA), Department of Water and Sanitation (DWS), Economic Development, Tourism, and Environmental Affairs (EDTEA), and the KwaZulu-Natal (KZN) Sharks Board. Interviewee 3 (personal communication, August 05, 2024) emphasised, “*PRC (Parks, Recreation and Culture Unit) colleagues are responsible for the management of the beaches and the opening and closure of the beaches, but also, there is another layer from the Sharks Board, responsible for the sea, those are some of the key drivers, but there are many layers*”. Interviewees unanimously agreed that this collaboration extends beyond government entities to include non-profit organisational stakeholders.

Collaboration is identified as a key driver for successful Integrated Coastal Zone Management (ICZM) in Xiamen, China. Islam, Xue and Rahman (2009, p.37) state that “ICZM in Xiamen involves the establishment of cross-sectoral management, implementation of integrated land-sea use planning, and active participation of scientists and stakeholders in resource conservation and environmental protection”. Alves et al. (2013) propose an ICZM model based on public-private partnerships (PPP), particularly in light of the challenges faced in Portugal’s ICZM, highlighting the importance of collaborative efforts for effective WQMS. Mohammed and Francis (2005) further advocate that collaboration should commence at the policy development stage to prevent bottlenecks experienced in Tanzania’s ICZM.

### 4.3 Effectiveness of the WQMS

Interviewees were asked to describe how these strategies are monitored and evaluated for effectiveness in improving beach water quality. The following themes emerged from their responses.



Figure 4.2: Identified themes on monitoring and evaluation of the effectiveness of the strategies.

Source: Created by the author using NVivo and information from interviews (2024).

#### 4.3.1 Sampling and testing

Interviewees described the water quality monitoring and evaluation process as encompassing rigorous sampling and testing of rivers and beaches, with intense frequency during peak periods such as festive seasons or major city events. The sampling frequency is also increased when there are water quality issues, especially after heavy rains, as interviewee 4 (personal communication, August 14, 2024) explains, “*The water sampling is conducted every 14 days under normal circumstances, but if there are issues related to water, maybe after heavy rains we increase the frequency of testing*”. This effort involves collaboration with stakeholders like Adopt-A-River and Durban University of Technology (DUT) and includes the joint publication of results across various platforms. Additionally, various service level agreements (SLAs) between eThekweni Municipality departments and external stakeholders support the monitoring and evaluation framework. Interviewee 5 (personal communication, August 08, 2024) noted, “*There are things that we do daily on the operations to monitor (water quality). On top of that, there is a set of SLAs or the service level agreement*”.

Collaborative sampling and testing serve as a valuable exercise in proficiency testing, assessing the accuracy and reliability of the eThekweni Municipality laboratory results by comparing them across different labs. According to the US EPA (2012), stakeholders should have access to water monitoring data and participate in water quality regulation. This strategy contributes to institutional sustainability by promoting good governance and fostering partnerships with stakeholders through enhanced transparency and democratic processes (Forbes & Demetriades, 2008). Islam et al. (2009) suggest that the sustainability of coastal management depends on various factors, including the involvement of multi-disciplinary

stakeholders who can provide advisory expertise to local municipalities. Similarly, van Heerden (2015) emphasises the importance of involving diverse actors in policy processes related to environmental issues, as it affects the broader community.

To quantitatively assess the effectiveness of eThekweni Municipality's beach water quality monitoring system, an analysis of water quality data collected since 2014 that was undertaken may be used. The analysis involved calculating the 95<sup>th</sup> and 90<sup>th</sup> quantiles of E. coli levels to assign a rating of excellent, good, satisfactory or poor to the beaches, as illustrated in Table 2.4 (eThekweni Municipality, 2024). The analysis revealed that the majority of beaches received poor ratings, which indicates that the water is considered high-risk and unsafe for recreational use most of the time. For instance, the poor ratings correspond to an estimated gastrointestinal (GI) risk of greater than 8,5% per exposure, where "exposures are defined as 10 minutes of swimming with three head immersions" (DEA, 2012, p.18; City of Cape Town, 2023b, p.3).

The rating analysis demonstrated a concerning trend of deteriorating water quality over the years, with a particularly severe outcome in 2022, when all beaches culminated in a 100% poor rating. This year coincided with one of the most catastrophic flood disasters in the province's history to be recorded (Grab & Nash, 2023). The poor water quality persisted beyond 2022, with 95% of the beaches still receiving poor ratings in 2023. This trend continued through the first four months of 2024 when the analysis concluded. The ongoing poor water quality resulted in several beach closures due to non-compliance with water quality standards, indicating the ineffectiveness of the current monitoring system. Correspondingly, the interviewees acknowledge that the system is not fully effective and that the floods exacerbate the issue. As interviewee 5 (personal communication, August 08, 2024) stated, "*After the floods, we realised that pump stations along the coast were the major contributors to beach pollution*". This highlights the role of persistent sewage pollution, particularly following heavy rainfalls and flooding, in continuously degrading beach water quality. Even though some beaches close temporarily, the reoccurrence of these closures signals a chronic problem.

Despite these challenges, the eThekweni Municipality interviewees revealed that measures are being implemented to address flood-related damages. As interviewee 3 (personal communication, August 05, 2024) explained, "*The WWTWs that were also affected by the floods are also being revamped now. They are also doing those functional upgrades. I think once we take care of the sanitation issues, we will see improvement in water quality*". While these efforts are crucial for improving the situation, it is worth noting that the water quality issues in the region predate the 2022 floods. Therefore, employing an evaluation process similar to that used by the City of Cape Town on an ongoing basis could help pinpoint specific weaknesses in the eThekweni Municipality's beach water quality monitoring system. This could provide a clearer understanding of where improvements are needed to ensure safe water quality for recreational use.

### 4.3.2 Permitting

Interviewees noted that the permitting process is a crucial component of the monitoring and evaluation protocol. The process includes the WWTWs Water Use License Application (WULA) or General Authorisation (GA) for all 29 treatment works, although not all facilities have obtained permits. Interviewee 5 (personal communication, August 08, 2024) explained, “*WWTWs, obviously, are permitted, and we must ensure that they respond and that the quality is in line with our licence and permit requirements.* The WULA is a formal application process required for the operation of WWTWs by the eThekweni Municipality, while the GA serves as another regulatory mechanism that allows certain water use activities to proceed, acting as a good monitoring process mandated by legislation from the DWS, as outlined in the National Water Act (No. 36 of 1998) (DWS, 1998).

Industries generating trade effluent are monitored through schedule or trade effluent permits to ensure compliance with eThekweni Bylaws. These permits specify conditions and quality limits for safe and environmentally friendly disposal of trade effluent, as outlined in the eThekweni trade effluent policy (eThekweni Municipality, 2021). Industrial permitting is integral to the monitoring process, as it ensures that industries adhere to the trade effluent policy in conjunction with the Sewage Disposal Bylaws (eThekweni Municipality, 2015b). Lin, Yang and Xu (2022) state that water pollution is a result of industrialisation due to various toxic chemicals that are released in industrial production. Verma et al. (2020) also highlight that chemical pollution poses significant concerns for public health and can cause extensive environmental and economic damage.

Furthermore, a report by the eThekweni Municipality (2020b) indicated that industrial effluents have a detrimental effect on aquatic ecosystems due to the toxicity introduced by various chemicals. The processes at WWTWs often fail when sewage-treating bacteria are exposed to harmful chemical substances, resulting in detrimental effects on wastewater treatment and, ultimately, the beach water quality. The effluent quality produced by both the industries and WWTWs is crucial for beach water quality compliance and should be evaluated to determine if the current monitoring strategy is efficient.

#### 4.4 Primary sources of pollution

Interviewees identified primary sources of beach water pollution that pose challenges in the current beach water quality monitoring system and contribute to poor water quality. The themes that emerged from their responses are summarised below.



Figure 4.3: Identified themes of challenges in implementing the strategies.

Source: Created by the author using NVivo and information from interviews (2024).

##### 4.4.1 Sewer infrastructure

Interviewees unanimously recognised sewer infrastructure as the most significant source of water pollution that poses a challenge to water quality management. Damage from various flood events, particularly those in April 2022, has exacerbated the situation. Deferred asset maintenance, ageing, and overburdened infrastructure, often due to overpopulation, were cited as primary causes of recurring failures. The ingress of stormwater, silt, and sand, compounded by residents' illegal connections of stormwater to sewers, further complicates the issue. As interviewee 7 (personal communication, September 06, 2024) noted, *“The sewer is not designed for stormwater, which is why you are finding that every time it rains, the sewer overflows. That should not be the case. Sewers are designed for an ingress of stormwater, but not a total connection”*.

Constant sewage pollution stemming from flood-damaged infrastructure has led to various economic, social, and health issues in the eThekweni Municipality. This sewage pollution not only contaminates the rivers but also results in beach closures, negatively impacting tourism businesses and social activities (CSRI, 2019; Spetter et al., 2023). Johnson (2015, p.1) further substantiates this by emphasising that “poor water quality jeopardises public health and has an adverse effect on tourism and, consequently, the economy”. Estimates by Mazibuko (2019) and Lin, Yang and Xu (2022) indicate that at least 80% of beach water pollution, particularly sewage pollution, originates from human activities inland, highlighting the critical need for properly managed sewer infrastructure. Verma et al. (2020) propose that preventing beach

water pollution depends on ensuring that sewage remains in the sewer through regular maintenance of sewer infrastructure and cleaning of the polluted streams.

#### **4.4.2 Social challenges**

Social issues emerged as major challenges in water quality management, according to interviewees. Misuse of infrastructure, theft, and vandalism, often stemming from a lack of public awareness, were frequently mentioned. Public negligence was highlighted as another significant factor, along with industrial pollution, particularly fats, oils, and grease (FOG), which led to sewer blockages. Abuse of infrastructure, including dumping foreign objects into sewers and illegal connections, further compounds the issue. Interviewee 6 (personal communication, August 26, 2024) remarked, *“At our beachfront, especially our beachfront premises, we are not dealing with the fat, oil and grease in their facilities that are clogging up our sewer networks. And then we have got spillages, and that also ultimately ends up on our beach”*.

Interviewees noted a significant influx of people into the city over the years, with insufficient adjustments to balance supply and demand. As interviewee 7 (personal communication, September 06, 2024) remarked, *“If the population grows, the infrastructure is supposed to be upgraded as well in accordance with the growth, so we do not have that. Our infrastructure is as it was 20 years ago”*. Additionally, urbanisation has led to the increase of informal settlements, often located over watercourses. The absence of appropriate sanitation and waste management in these areas has further compromised river water quality.

Urbanisation presents one of the most substantial challenges in water quality management, not only due to the strain on sewer infrastructure but also because of the accompanying social challenges. eThekweni’s urban population has grown from 3.4 million to 4.2 million in the past decade, contributing to a surge of informal settlements (Stas SA, 2024). Mancera-Pineda and Gavio (2018) suggest employing a scenario planning approach for coastal water quality management that includes population projections and planning. Islam, Xue and Rahman (2009) advocate for public awareness activities that incorporate weekly environmental education across various communication platforms to address some of these social challenges. Some of these social challenges require political intervention. Successful implementation of a WQMS requires robust political support, spanning operations, budget allocation, and policy development. Sowman and Malan (2018) note that a significant challenge to advancing a progressive WQMS agenda is the lack of political support. Furthermore, coherence and integration between regulators and the public, supported by political backing and stakeholder engagement, are vital for effective coastal management (Alves, da Silva & Pinto, 2007; Alves et al., 2013).

### 4.4.3 Environmental challenges

Most interviewees highlighted environmental challenges, particularly climate change, as introducing numerous problems. Recent floods in Durban City have caused significant damage to infrastructure, much of which remains unrepaired, leading to significant sewage spills into the receiving environment. The US EPA (2012) identifies climate change as one of the top coastal management challenges, leading to severe storms, flooding, and soil erosion. For a city like Durban, which is vulnerable to the impacts of climate change, Spetter et al. (2023) recommend implementing effective WQMS tailored for global environmental sustainability. The eThekweni Municipality interviewees stated that the city has recognised climate change as a significant factor contributing to water pollution; hence, the city has established a dedicated Climate Change Department to tackle the challenges. As interviewee 3 (personal communication, August 05, 2024) remarked, “*There is a climate department now standing on its own of which they are really adopting all those climate resilient strategies*”.

### 4.5 Recommended measures to enhance current WQMS

To identify ways to enhance beach WQMS, interviewees with firsthand experience and deep knowledge of the issues were invited to share their recommendations. Their insights not only highlighted existing measures already in progress but also revealed key themes that suggest practical solutions drawn from their direct daily involvement in operations.

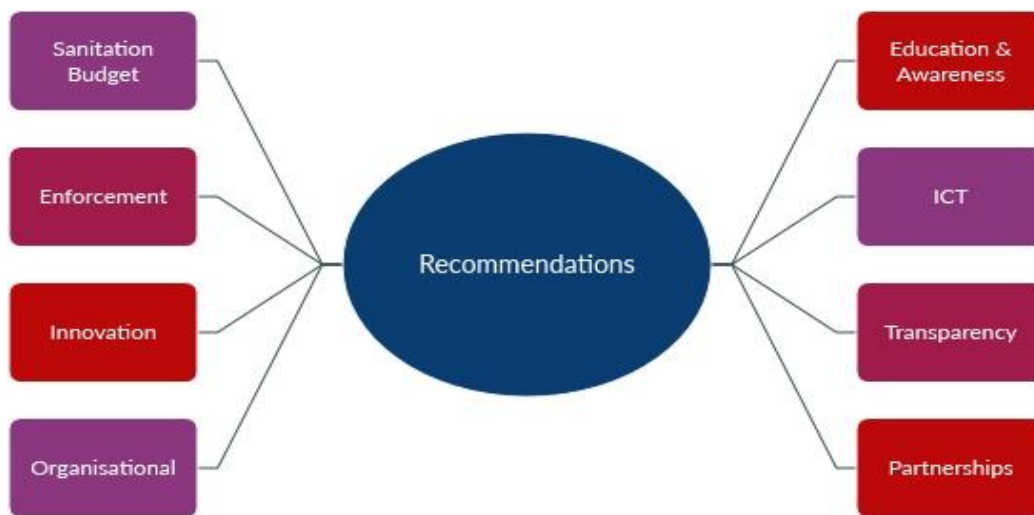


Figure 4.4: Identified themes on recommended measures to enhance current strategies.

Source: Created by the author using NVivo and information from interviews (2024).

#### 4.5.1 Sanitation budget

Interviewees unanimously agreed on the need to increase the budget allocated to sanitation. A larger budget could support several critical projects aimed at improving beach WQMS. The following projects were identified as essential:

- Improve security for critical infrastructure: Theft and vandalism of essential sewer infrastructure present significant challenges, leading to repeated expenditures on repairs and replacements. Interviewees emphasised the importance of enhancing security measures. As interviewee 3 (personal communication, August 05, 2024) noted, *“What we can do currently is to really invest in security and protecting the infrastructure”*.
- Upgrade sewer infrastructure: There is an urgent need to upgrade ageing sanitation infrastructure, which has suffered from inadequate maintenance and increased demand due to urbanisation. EM interviewee 5 (personal communication, August 08, 2024) stressed, *“There must be a commitment to deal with the ageing infrastructure, and the commitment is seen by putting money where the infrastructure is needed. The strategy must also deal with obviously the growing city”*.
- Build redundancy: Redundancy refers to a system design intended to enhance reliability by incorporating multiple methods to perform a function, such as a standby sewer pump or a backup generator (Clarke & Hollister, 2010). Redundancy ensures effective recovery during disasters or unexpected disruptions. Critical sewage infrastructure, such as pump stations and WWTWs, must include redundancy measures. Interviewee 3 (personal communication, August 05, 2024) highlighted the need for backup pumps and generators, stating, *“The moment one pump packs, we have got another pump ready to kick in. You cannot say no; we are going to get another one; we are waiting for procurement processes; no, we ought to build that redundancy”*.

#### 4.5.2 Education and awareness

Interviewees unanimously recognised that many issues related to beach water quality management stem from a lack of public awareness. Several educational initiatives were proposed:

- Community war rooms: Establishing regular meetings between city officials and community leaders can provide a platform for communities to voice concerns while allowing the city to educate them on key issues. Interviewee 8 (personal communication, September 04, 2024) explained, *“We present to the community the work that we have done and the issues that we have come across, and we try to work with the community to find solutions together”*.
- Intense advertising: Interviewees suggested leveraging intense advertising for educational purposes related to environmental issues, similar to successful business marketing campaigns. Interviewee 7

(personal communication, September 06, 2024) noted, *“Electricity used to have an advert after the news, after the weather, they tell you that red is for this, orange is for this, green is for this. I think we should implement a similar strategy, as costly as it is, but we need to implement something”*.

#### **4.5.3 Enforcement**

The need for stricter enforcement in the city was a recurring theme, as inadequate regulation significantly affects water quality. Key issues identified include:

- Theft, vandalism, and abuse of infrastructure: Critical infrastructure faces significant threats from theft and vandalism, leading to costly replacements and sewer pollution. Interviewee 7 (personal communication, August 08, 2024) emphasised, *“We need to attend to the problem of vandalism. It is so big that we have to strategise with our law enforcement agencies to prevent this”*.
- Industrial pollution: Interviewees highlighted that industries discharging untreated effluent contribute to sewer system corrosion and disrupt WWTW operations, underscoring the need for tighter enforcement.
- Illegal connections: Illegal connections to sewer lines allow stormwater to enter the system, overwhelming the infrastructure during rainy seasons. As interviewee 7 (personal communication, September 06, 2024) explained, *“The sewer is not designed for stormwater, which is why you are finding that every time it rains, the sewer overflows”*.

#### **4.5.4 ICT**

Improvements in Information and Communication Technology (ICT) could significantly enhance operational effectiveness. Interviewees suggested the following:

- Automated processes: Many critical processes are currently manual, limiting efficiency. Interviewee 1 (personal communication, August 13, 2024) stated, *“A computerised maintenance system, which is a core maintenance, that is where we need to go to, to change things around”*.
- Apps development: Given the significant amount of work conducted on-site, there is a pressing need for mobile applications that facilitate remote responses. Interviewees from eThekwin Municipality highlighted concerns regarding the manual nature of many operations, which has resulted in inefficiencies. However, two notable applications which are still under development were mentioned by the eThekwin Municipality interviewees. As interviewee 7 (personal communication, September 06, 2024) explained, *“The department is currently working on an app system with Microsoft to monitor (sewer) blockages transparently”*.

#### 4.5.5 Innovation

Innovation is essential for improving services and enhancing processes. Interviewees stressed the importance of investing in innovative approaches:

- Sewer overflow detectors: The reliance on community reporting for sewer overflows often results in delayed responses. Interviewee 9 (personal communication, August 27, 2024) suggested introducing monitoring systems that detect blockages early, stating, *“Introduce some sort of monitoring or electronic system where it would detect a blockage or look at different flows”*.
- Drone technology: Monitoring the city can be challenging due to limited resources. Interviewee 6 (personal communication, August 26, 2024) proposed using drones for remote monitoring, explaining, *“Looking at drones that could fly up our river areas to see if they could identify any leaks and breaches”*.
- Online water testing: Traditional water testing methods can take up to 24 hours to produce results. The Colilert-18 technique (which is sometimes referred to as the Quanti-Tray method, is a water quality testing procedure that involves overnight incubation of samples to simultaneously detect both total coliforms and Escherichia coli in water, providing results within 18 hours) has improved turnaround times, but further advancements, such as online testing, could significantly reduce this time (Kinzelman et al., 2005). As interviewee 3 (personal communication, August 05, 2024) noted, *“We have moved to Colilert-18 where you are getting results within 18 to 22 hours. It is quicker than that traditional method where in the past we used to do it in 24 hours”*.
- Climate change-resistant infrastructure: With mounting evidence of climate change, the eThekweni Municipality must invest in climate change-resistant infrastructure to withstand flooding and pollution. As interviewee 3 (personal communication, August 05, 2024) clarified, *“We have to upgrade from what we had to climate-resilient stuff so that we really making sure that we are coping with these climate changes that now seem they are going to be more often than it used to be”*.

#### 4.5.6 Transparency

Enhancing transparency is essential for building trust and accountability. Interviewees suggested improvements in the municipality’s communication, especially concerning water quality results. As interviewee 10 (personal communication, August 22, 2024) emphasised, *“I think that transparency of information is ultimately in the interests of the society, and I would encourage that that be optimised”*.

#### **4.5.7 Organisational**

Interviewees identified several initiatives to improve beach WQMS from an organisational perspective, noting that some bottlenecks originate within the municipality. The suggested improvements include:

- Supply Chain Management (SCM) processes: SCM is critical for improving services for municipalities. The interviewees from eThekweni Municipality emphasised the need to optimise SCM processes to enhance the municipality's effectiveness.
- Single point of reporting: Implementing a centralised reporting system could enhance clarity and accountability. Several interviewees expressed concerns about departments working in silos, which contributes to inefficiencies. As interviewee 7 (personal communication, September 06, 2024) noted, *"We are not in sync. Everyone is working in silos"*. The single point of reporting should encompass SCM, as one interviewee pointed out, *"Streamlining the SCM processes just to ensure that when there is a challenge, it gets fixed quickly rather than relying on or waiting for the SCM"* (Interviewee 2, personal communication, August 13, 2024).

#### **4.5.8 Business partnerships**

Collaborating with businesses, particularly those producing waste that contributes to pollution, like fats, oils, greases (FOG), diapers, tampons, and plastics, was deemed essential. Such partnerships could enhance not only the environmental landscape but also social and economic outcomes. As one interviewee from the NPOs noted regarding waste, *"It is an issue, and I am saying I think that does need to come into the picture of quantifying cost and cost-benefit of improving management by the public of their waste, and in other words, you know, like if there was engagement with the producers, you know, expanded producer responsibility is the extreme version of where it could go"* (Interviewee 10, personal communication, August 22, 2024).

### **4.6 Conclusion**

This chapter offers key findings and a comprehensive discussion focused on assessing and enhancing beach WQMS at the eThekweni Municipality. Several key themes emerged based on the four research objectives. The first objective assessed the current beach WQMS, revealing the absence of a formal, documented strategy. The primary method for monitoring water quality is based on periodic sampling and analysis, with flexibility to accommodate varying circumstances, such as heavy rains or peak beach usage seasons, which prompt more frequent testing.

The second objective evaluated the effectiveness of the current monitoring system in improving beach water quality standards. The findings concluded that the employed monitoring system is ineffective in achieving

compliance with set water quality standards for safe recreational use, as evidenced by the frequent beach closures linked to sewage pollution, particularly following heavy rainfall events. The study emphasised the need for a more robust quantitative evaluation of the effectiveness of the current monitoring system, suggesting the formal adoption of a water quality rating analysis based on the South African Water Quality Guidelines for Coastal Marine Waters, which calculates the 90<sup>th</sup> and 95<sup>th</sup> percentiles for *Enterococci* and *Escherichia coli*. This analysis could provide valuable insights into the actual performance of the monitoring system. By using the unpublished rating analysis of *E. coli* levels since 2014, the study identified a concerning trend of deteriorating water quality, particularly in 2022, when all beaches received a poor rating. The deterioration continued into subsequent years, with 95% of the beaches receiving poor ratings, resulting in intermittent closures. While this period coincided with the region's worst flood disaster in recent history, it is important to recognise that water quality issues in the region existed even before the 2022 floods, suggesting a more systematic issue with the current monitoring system.

The third research objective focused on identifying the primary sources of beach water pollution. The study found that sewer infrastructure failures were the main culprit, contributing to contamination and exacerbated by factors such as insufficient budget, poor maintenance, and systematic issues like theft, vandalism, and abuse of infrastructure. Additionally, challenges related to organisational inefficiencies, such as shortages of tools, misalignment of departmental functions, miscommunication, and unaccountability, were identified as significant barriers to effective pollution control.

In response to these challenges, the final objective explored recommendations for enhancing existing WQMS and noting a few developments and innovations currently underway. Proposed improvements include increased investment in sanitation infrastructure, stronger public education and awareness campaigns, enforcement of regulations, adoption of innovative technologies, and the establishment of partnerships to address pollution issues. The subsequent chapter provides a comprehensive conclusion and recommendations to improve the beach water monitoring system at the eThekweni Municipality.

## CHAPTER FIVE

### CONCLUSION AND RECOMMENDATIONS

#### 5.1 Introduction

This chapter aims to synthesise the findings of the study in relation to the established objectives and to propose recommendations that could enhance the current beach water quality management strategies (WQMS) employed by the eThekweni Municipality.

Chapter one set the stage for the research by outlining the background, defining the research problem, and articulating the research objectives and questions. In chapter two, a comprehensive literature review was conducted, showcasing various beach WQMS used both locally and internationally. Chapter three detailed the research design and methodology, providing a clear rationale for the chosen approach. In chapter four, the research findings were presented and thoroughly discussed in relation to the research objectives.

This chapter is structured as follows: Section 5.2 summarises the research findings in relation to the four research objectives. Section 5.3 provides the research conclusion by answering the research questions. Section 5.4 outlines the recommendations aimed at enhancing the beach WQMS at eThekweni Municipality. Section 5.5 suggests areas of future research.

#### 5.2 Summary of findings

The study aimed to assess and enhance the beach WQMS by eThekweni Municipality through four key objectives. Based on the collected data, the following findings emerged.

##### 5.2.1 Objective 1: To assess the current beach WQMS

The study revealed that the eThekweni Municipality lacks a documented beach WQMS. The primary monitoring system involves the fortnightly sampling and testing of beach water, along with monthly monitoring of river water quality. The responsibilities are divided among several units: the Water and Sanitation Unit (Scientific Services department) is tasked with water quality monitoring, which involves sampling and testing; the Parks, Recreation, and Cemetery Unit manage the opening and closing of beaches based on the water quality results; the Health Unit ensures public health and safety, and the Communications Unit informs the public about the state of rivers and beaches through various communication channels.

### **5.2.2 Objective 2: To evaluate the effectiveness of these strategies in improving beach water quality standards**

The study revealed that the current beach water quality monitoring system is ineffective in meeting the established beach water quality standards for recreational use. Both local and international guidelines set the limit for *Enterococci* at  $\leq 200$  cfu/100 ml and for *Escherichia coli* (*E. coli*) at  $\leq 500$  cfu/100 ml for safe recreational use (DWAF, 1996; U.S. EPA, 2012; DEA, 2012). Using the water quality ratings system outlined by the City of Cape Town (2023b), as shown in Table 2.4, a concerning trend of declining water quality was observed, particularly in 2022. That year marked the worst water quality ratings, with 100% of the beaches receiving poor ratings. The deterioration coincided with KZN's worst flood disaster in recent history, but unfortunately, the poor water quality persisted well beyond this period. By the first quarter of 2024, 95% of the beaches still received poor ratings, indicating that the issues were not limited to a one-time flood incident but reflected a chronic problem. The issue of beach non-compliance, particularly at the central and Bluff beaches, predates the floods and has resulted in frequent intermittent beach closures. These closures are temporary but ongoing, highlighting concerns about the effectiveness of the monitoring system. The following sections address the primary causes of poor beach water quality and propose improvements to the current strategies.

### **5.2.3 Objective 3: To identify the primary sources of beach water pollution**

The study identified multiple sources of pollution contributing to poor beach water quality in eThekweni Municipality, with sewer infrastructure emerging as the main culprit. Key issues include overflowing sewer manholes, blockages, damaged sewer lines, malfunctioning sewer pump stations, and non-compliant WWTWs. Contributing factors include insufficient sanitation budget, inadequate maintenance, lack of redundancy, and social issues such as theft, vandalism, and abuse of infrastructure. Additionally, organisational challenges such as shortages of tools of trade, misalignment of departmental functions, miscommunication, and lack of accountability further exacerbate water pollution.

Environmental challenges, particularly climate change, were also identified as significant factors, with flooding events severely damaging the infrastructure, most notably the catastrophic natural disaster floods of April 2022 (Grab & Nash, 2023). Industrial pollution and inadequate enforcement measures were additional challenges impacting water quality. However, plans to mitigate these issues are in place, including increased sanitation budgets, upgrades to sewer infrastructure, and the establishment of a climate change department to tackle issues such as flooding in the City and its increasing frequency, which has almost doubled over the last century (Grab & Nash, 2023).

#### **5.2.4 Objective 4: To propose recommendations for enhancing beach water quality management strategies**

The research offered several recommendations that could significantly improve water quality in the eThekweni Municipality. Some of these recommendations are already in progress and include:

- Increased sanitation budget – Allocate additional funds to support several projects aimed at upgrading sanitation infrastructure. This includes enhancing facilities to meet the rising demand driven by urbanisation, improving security measures for critical infrastructure, and building redundancy in WWTWs and sewer pump stations to ensure reliability and resilience.
- Education and awareness campaigns – Implement public education initiatives to raise awareness about sewer issues and the importance of proper waste disposal. These campaigns will propose practical solutions to environmental challenges, aiming to prevent the misuse of sewer infrastructure and promote responsible behaviours among the eThekweni Municipality residents.
- Enforcement measures – Strengthen enforcement actions to deter abuse, theft, and vandalism of sewer infrastructure. This includes addressing pollution from non-compliant industries by enforcing regulations (such as the Sewage Disposal Bylaws, 2015 and Trade Effluent Policy, 2021) and ensuring compliance to protect the integrity of the sewage system.
- Improvement of ICT – Invest in advanced ICT solutions to improve the effectiveness of water quality management strategies. By automating processes and improving monitoring and response time, the water quality will ultimately improve.
- Investment in innovation – Foster a culture of innovation by investing in cutting-edge technology. This includes researching and implementing solutions that address the impacts of climate change on water quality management.
- Organisational improvements – Streamline and align organisational processes to enhance service delivery. By ensuring transparency in operation, trust will be restored with stakeholders and foster a collaborative environment.
- Build partnerships – Establish and strengthen partnerships with relevant public and private stakeholders. Collaboration with stakeholders will be essential for addressing waste and pollution challenges effectively, as they leverage shared resources, expertise, and community engagement.

By implementing these recommendations, the eThekweni Municipality will create a more sustainable and efficient sanitation system that meets the needs of an exponentially growing urban population while safeguarding the environment.

### 5.3 Conclusion

This study aimed to assess and enhance the beach water quality management strategies in eThekweni Municipality by assessing the current practices, evaluating their effectiveness, identifying primary sources of pollution, and proposing recommendations for improvement.

A comprehensive review of existing literature on beach water quality management was conducted using credible sources from academic journals and books. Following the successful acquisition of ethical clearance from the UKZN's HSSREC and a gatekeeper's letter from the eThekweni Municipality, a qualitative study was undertaken using purposive sampling. The interviewees included seven decision-makers in water quality management from the eThekweni Municipality and three representatives from local environmental conservation NPOs: Adopt-A-River, Durban Green Corridor and DUCT. Primary data were collected between the 5th of August and the 4th of September 2024, with each lasting not longer than 30 minutes through semi-structured interviews conducted via MS Teams, which were recorded, transcribed, and analysed using NVivo software.

The study findings indicate that the eThekweni Municipality lacks a documented beach water quality management strategy despite conducting water quality monitoring. While the water quality data is used to assess the effectiveness of the existing monitoring system, it shows that the current approach fails to maintain the required water quality standards. In recent years, the beach water quality has been poor, with deterioration predating the 2022 floods and continuing thereafter. As a result, the *Enterococci* and *Escherichia coli* (E. coli) levels have frequently exceeded the safe thresholds for recreational water of  $\leq 200$  cfu/100 ml and  $\leq 500$  cfu/100 ml, respectively, leading to the closure of beaches on numerous occasions, with 2022 being the worst year on record.

The study identifies sewer infrastructure as the primary source of beach water pollution, a situation further exacerbated by the April 2022 floods, although pollution levels were problematic even before this catastrophic event. Based on these findings, several recommendations are proposed to enhance the current strategies. These include increasing the sanitation budget to fund required projects, implementing effective education and awareness campaigns, enforcing stricter penalties for transgressors, aligning organisational functions for improved efficiency, investing in ICT and innovation, and fostering partnerships with relevant private stakeholders to improve waste management practices.

## **5.4 Recommendations**

### **5.4.1 Documentation of an Integrated Beach Water Quality Management Strategy**

The documentation of an integrated beach water quality management strategy is essential for ensuring effective collaboration among various departments and stakeholders. A clearly outlined strategy will establish specific goals and objectives, align the functions of all interviewees, and promote accountability. This approach will enhance decision-making processes and facilitate the evaluation of outcomes, allowing for necessary adjustments when circumstances change. Additionally, the strategy will support disaster management by identifying potential challenges, such as floods, and detailing appropriate responses and mitigation measures.

### **5.4.2 Improvement of the Water Quality Monitoring Plan**

The existing fortnightly monitoring of beach water quality and monthly monitoring of river water quality need to be reassessed. Since inland activities and river conditions influence beach water quality, increasing the frequency of river monitoring is crucial for detecting potential pollution before it reaches the beaches. This monitoring should include assessments of the entire catchment area, focusing on sewer pump stations, WWTWs, and sewer networks as the key sources of pollution. By addressing issues at their source, pollution can be mitigated or prevented from impacting beach waters.

Currently, monitoring beaches more frequently than rivers leads to reactive measures, resulting in the premature closure or reopening of beaches due to delayed pollution identification. To enhance transparency and stakeholder engagement, the plan must include the implementation of a monthly report detailing identified issues, corrective actions taken, and water quality results. Additionally, the plan must aim to explore predictive models and rapid testing systems that extend beyond traditional faecal indicators for a more comprehensive understanding of water quality.

Finally, the eThekweni Municipality must reconsider its participation in the Blue Flag programme. While the programme does come with its challenges, the positive impact it has on beach management, environmental protection, and the tourism sector cannot be overstated. The Blue Flag certification serves not only as a valuable tool for raising awareness about environmental sustainability but also plays a crucial role in attracting both local and international tourists. Rejoining the programme would undoubtedly enhance the municipality's efforts to promote cleaner, safer beaches while boosting the region's appeal as a tourist destination.

## **5.5 Areas for future research**

This study primarily focused on interviewees from eThekweni Municipality and three non-profit organisations (NPOs) involved in environmental conservation. Future research should expand its scope to include provincial and national stakeholders, such as the Department of Economic Development, Tourism, and Environmental Affairs (EDTEA), the Department of Forestry, Fisheries and the Environment (DFFE), and the Department of Water and Sanitation (DWS). Involving these regulatory bodies will provide a more comprehensive understanding of the perspectives and regulations governing the receiving environment.

This study primarily focused on the qualitative analysis of the current beach WQMS, but future research should expand to include a comprehensive quantitative analysis of the beach water quality data. A statistical analysis of the beach water quality, utilising models such as the City of Cape Town's beach ratings system, would offer valuable insight into the state of the beaches. Additionally, while the study concentrated on beach water quality management, future research should broaden its scope to include river water quality. Rivers play a vital role in the transport of water to beaches, and their quality directly impacts coastal water conditions. Investigating river water quality alongside beach monitoring would provide a more holistic understanding of the entire water management system. Additionally, future research should explore the specific activities and pollution sources within different catchments, offering a more detailed examination of how various factors contribute to water contamination. Such research would help pinpoint targeted interventions for improving water quality across both inland and coastal ecosystems.

A comprehensive quantitative analysis of water quality results should be conducted to establish correlations between periods of poor beach water quality and rainfall events. This data-driven approach would enhance our understanding of how weather patterns affect water quality issues, specifically addressing several key questions: How long after the rains do beaches experience deterioration in water quality? What is the duration of the contamination period before beaches return to acceptable standards? What volumes of rainfall trigger significant beach water pollution? The insights gained can identify critical thresholds and timelines that serve as predictive models for water quality management, informing proactive measures such as timely public notifications and beach closures.

Moreover, it would be valuable to explore the economic impact of beach closures on the business sector, particularly the tourism industry. Research could compare visitor numbers during beach closures with those when beaches are open to assess the overall economic implications of water quality on both the eThekweni Municipality and the broader KZN province. Understanding this relationship could inform water and sanitation funding and policy decisions aimed at improving water quality and consequently supporting local economies.

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## Appendix 1: Ethical Clearance



19 July 2024

Stanley Sizwe Mbatha (205502869)  
Grad School of Bus & Leadership  
Westville Campus

Dear SS Mbatha,

Protocol reference number: HSSREC/00007273/2024

Project title: Assessment and enhancement of beach water quality management strategies in eThekweni Municipality

Degree: Masters

### Approval Notification – Expedited Application

This letter serves to notify you that your application received on 18 June 2024 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number.

**PLEASE NOTE:** Research data should be securely stored in the discipline/department for a period of 5 years.

Incidents of adverse events and serious adverse events (AEs and SAEs) should be reported in writing to HSSREC, the study sponsors, and any regulatory authority (where appropriate), within 7 working days of the occurrence for local sites and 14 days for all other South African sites.

This approval is valid until 19 July 2025.

To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

HSSREC is registered with the South African National Health Research Ethics Council (REC-040414-040).

Yours sincerely,



Professor Dipane Hlalele (Chair)  
/nng

### Humanities and Social Sciences Research Ethics Committee

Postal Address: Private Bag X54001, Durban, 4000, South Africa

Telephone: +27 (0)31 260 8350/4557/3587 Email: [hssrec@ukzn.ac.za](mailto:hssrec@ukzn.ac.za) Website: <http://research.ukzn.ac.za/research-Ethics>

Founding Campuses: ■ Edgewood ■ Howard College ■ Medical School ■ Pietermaritzburg ■ Westville

INSPIRING GREATNESS

## Appendix 2: Informed Consent Letter

**Informed Consent Letter 3C**

**UNIVERSITY OF KWAZULU-NATAL  
GRADUATE SCHOOL OF BUSINESS AND LEADERSHIP**

Dear Respondent,

**MBA Research Project**  
**Researcher: Mr. Sizwe Mbatha (08XXXXXXXX)**  
**Supervisor: Prof. Mihalisi Chasomeris (03XXXXXXXX)**  
**Research Office: Ms. P Ximba (03XXXXXXXX)**

I, Stanley Sizwe Mbatha an MBA student, at the Graduate School of Business and Leadership, of the University of KwaZulu Natal. You are invited to participate in a research project entitled **Assessment and Enhancement of Beach Water Quality Management Strategies in eThekweni Municipality**. The aim of this study is to: **assess the current beach water quality management strategies in eThekweni Municipality and to propose enhancements to improve these strategies.**

Through your participation I hope to understand answers to three key questions regarding beach water quality management in eThekweni Municipality. **Firstly, to identify the current strategies in place for managing beach water quality. Secondly, to assess the effectiveness of these strategies in enhancing beach water quality. Lastly, to determine the contributing factors to beach water pollution and to evaluate the pollution prevention strategies employed to address these factors.** The results are intended to contribute to the proposal of measures for enhancing beach water quality management strategies in eThekweni Municipality.

Your participation in this project is voluntary. You may refuse to participate or withdraw from the project at any time with no negative consequence. There will be no monetary gain from participating. Confidentiality and anonymity of records identifying you as a participant will be maintained by the Graduate School of Business and Leadership, UKZN.

If you have any questions or concerns about participating in the interview or about participating in this study, you may contact me or my supervisor at the numbers listed above.

The interview should take you about 45 minutes. I hope you will take the time to participate in this study.

Sincerely

Investigator's signature \_\_\_\_\_ Date \_\_\_\_\_

**This page is to be retained by participant.**

**UNIVERSITY OF KWAZULU-NATAL  
GRADUATE SCHOOL OF BUSINESS AND LEADERSHIP**

**MBA Research Project**  
**Researcher: Mr. Sizwe Mbatha (08XXXXXXXX)**  
**Supervisor: Prof. Mihalios Chasomeris (03XXXXXXXX)**  
**Research Office: Ms. P Ximba (03XXXXXXXX)**

**CONSENT**

I..... (full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

**SIGNATURE OF PARTICIPANT**

**DATE**

.....

.....

**This page is to be retained by researcher.**