



**Condition Assessment of Sewerage Infrastructure in Selected Townships in Cape  
Town, South Africa**

**by**

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## ABSTRACT

The provision of adequate and dignified water and sanitation services remains a challenge in South Africa. This stems from rapid urbanisation, deteriorating infrastructure, poverty and inequality, corruption and shortage of skilled human resources. These challenges have led to the destruction and complete failure of critical infrastructure that is intended to service both affluent and vulnerable communities throughout South Africa. Failures of the sanitation infrastructure across the country have been characterised by sewer overflows that are prevalent in lower-income areas. This research study sought to establish the current state of sanitation infrastructure in Samora Machel, Lower Crossroads and Nyanga, which are township developments on the outskirts of the city centre in Cape Town. South Africa is considered one of the most unequal societies in the world and this is visible in the manner in which sanitation infrastructure was developed in townships versus the infrastructure in more affluent areas. The poor design of sanitation infrastructure by the previous government and the inadequate maintenance by the current government have led to sewer overflows being a common occurrence in lower-income areas, particularly townships and informal settlements. The research study was initiated to investigate the causes or factors leading to the dilapidation of sanitation services in the Nyanga, Lower Crossroads and Samora Machel townships within the City of Cape Town. The main objectives of the research study were to determine the condition of sanitation services in these selected townships and to ascertain and identify the causes of dilapidation of the sanitation services, with a view to suggesting solutions to such challenges. The study employed a mixed method approach relying on both qualitative and quantitative research methods. Interviews were held with City officials and ward councillors while surveys were distributed to residents of the affected areas to get an in-depth response on the challenges that they face regarding sewer overflows. A database, obtained from the City of Cape Town, also provided much needed insight into the common causes of overflows in the area of study. The data, gathered through surveys, interviews and the City of Cape Town's databases, revealed that numerous overflows occurred in the selected study area between 2019 and 2021. Most of these overflows were caused by the residents' disposal of foreign objects into the sewer lines. Sewers were not designed to carry heavy, insoluble objects, and such foreign objects often interfered with the operations of critical sewer infrastructure. Residents need to refrain from misusing sewers, as the persistent misuse of these services can significantly diminish the design lifespan of civil infrastructure. The study also revealed that a large percentage of the population did not understand the concept of foreign objects in the sewer network and many residents were not aware of the reporting channels for sewer-related faults. This delays service delivery and residents are often exposed to unhygienic conditions due to not following the correct reporting channels with the City. The sewers in the area of study were originally designed with a lifespan exceeding 50 years. However, continued

dumping into the sewers and the theft of critical sewer infrastructure have significantly diminished the lifespan of the services. An adjustment in the behavioural patterns of the residents within the affected area could improve the lifespan of critical sewer infrastructure in the lower-income areas.

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## **ACRONYMS**

CSIR	Council for Scientific and Industrial Research
CCT	City of Cape Town
EPWP	Extended Public Works Programme
LFTEA	Less Formal Township Establishment Act
MPBL	Municipal Planning Bylaws
SPLUMA	Spatial Planning and Land Use Management Act
W & S	Water and Sanitation
IQMS	Integrated Quality Management System

## GLOSSARY

**Sanitation services** – The provision of facilities and infrastructure for the safe disposal of human urine and faeces (World Health Organisation, 2021).

**Water and Sanitation** – The conveyance of drinking water and sewerage to and from human settlements (World Health Organisation, 2021).

**Township** – In the South African context townships are human settlements that have a unique distinct history. They were designated under the apartheid system for exclusive habitation by people classified as blacks, coloured and Indians (Donaldson, 2014).

**Service delivery** – The provision of basic services to the population by an organ of state (Nkomo, 2017).

**Local municipality** – An organ of state below the provincial government. This is the sphere of government closest to the people and is responsible for the provision of basic services (Herbig, 2019).

**Protest** – Unrest in the community due to dissatisfaction from the community members relating to the provision of services (Nkomo, 2017)

## CHAPTER 1: INTRODUCTION

This chapter provides the context for the research study, introduces the research question and problem, and outlines the aims and objectives of the study.

### 1.1 Background to the problem

Access to hygienic, dignified and environmentally friendly sanitation services remains crucial to human health and the fight against waterborne diseases. However, the provision of sanitation services has become a challenge for many African countries. This stems from rapid urbanisation, deteriorating infrastructure, poverty and inequality, corruption, and a shortage of skilled human resources (Sutherland et al., 2020). South Africa is no exception to the African countries faced with water and sanitation challenges. According to Herbig (2019), the rapid rate of urbanisation and the growing number of informal settlements have placed a tremendous strain on the municipal sewer infrastructure. Odendaal (2017) further highlighted that pollution due to sewerage overflows has become a common occurrence in low-income areas due to a plethora of reasons, which were explored in this study.

Sewerage overflows pose a threat to the health and well-being of residents in communities impacted by failing/ deteriorating municipal infrastructure. Kretzmann et al. (2021) alluded to the fact that many residents living in less formal areas across the country were exposed to raw sewerage overflows daily due to failing municipal infrastructure. Studies have shown that raw sewerage contains *Escherichia coli* (*E. coli*) which is a harmful bacterium that causes diseases and infections upon exposure to humans (Cho et al., 2018). Sewerage overflows have often resulted in an unfavourable odour that disrupts the well-being of residents. This study sought to examine and understand the reasons behind frequent sewerage overflows in the selected townships in Cape Town with the aim of proposing effective solutions to address the issue.

Mabuza (2017) alluded to the fact that an exponential increase in the volumes of sewerage running through the sewer network in low-income areas has attributed to the deterioration of municipal sewerage infrastructure. There has also been an increase in backyard dwellers. According to Thompson et al. (2019), the City of Cape Town experienced an increase of 53% in backyard settlers living in shacks. Backyard dwellers were exempted from the wastewater planning by-laws through the Less Formal Township Establishment Act 113 of 1991 (LFTEA) which means that these settlers do not pay for Water & Sanitation services. Backyard dwellers have been very vocal in demanding services as evidenced by service delivery protests across the country. Most of these protests have become violent and resulted in damage to municipal and private infrastructure (The Institute for Security Studies Protest and Public Violence Monitor, 2021). Another challenge

that faced township services was that the condition and extent of damage to most sewerage infrastructure in township settlements remains unknown. This limited proactive measures by water and sanitation service providers (Ngcamu, 2019).

Consequently, there was a need to identify solutions to address the problem of sewerage blockages. This study, therefore, sought to assess the current state of sewerage infrastructure in selected townships (Samora Machel, Nyanga and Lower Crossroad) in Cape Town. The costs of repairs to blocked sewers were analysed through data sourced from the City of Cape Town's database and an investigation into the causes of the deterioration of the sewerage infrastructure were also conducted. In addition, the study delved into the socio-economic impacts of sewage issues on the community member's lives. Finally, collaborative efforts with the City of Cape Town and the affected communities were employed to identify solutions to the problems.

## **1.2 The Research problem**

Many authors have explored the topic of sewer infrastructure and sanitation requirements in cities across the globe. Numerous studies recommend alternative sewer infrastructure as part of the solution. Tscheikner-Gratl et al. (2020) stated that ageing sewerage infrastructure and exponential population growth have placed tremendous pressure on decision-makers to develop alternative sewer infrastructure asset management models. Pericault et al. (2018) conducted a comparative sustainability assessment exploring technical alternatives for sewer, water and heat distribution in Sweden. Bruaset et al. (2018) adopted a similar approach to that of Pericault et al. (2018) with the intention to assess the life expectancy of the different pipe groups. Sutherland et al. (2020) investigated an alternative sewerage system that did not depend on a consistent steady supply of water as is the case in most areas in South Africa. However, the study was conducted on a peri-urban household area in Durban, South Africa. This research study focused particularly on 3 townships in the City of Cape Town to determine alternatives to the sanitation challenges experienced in lower income areas. Research conducted previously focused on other parts of the world and limited research was conducted which was specific to the unique challenges facing township developments in Cape Town.

Limberg (2021) indicated that the challenge of sewerage overflows and blockages in township developments is a persistent issue that has been given priority in terms of planned projects for the near future in the City of Cape Town. The deteriorating state of municipal wastewater infrastructure has become a crisis in South Africa that should be resolved by the different spheres of government (Herbig, 2019). Sutherland et al., (2020) further opined that there is a need for innovative sanitation solutions to improve the sanitation challenges experienced by local authorities in the provision of these services.

Researchers have sought alternatives to mitigate the high costs and time associated with repairing dilapidated sewerage infrastructure. This research study delved into costs associated with repairing blocked sewers in the selected townships in Cape Town. Additionally, alternatives to solve sewer related problems were also explored. Communities were encouraged to take ownership of the services by protecting the infrastructure from vandalism. Long-term solutions to effectively address sanitation issues experienced in township developments require a collaborative effort between the local authority and residents from the affected communities (Limberg, 2021).

This research study focused on assessing the current state of municipal sewer infrastructure in the selected townships in the City of Cape Town. Nkomo (2017) stated the fact that the condition of most sewer infrastructure in lower-income areas remains unknown, which prohibits proactive maintenance activities that could prevent blockages and overflows. Herbig (2019) alluded to the fact that the mismanagement of municipal sewer infrastructure has led to the deterioration experienced on the municipal services. Therefore, this research study attempted to identify the causes of deterioration of the sewer infrastructure in the selected townships.

### **1.3 Research questions**

The study attempted to answer the following research questions:

- What is the current condition of the sewerage infrastructure in the selected townships (Samora Machel, Nyanga and Lower Crossroads) in Cape Town?
- What are the annual costs of protecting and repairing dilapidated sewerage infrastructure in the selected townships?
- What are the causes of the dilapidation in the sewerage infrastructure in the selected townships?
- What are the socio-economic impacts of sewerage infrastructure dilapidation in the selected townships?
- What are the effective solutions that may be used to remedy the dilapidation of the sewerage infrastructure in the selected townships?

### **1.4 Aims and objectives of the research**

The aim of this study was to assess the current condition of the sewerage infrastructure in selected townships in Cape Town. This in turn assisted in identifying the causes of dilapidation of sewerage infrastructure in the townships. Furthermore, the study sought to explore potential



solutions that can be implemented by the local authorities to address sanitation service delivery issues in townships. To achieve this, the study objectives were as follows:

- To assess the current state of sewerage infrastructure in the selected townships in Cape Town (Samora Machel, Nyanga and Lower Crossroads).
- To analyse the annual costs of protecting and repairing dilapidated sewerage infrastructure in the selected townships.
- To assess the causes of the dilapidation of the sewerage infrastructure in the Samora Machel, Nyanga and Lower Crossroads Townships.
- To explore the socio-economic impacts of the sewerage infrastructure dilapidation on the lives of people in Samora Machel, Nyanga and Lower Crossroads Townships.
- To explore and recommend possible solutions to address the dilapidation of the sewerage infrastructure in Samora Machel, Nyanga and Lower Crossroads Townships.

### **1.5 Significance**

This study sought to identify the major causes of dilapidation in the sewer infrastructure within the selected townships within the City of Cape Town. The data collected from diverse sources could aid local authorities in implementing proactive measures to reduce and eradicate sewer overflows in the lower-income areas. The study's significance lies in its focus on townships in Cape Town, offering the potential to assist the city in enhancing sanitation services within densely populated township areas.

### **1.6 Delineation**

The scope of the study was limited to three townships (Samora Machel, Nyanga and Lower Crossroad) in Cape Town due to time constraints. The study focused on sanitation services exclusively and did not cover the other basic services to ensure project feasibility.

### **1.7 Context of the research**

The research is within the field of Civil Engineering under Municipal and Water Engineering.

### **1.8 Chapter organisation**

Chapter 1 introduces the study and outlines the rationale behind the study. It provides an overview of the background, problem statement, research question, objectives, and outcomes. It also outlines the limitations and scope of the study.

Chapter 2 conducts a review of existing literature research conducted by other local and international scholars, presenting insights and findings.

Chapter 3 provides a detailed overview of the research methods employed in the study, offering a thorough analysis of sampling methods, research design, methodology, data collection, and data analysis techniques.

Chapter 4 presents and discusses the results. Data gathered through surveys and interviews is visually presented using appropriate tables and graphs. The discussion highlights the trends identified during the analysis of the data.

Chapter 5 provides the interpretation and limitations of the research findings.

Chapter 6 provides the conclusion and recommendations based on the research findings.

## **CHAPTER 2: CHALLENGES RELATING TO THE PROVISION OF WATER AND SANITATION SERVICES IN SOUTH AFRICA**

### **2.1 Historical setting of townships in South Africa**

Township planning and establishment in South Africa was implemented through a rigorous legislative framework. Legislation such as the Urban Areas Act 21 of 1923 and the Group Areas Act of 1950 further cemented the establishment of township developments on the periphery of urban areas reserved for people of colour. The Urban Areas Act of 1923 enabled municipalities to designate locations on the outskirts of urban areas, which were specifically created for black and coloured individuals that were employed in urban areas (Seekings, 2011). Maylam (1995) highlighted that the Group Areas Act of 1950 was later introduced to support the implementation of the Urban Areas Act. Between 1948 to 1960, there was a significant introduction of a variety of policies and legislation aimed at securing the ongoing prosperity of the white population. An example of such legislation includes the Bantu Authorities Act of 1951 and the Black Homelands Citizenship Act of 1970, which increased government control over the oppressed masses (The World Bank, 2014). The main objective of these legislative developments was the exclusion of some racial groups from economic and political activities in South Africa (Hindson, 1995). This meant that cities were designed for the white population and facilitated their active participation in economic activities, which improved their standard of living.

Findley and Ogbu (2011) observed that townships became an establishment for accommodating the non-white labour force employed particularly in mines and industrial developments in urban areas. Very minimal infrastructure development was provided for the townships and people of colour often lived in appalling conditions (Hindson, 1995). The effects of the lack of infrastructure development in townships are visible to this day as many services in townships are below standard and are deteriorating at a rapid rate. Breakfast et al. (2019) observed a vast contrast in services such as water & sanitation services that were provided to townships compared to those provided in urban areas. Midblock sewers are often used as an example of poor infrastructure planning and development in areas that were previously classified as townships. Midblock sewers are municipal sewers that pass-through people's backyards, posing potential health risks in the event of overflows. Sewers in urban areas were installed in the roadway and overflows were accommodated in the storm water catchment system. Municipalities had minimal consideration for township developments and allocated limited financial investment into township infrastructure in the past.

The lack of financial support from government meant that people residing in townships had to cater for themselves. Many informal economic activities emerged in many townships around the

country. Malls and shopping centres were placed far away from townships therefore residents had to resort to 'tuckshops' for day-to-day household goods. Moreover, there was a rise in private black-owned minibus taxis to address the lack of adequate public transport for commuters going to work (Findley & Ogbu, 2011). These economic activities are still the cornerstone of the township economy and are the only source of income for many families. The lack of financial support from government also created a housing problem for many people residing in the townships. This resulted in a rise in informal housing and backyard dwellers (Hindson, 1995). Herbig (2019) alluded to the fact that informal settlements as well as backyard settlers place a tremendous strain on water & sanitation services as these settlers were not catered for in the design of the infrastructure. This study sought to identify the main causes of deterioration on the sewer services in the three selected townships and to establish a link between backyard dwellers and the deterioration of municipal services.

The Township Renewal Source Book (2009) states that the planning and development of the majority of townships in South Africa was based on international standards such as the British "New Towns". However, the apartheid government intentionally provided substandard facilities in the townships to ensure underdevelopment of these areas. A publication from the World Bank highlights that townships now accommodate more than 50% of the urban population and the majority of these individuals remain unemployed (BusinessTech, 2016). The recent migration from rural areas to urban areas is primarily driven by individuals seeking improved employment opportunities. However, South Africa has also experienced an influx of people from neighbouring countries seeking better prospects within its borders (Stats SA, 2011).

Certain characteristics were unique to townships and are still present to this day. The concept of 'townships' was shaped by the strict legislative framework designed to regulate the movement and residence of specific segments of the population. Townships were built at a distance away from white areas and economic hubs, consisting of rows of uniform houses lacking essential infrastructure, including proper roads, water electricity and sanitation services (The World Bank, 2014). Workers employed in middle to high income areas were exposed to the exceptional quality of services in such areas, which contributed to the feeling of inferiority for black and coloured workers. The Department of Cooperative Governance and Traditional Affairs (CoGTA, 2009) published a list of requirements that were used by the apartheid government to develop township settlements, which were as follows:

- Townships were to be developed at an adequate distance from white towns
- New township developments were developed in such a manner that they became an extension of an existing township.

- The presence of buffer areas around the township were required. These could include greenbelts, water bodies and other facilities of a similar nature.
- Industrial areas were used as buffers between township developments and white areas to limit access to white areas for people of colour.
- Any expansion of the townships was to be done away from white areas.
- The townships were developed close to modes of transport such as rail and bus stations to enable workers to commute easily to work.
- The townships were constructed in locations where only 1 road connected such areas to white areas.
- The townships were positioned at a considerable distance away from national and provincial roads.
- Certain minimum design standards were developed for the construction of the houses.

These requirements, together with the legislative framework shaped the township developments, which have remained fairly the same over the years (Findley & Ogbu, 2011). The post-apartheid government developed numerous initiatives such as the Reconstruction and Development Programme (RDP), which became the urban development strategy of South Africa. This initiative essentially continued to implement similar spatial planning policies as those implemented during apartheid. The RDP resulted in the government constructing uniform four-roomed 'matchbox houses' constructed in a row, all identical in design. Although this initiative sought to eradicate the housing issue, it appeared as though this legacy was an extension of the apartheid policies and spatial planning (Pieterse, 2009). This housing initiative undertook different names and forms over the years and has survived multiple administrations of the new government in South Africa (The World Bank, 2014).

## **2.2 Modern-day townships in South Africa**

Hunter (2019) defined a township in terms of the South African context as being a densely populated urban settlement usually located on the outskirts of commercial and industrial areas. The townships were designed by the apartheid government for black individuals working in mines and factories. The previous government did not consider internal economic logic and adequate service delivery in the design of the townships (Hunter, 2019). The townships, 28 years' post-apartheid, have become areas affected by high levels of violence and crime, unemployment as well as disparities to access basic public services (The World Bank, 2014). Many townships have

experienced an exponential increase in backyard dwellers in recent history because every 1 in 5 households in the township is a shack (Turok & Borel-Saladin, 2018).

The post-apartheid South Africa has seen an exponential increase in the population throughout the country. This can be attributed to natural population growth as well as an influx of people from neighbouring countries. Some of the residents from the Southern African Development Community (SADC) have relocated to South Africa in search of better opportunities and to seek refuge (The World Bank, 2014). Countries in the SADC block include South Africa, Angola, Zimbabwe, Namibia, Malawi, Zambia, The Democratic Republic of Congo, Tanzania, Madagascar, and Mauritius. Unfortunately, much of this migration has been centred around informal settlements, which have been observed to develop much faster than formal township developments. A large proportion of residents that reside in both townships and informal settlements remain unemployed and without an income, widening the gap between the rich and the poor in South Africa (The World Bank, 2014). The vision and mission statement of the Urban Framework of 1997 stated that:

*“Rebuilding the townships cannot occur in isolation from integrating strategies. The intention is to move actively away from the segregation of different parts of the city and to ensure equity across the urban landscape, thus offering all urban residents access to opportunities and facilities.”*

A brief look at the informal settlements and township developments can confirm that the vision has not been realised despite multiple attempts. Townships and informal settlements remain predominantly for people of colour whilst the white population enjoy the benefits of living in upmarket areas. The perceived poor location of the townships has restricted access to basic services for large parts of the population living in townships and informal settlements. Many informal settlements and settlers thereof attain land through ‘land grabs’ where individuals occupy land that does not belong to them or has not been officially allocated to them (Garau et al., 2005). Certain limitations and exclusions result from the illegal occupation of land, impacting the development of services such as water and sanitation services, electricity and roads. Other exclusions include inadequate access to educational services; however, residents of informal settlements are welcome to travel to more formal areas in search of opportunities.

People living in informal settlements are excluded from accessing municipal services such as water and sanitation services due to the illegal occupation of land (Garau et al., 2005). These exclusions are often implemented to limit the increase of the informal settlements that do not comply with municipal regulations, especially where land is illegally occupied. Thompson et al. (2019) further state that townships and informal settlements have very limited access to basic

municipal services, which worsens the living conditions of individuals or residents in these communities. Sanitation services in township settlements often deteriorate due to inadequate planning and maintenance from government both pre and post 1994 (Findley & Ogbu, 2011). This study therefore sought to assess the condition of sanitation services in 3 selected townships in the City of Cape Town and explore the main causes of dilapidation on the sanitation services.

Cape Town is home to more than 4 million residents and the failure of any sewerage infrastructure can be detrimental to the health and well-being of its residents. The City of Cape Town also boasts a network of more than 9000 kilometres of sewer pipes, approximately 480 sewer pump stations and manholes in excess of 200 000. The townships selected in this study Samora Machel, Nyanga and Lower Crossroads, experienced frequent blockages, and overflows, which suggests the fact that either the sewerage infrastructure in these areas lack capacity or the community members are misusing the sanitation services. According to Limberg (2021), more than 70% of the service requests logged to the Water and Sanitation team in the City of Cape Town were due to the misuse of the services. This research study sought to determine the causes of these challenges and ascertain the impact of the socio-economic challenges on the way that residents use sanitation services. The responsibility of maintaining and rehabilitating the dilapidated sanitation services rests on the local government, irrespective of the cause of dilapidation on the services. Therefore, the recommendations made in this study aim to enhance service delivery to the people. Thompson et al. (2019) highlighted or stated that government passively accepts informal settlers without any real intention of providing adequate services to them. Many township dwellings in South Africa have seen an increase in informal settlements, which has placed tremendous strain on municipal services (Herbig, 2019). The condition of many municipal sewers in townships remains unknown and the service delivery protests witnessed throughout the country in township settlements indicate that the municipal services do not adequately service the communities (Nkomo, 2017). This study aimed to assess the condition of sanitation services in the selected townships with the goal of understanding and proposing solutions to the sanitation challenges experienced in these areas.

Many residents in townships often associate good service delivery, with more affluent areas, which they have not experienced in townships (Ndlovu, 2020). This is due to a number of factors that were explored in this study. Many township developments have become extremely volatile posing safety challenges to water and sanitation teams working in such areas. Theft and vandalism of municipal sewer infrastructure has been reported by the City of Cape Town to be one of the leading causes of sewer spillages and overflows in townships. Limberg (2021) alluded to the fact that the community members in townships often refrain from reporting incidents of vandalism and damage to City infrastructure. This in turn affects service delivery to township developments. Ndlovu (2020) also

stated that residents in townships perceive municipal workers as selective in providing services to areas and are more responsive to faults in predominantly 'white areas'. The effects of apartheid spatial planning is still visible to this day, in modern day service delivery challenges. Consequently, this study explored the main causes of dilapidation on the sanitation infrastructure in selected townships, with the incurred costs for repairs to address the issue.

The development of cities and towns in recent times has taken a multi-nodal approach where cities are expanding beyond the conventional confines of a central business district. Many towns and cities are expanding closer to township developments, which could assist to improve the quality of life for township residents and make it easier to commute to work (The World Bank, 2014). Researchers have however argued that the proximity of economic hubs to township developments has not resulted in a visible integration nor developmental benefits to townships (Findley & Ogbu, 2011). Infrastructure in township developments has consistently lagged in development and capacity.

### **2.3 Rapid urbanisation**

The provision of water and sanitation services in South Africa has been largely characterized by both challenges and achievements during the post the apartheid era (Herbig, 2019). The sporadic increase in service delivery requests from an ever-growing population within the country places a tremendous strain on the government to provide basic services such as water and sanitation services. Rapid urbanisation within South African borders has led to informality, sanitation backlogs, deteriorating municipal infrastructure and inadequate capacity to provide safe sanitation services for the residents (Sutherland, 2020). Rapid urbanisation and vandalism by community members has also resulted in the further dilapidation of sanitation infrastructure. More than half of the blockages and overflows reported to the water and sanitation team are due to the misuse of the sanitation infrastructure by members of the community (Limberg, 2021). The misuse of the sanitation infrastructure involves criminal acts such as vandalism or the improper disposal of foreign objects into the sewer system, leading to blockages. The misuse of the sanitation infrastructure further hinders the provision of effective sanitation services. This study sought to identify the causes of the dilapidation in the sewerage infrastructure and to identify solutions to address them.

In recent times South Africa has been impacted by inequality, persistent poverty, high unemployment, infrastructure failure and sluggish economic growth. This has led to domestic (internal) migration issues with a significant number of people leaving rural areas in search of employment opportunities in urban areas (Arndt et al., 2018). Poverty and unemployment are more evident in rural areas where there is limited access to economic activities. Rapid



urbanisation has however led to an infrastructure and housing problem. Slow economic growth has resulted in low levels of infrastructure development in urban areas, causing the infrastructure in urban areas to struggle to cope with the rapid levels of urbanisation (Findley & Ogbu, 2011). Rural-urban migration is a phenomenon that has affected the City of Cape Town in recent times and has created an accommodation issue. This study therefore sought to investigate the effects of socio-economic dynamics on sanitation infrastructure in the selected townships in the City of Cape Town.

Numerous consequences have been linked to rapid urbanisation across the African continent:

- Multiple informalities arise from rapid urbanisation and the forced expansion of metros.
- A lack of viable land for settlement has compelled people to enact illegal land grabs as a means to provide themselves with shelter.
- Health care services and social security deteriorate.
- The infrastructure allocated to formal areas often suffers the consequences of unplanned expansions to areas of settlement.

Despite the progressive rights-based Constitution in South Africa and the large-scale housing subsidy scheme, access to and possession of viable land for developments and townships remains a challenge in urban areas (Department of Cooperative Governance and Traditional Affairs, 2014). Acknowledging such challenges and understanding them can assist government in developing positive response plans, which include providing sufficient capacity of existing infrastructure to accommodate large-scale migration.

Perceptions and attitudes of people towards urbanisation in South Africa have been complicated and reflect a legacy of institutionalised racism and apartheid, which classifies people into housing schemes according to their race. The institutionalised racism and the confinement of people of colour to certain township establishments limited migration during apartheid. Therefore, the phenomenon of migration rapidly occurred in the period after apartheid. The collapse of rural employment opportunities in recent times has been the leading cause of rural to urban migration. It is estimated that only one out of four people living in rural areas is currently employed, resulting in the migration from the rural areas to urban areas.

South Africa is considered one of the most urbanised countries in Africa, with approximately 67% of the population living in urban areas (Stats SA, 2011). Migration and urbanisation have been viewed negatively, such that it is considered a threat that needs to be avoided. Common factors that result in mass migration of people include war, famine, environmental disasters, economic

collapse, health problems and deteriorating infrastructure. Migration and urbanisation have also resulted in many challenges, which include deterioration in infrastructure and housing issues (Stats SA, 2006). In order to develop effective solutions to combat such challenges, they need to be understood. The decline in sewer infrastructure in lower income areas is often linked to rural-urban migration and the sudden increase in population density in those areas. Sewers and other civil engineering infrastructure are designed to accommodate a specific population size and the sudden influx of inhabitants into an area places significant pressure on the infrastructure.

The consequences of migration, be it internal or international, have varying consequences based on the scale at which it occurs. These are as follows:

- The areas of destination experience both economic impacts and challenges in infrastructure and service delivery. The sudden influx of people into a specific requires additional resources to accommodate the increase. However, many of the government agencies throughout the country lack the necessary resources to address this. Herbig (2019) asserted that government in all spheres, lacks the necessary skill set and knowledge to effectively run and manage the infrastructure that was built by the apartheid government. A significant portion of this infrastructure has deteriorated to such an extent that it needs to be seriously overhauled.
- Health care services often suffer the consequences of this migration as the health care resources remain constant even as the population experiences significant growth. Sewer overflows and spillages often result in serious health care challenges. This includes insufficient capacity of health care facilities to accommodate the community.

The consequences listed above were considered to have a significant impact on the deterioration of the sanitation services in lower income areas. Therefore, these challenges were explored during this research study.

## **2.4 Poor service delivery in townships**

The provision of water and sanitation services has previously been linked to socio-economic factors, particularly wealth and social status. The segregation policies of the apartheid era resulted in the government providing world-class services to the white population at the expense of the previously disadvantaged ethnic groups (Breakfast et al, 2019). The effects of the segregation policies are still visible to the present day. Community members from middle to high-income areas are more positive about service delivery and the services received from the various local authorities (Nkomo, 2017). This is in contrast to the service delivery protests seen throughout South Africa, particularly in the lower-income areas (townships). The Institute for Security Studies

Protest and Public Violence Monitor (2021) reported an average of 8 protests perday in July 2020 in response to poor service delivery in the less affluent areas of the country. Community members vent their frustrations through protests to seek redress from the government. Protests mostly occur in township areas among shack dwellers, local community members and ordinary citizens on matters relating to issues of socio-economic fairness (Ngcamu, 2019). The protests are directed at the local municipalities, which are the custodians of the water and sanitation services.

The post-apartheid government in South Africa committed to reversing the injustices that occurred over decades in South Africa. This was further enshrined in the South African Constitution Act 108 of 1996 (Constitution of South Africa) which guarantees the equality of all citizens (Thompson et al., 2017). Hence, all citizens were afforded equal access to basic services. Unfortunately, the right to equality has not been fully realised as government intended South Africa remains one of the most unequal countries in the world and such inequalities affect the provision of basic services to poorer communities (Bhorat, 2015). Residents of most townships throughout South Africa have expressed concerns over lack of service delivery and such concerns were explored during this study.

Service delivery post-apartheid has been linked with social justice, human rights, poverty alleviation and inequality (Chikulo, 2016). Certain services constitute the backbone of service delivery. These services include sanitation services, drinking water, waste removal, roads, electricity, and shelter. The emergence of a new government in South Africa led people to anticipate poverty eradication, provision of services and infrastructure to all, clearing of housing backlogs and improvement of the quality of life. However, numerous scholars have argued that the various spheres of government and the quality of life in South Africa have deteriorated post-apartheid (Herbig, 2019). The Constitution of South Africa (1996) mandates local government with the delivery of these core basic services to all. Nkomo (2017) emphasized that local government should collaborate with citizens and civil society organisations to develop sustainable ways to improve the social, economic, and material needs of different communities. These sustainable measures can only be developed once local government comprehends the complexities surrounding the causes of infrastructure dilapidation. A report submitted by the Human Rights Commission in South Africa (SAHRC, 2010) confirmed that the provision of basic services has become ineffective and is non-existent in certain parts of the country. Much of this can be attributed to corruption and crime that has been brought to the spotlight post-apartheid. This is due to high incidence of corruption and crime in the post-apartheid area. In addition to the above, many State-Owned Enterprises (SOEs) and organisations lack the necessary expertise to effectively provide the necessary services.

The topic of service delivery in post-apartheid South Africa has become a topic of contention. The government, through its various administrations post 1994, has provided statistics highlighting that service delivery has been prioritized. Chikulo (2016) however, argues that there is a big difference between access to services and the utilization of those services. He further argues that service delivery should not be evaluated solely based on statistics. Mc Donald et al. (2002) further argue that a significant portion of services and civil engineering infrastructure has been discontinued in various parts of the country due to a lack of funding and corruption. This phenomenon has been seen throughout the African continent. Previously disadvantaged groups have often suffered the consequences of this. Despite significant progress in reducing the service delivery backlog, many parts of the country still lack sufficient resources to effectively service communities.

In addition, many municipalities cannot accommodate the rapid population growth of residents in informal areas, on the periphery of urban areas. The South African Local Government Association (SALGA, 2009) stated that residents of informal settlements have been unequivocal in demanding services. Such demands have often resulted in riots and clashes between law enforcement agencies and the residents. These informal settlements were not catered for in the spatial planning policies. Furthermore, specific exclusions have been enacted by local governments to curb the development of these informal settlements (Herbig, 2019). External migration from neighbouring countries and rural to urban area internal migration further strain on government's capacity to provide services to a growing population (Chikulo, 2016). Whilst there have been significant advancements in the provision of services to the general population in South Africa in line with the Constitution, local authorities lack capacity to fulfil the demands of the growing population. This has resulted in substantial anger and frustration towards the quality and affordability of services in lower income areas (Chikulo, 2013).

Government, in a statement issued by the Presidency in 2014, openly acknowledged the challenges that exist with service delivery by stating the following:

*“However, a challenge that has emerged is that there has been a decline in functionality of municipal infrastructure due to poor operation and maintenance in some municipalities. This means, for example, that while people might have access to a tap, there might be no water coming out of the tap.”*

This statement supports the assertion by Chikulo (2016) that there is a significant difference between access to, and the utilization of services. Although many more parts of the country have been capacitated to have access to basic services, the utilisation of such services remains exclusive to those that can afford them. Nkomo (2017) argues that local governments have

prioritized service delivery in affluent areas and been neglected lower income areas. In most cases, this can be considered to be the remnants of the apartheid system whereby world class services were provided to a limited part of the population while the rest of the country remained neglected or received substandard services. Despite the development of programmes to address the consequences of the apartheid system, local governments do not have capacity to provide for the growing population in various areas throughout the country. This research study focused on sanitation services and sought to comprehend the complexities of service delivery in lower income areas and ascertain the causes of dilapidation of sanitation infrastructure in the selected townships within the Cape Metropolitan.

## **2.5 Responsibilities of local government**

The government in South Africa was divided into 3 major spheres, namely national government, provincial government as well as local (or municipal) authority. These spheres were allocated unique core functions in society and are interdependent and interrelated (Herbig, 2019). The policy of cooperative governance is the driving force behind the relations within the different spheres of government. Section 152 of the South African Constitution of 1996 imposes an obligation on the local (municipal) authority to provide basic services. The South African Constitution (1996) further provides that local government is responsible for ensuring the provision of basic services to the community in a sustainable manner. Odendaal (2017) however argues that the spheres of government in South Africa are appalling. This is evident through the lack of efficient and effective service delivery to communities. According to the Institute for Security Studies Protest and Public Violence Monitor (2021) between August 2020 – January 2021 an average of 5-service delivery protests were reported per day. This indicates that many municipalities are struggling to cope with the demand for effective services to the growing populations in the different respective areas. Limberg (2021) mentioned that the water and sanitation teams were working continuously to ensure that the sewerage infrastructure across the City of Cape Town operates at the highest capacity possible. Limberg (2021) further noted that challenges continue to be experienced in relation to the provision of sanitation services across the Cape Metro, given that more than 300 service requests were received by the City each day. Nkomo (2017) advocates for government to conduct meaningful community engagements to ascertain the causes of the challenges experienced. This study, therefore, sought to ascertain the condition of the sewerage infrastructure in the Samora Machel, Nyanga and Lower Crossroad townships in an attempt to identify the causes of the sewerage blockages and overflows, in order to propose alternative solutions to address the issues. A significant number of researchers argue that service delivery and the municipal systems in South Africa have failed given the frequency of protests post 1994, which shows the general public's dissatisfaction with the quality of services delivered. Residents

protest to vent and to show their disapproval of the perceived betrayal by the government (Chikulo 2016). Residents and inhabitants of lower income areas are of the perception that peaceful protests have become ineffective leading to violent protests in recent times (Dodds, 2014). Cape Town is no exception to the violent protests. The Cape Metro has seen an increase in service delivery protests in recent times. This phenomenon creates the notion that the local authority in Cape Town struggles to meet the demands of the growing population. This research study also sought to ascertain the impact of informal settlements on the sanitation services within the selected area of study.

The issue of service delivery protests stemming from frustrations of the general public is a crucial matter. The Star (2014) reported that approximately 43 protesters were killed by the police between 2004 to 2014. Another phenomenon that has been observed in South Africa is that service delivery protests often descend into outbreaks of xenophobic attacks. These attacks are aimed at foreign nationals in township developments. Residents in townships and informal settlements often blame foreign nationals residing in these lower income areas for the deterioration of provision of services. However, such assertions are dangerous and have resulted in many vigilante groups inflicting unnecessary pain on selected groups.

Nkomo (2017) advocates for local authorities to actively involve the public in resolving service delivery related matters. The general public are the end users of services and the deterioration of these services are at their hands. The Municipal Systems Act 32 of 2000 (Municipal Systems Act) allows for community participation development through Ward committees, established in line with section 17(1) of the Municipal Structures Act, 1998 (Act 117 of 1998). These ward committees are mechanisms through which communities can interact with the local government (Chikulo, 2016). These ward committees, together with Civil Society Organisations and other structures within the community are expected to collaborate and address matters relating to service delivery. Such organisations can assist local governments to resolve community matters without violence. Legislation in the new South Africa provides for various avenues for public interaction and participation in municipal planning and performance evaluation. To this end, municipalities are also mandated to regularly report on the state of internal affairs and provide feedback on the objectives of the municipality for each financial year.

The Department of Cooperative Governance and Traditional Affairs (DoCOGTA, 2014) acknowledges the lack of communication between local government and communities. It has stated that the social distance between local government and community organisations has widened since 1994. The protests that occur are therefore considered an attempt to voice out frustrations against the government and attract its attention (Nkomo, 2017). The frequency and

nuisance of sewer overflows in certain townships within the Cape Metro have provoked some segments of society to protest in retaliation. The experiences of the residents have led them to believe that government only responds to violent protests and or crimes and such perceptions are prevalent in lower income areas within the Cape Metro (Paradza et al., 2010). The trust deficit is often exacerbated by alleged corruption and conspicuous crimes by councillors and municipal staff. Moreover, the abuse of power and lack of accountability from municipal employees across the country has further fuelled the strained relationship between government and the communities (Manaanga, 2012). This research study therefore sought to establish the initiatives of the City of Cape Town in resolving sewer spillages and overflows within the selected townships of study.

## **2.6 Excessive costs of maintaining sewerage infrastructure**

Tscheikner-Gratl et al. (2020) noted the importance of enhancing strategies of local authorities in tackling challenges relating to the provision of sanitation services. The maintenance of sewerage infrastructure has proven to be very costly and complex. Tcheikner-Gratl et al. (2020) further state that the government in the Netherlands spends an average of €800 million to rehabilitate sewerage infrastructure. The national treasury in South Africa (2021) allocated R49 billion for the maintenance and rehabilitation of municipal infrastructure for the 2021/2022 financial year. This confirms the argument that the maintenance of municipal sewerage infrastructure is relatively expensive, constituting a large portion of the national budget. These costs are exacerbated by criminal acts such as vandalism to municipal property. For example, in a case of a vandalised sewer pump station in the Khayelitsha Township, Limberg (2021) stated that the cost of repairs was more than R6 million which was not budgeted for in the annual budget. This study therefore investigated the measures and steps implemented by the local authority in maintaining and rehabilitating the sewerage infrastructure in the selected townships. The study aimed to explore the extent to which community members contribute to the deterioration of sanitation services townships through misuse of the services and whether the local municipality is taking the necessary steps to ensure optimal operation of sanitation services.

The administration of the City of Cape Town, through its various platforms, has committed to quadruple the budget allocated towards pipe replacement. The city has committed to spending R755 million towards pipe replacement projects across the city, based on a prioritization matrix, which considers pipe age, material and the number of collapses amongst others. The high costs associated with sewer pipe replacement and rehabilitation requires local authorities to change their approach towards this. Public funding has often been the source of funding for sewer rehabilitation projects hence these funds need to be utilized effectively for the benefit of the public.

## **2.7 Asset management of municipal sewerage infrastructure**

One of the main aims of this research study was to explore effective solutions to address the sanitation challenges experienced in the selected townships. The solutions that were considered and recommended in this study seek to improve service delivery and make a positive change in the lives of people living in the townships. Tscheikener-Gratl et al. (2020) recommended additional research to investigate new methods of multi-utility asset management for the repair and maintenance of sewerage infrastructure. Existing literature focuses solely on the rehabilitation of the sewerage infrastructure at a network (actual sewer pipes) level and excludes future implications and the sustainability of maintaining the services in the future.

Nkomo (2017) emphasised the need for government to conduct meaningful community engagements to establish more sustainable solutions to the operations surrounding the maintenance of sanitation services in the townships. This statement by Nkomo supports the idea of a multi-utility asset management that focuses beyond the physical aspect of the assets managed as suggested by Tscheikener-Gratl et al. (2020). Sutherland et al. (2020) supported the idea of an alternative approach to the provision of sewerage services by exploring a more sustainable alternative for the lower-income areas. The alternative sanitation solution investigated by Sutherland et al. (2020) was not reliant on a steady supply of water to the household as is the case in most urban areas. The authors emphasized that the successful implementation of the alternative sanitation solutions would largely be dependent on the community members. They should take responsibility and ownership of the services and protect them from damage. The challenges of sanitation infrastructure in township developments are more than just an engineering problem as lives and livelihoods are at stake.

Relevant studies conducted in the past have attempted to find cost-effective sewer infrastructure models without assessing the cost distribution and implications of conventional sewer models. Local authorities need to ascertain the root cause of exorbitant sewer costs and develop alternative asset management models to effectively maintain sewer infrastructure, particularly in lower income areas.

## **2.8 Nyanga, Samora Machel & Lower Crossroads: The context of the study**

The origins and establishment of the City of Cape Town date back to 1652 when the Dutch East India Company developed a refreshment station for ships travelling through Southern Africa. The natives at the time provided cattle with no labour, therefore slaves were brought mainly from East Africa, Madagascar and the Bay of Bengal (Axelson, 2020). The slaves brought with them their cultural practises, which were mostly founded on Islamic principles. Today, more than 50% of the



residents in the City are coloured (the former term for mixed race people) while the remaining population comprises of the various races in South Africa. Spatial planning and segregation policies from the Apartheid regime forced the various racial groups to develop independently in their allocated geographical locations.

The Group Areas Act of 1950 and 1966 further strengthened policies of racial segregation and limited the movement of people to certain geographical locations as per their race. Most of the townships that emerged from racial segregation are still in existence till. Findley and Ogbu (2011) observed that the racial profile of these townships remains the same with a few exceptions. The large population of black people were restrained to Gugulethu, Nyanga West, Nyanga as well as the Langa townships. The Khayelitsha Township was also established to accommodate black people. Axelson (2020) stated that a large influx of people from the Eastern Cape in the 80's significantly increased squatter camps and resulted in an accommodation crisis, the effects of which are still seen today.

Nyanga, Lower Crossroads and Samora Machel (formerly Nyanga West) are still predominantly black townships and the majority of the population in these areas remains unemployed (BusinessTech, 2016). These areas have become extremely dangerous. In 2021 the Minister of Police, Bheki Cele stated that most murders for the year 2021 occurred in these townships. The 3 townships are bordered by major routes in Cape Town, the R300 to the East, the N2 to the North, Jakes Gerwel (M7) to the South and Govan Mbeki Drive to the West, which makes commuting relatively easy. Infrastructure dilapidation is evident in these areas and is observed by simply driving through parts of the townships.

The issue of water and sanitation services in townships has become a topic of contention in Cape Town as most residents have voiced their dissatisfaction on various platforms. Herron (2021) stated that the City of Cape Town had more law enforcement capacity compared to sanitation service capacity. Sotashe (2021) supported this statement by highlighting that that the City had no plan to conquer service delivery challenges and address the inequalities that existed in access to basic services. Tembo (2021) however noted that the community played a role in contributing to the poor service delivery to townships. Council workers are often targeted and are robbed in the townships where they conduct maintenance activities. The City of Cape Town suspended operations in Nyanga and Samora Machel in 2021 after an incident occurred whereby one of the staff members was shot while trying to unblock a sewer line. Limberg (2021) argued that incidents such as these delay service delivery as the City prioritizes the safety of the workers and will therefore avoid putting workers at risk in volatile working areas. However, incidents such as these continue to occur in Nyanga, Samora Machel and Lower Crossroads.

Figure 2.1 below represents the locality map of the Nyanga Township on the outskirts of the City of Cape Town. It is one of the oldest township establishments in Cape Town and dates back to 1948. The township was established for black migrant workers to settle as the Langa Township had become overpopulated and too small to accommodate any more workers (Besteman, 2008). A census conducted in 2011 estimated that the population in Nyanga stood at 57 996 and 98.8% of those people were black. SAHO (2011) stated that the township became notorious for violence in the 80's, a trait that is visible to this day. Sanitation services from the municipality have often been suspended in this area due to targeted violence on the workers conducting maintenance on sewerage infrastructure (Limberg, 2021). Sewer pump stations in this township are also vandalised regularly by criminals and this results in sewer overflows and blockages that negatively affect the residents of the community. This study sought to investigate the main causes of dilapidation on the sewer infrastructure in the Nyanga Township and to assess the socio-economic impact of sewer overflows on this community. There is a total of 995 registered households within the selected study area in Nyanga and a total of approximately 5.1 kilometres of sewers within this area.



Figure 2.1: Locality map of Nyanga Township (Source: City of Cape Town website)

Figure 2.2 shows the Neighbourhood of Samora Machel, which is located on the Eastern half of Philippi. Rapid residential growth in this area began in the late 70's and early 80's when racial tensions and apartheid policies were heightened (Anderson et al., 2009). People escaping prosecution from the Eastern Cape would find refuge in Philippi as the area was largely used for



agricultural purposes. Samora Machel is bordered by the Nyanga Township on the north-western side and Lower Crossroads on the North-Eastern side. The area has become extremely volatile, and cases of violence have become a norm in the area. Limberg (2021) expressed great concern over a City of Cape Town official that was shot in the area mid-2021. This led to the suspension of sanitation services in the area as the workers' lives were at risk.

The community members in Samora have raised concerns over the state of sanitation infrastructures in the township. Mabilwana (2018) mentioned that she ultimately had to relocate her children back to the Eastern Cape as daily exposure to raw sewerage caused skin infections. Mnyakama (2018) alluded to the fact that sewer lines in Samora Machel block every single day and suggested that the pipes be upsized to accommodate the number of residents in the area. One of the objectives of the study was to determine whether the sanitation services in Samora Machel were adequate to accommodate the community members. There is a total of 989 households within the selected study area in Nyanga and a total of approximately 4.4 kilometres of sewers within this area.



Figure 2.2: Locality Map of Samora Machel Township (Source: City of Cape Town website)

Figure 2.3 shows the locality map of the Lower Crossroads Township as well as the location of Nyanga and Samora Machel (Philippi) in relation to Lower Crossroads. Crossroads is one of the largest townships in Cape Town and borders Nyanga, Philippi, Heideveld, Gugulethu and Mitchell's Plain. The establishment of the township dates back to 1977 when workers from a nearby farm were evicted and told to settle on what is now known as Crossroads (South African History Online, 2022). At the time, approximately 18000 people were observed to be residents of the township. City Council declared Crossroads as an emergency camp in 1978 and started

supplying basic services to the people. The government also focused on destroying informal settlements in the area and encouraged people to build decent housing on freestanding plots (origin and track record, 2012). A census conducted in 2011 estimated the population in Crossroads to be 36043. These numbers are expected to have dramatically increased over the years. There is a total of 986 registered households within the selected study area in Nyanga and a total of approximately 4.5 kilometres of sewers within this area. As mentioned previously, the City of Cape Town boasts an amazing sewer network of pipes in excess of 9 000 kilometres and manholes in excess of 200 000. This is to service a total population estimated at 4.5 million and this number is expected to increase exponentially.

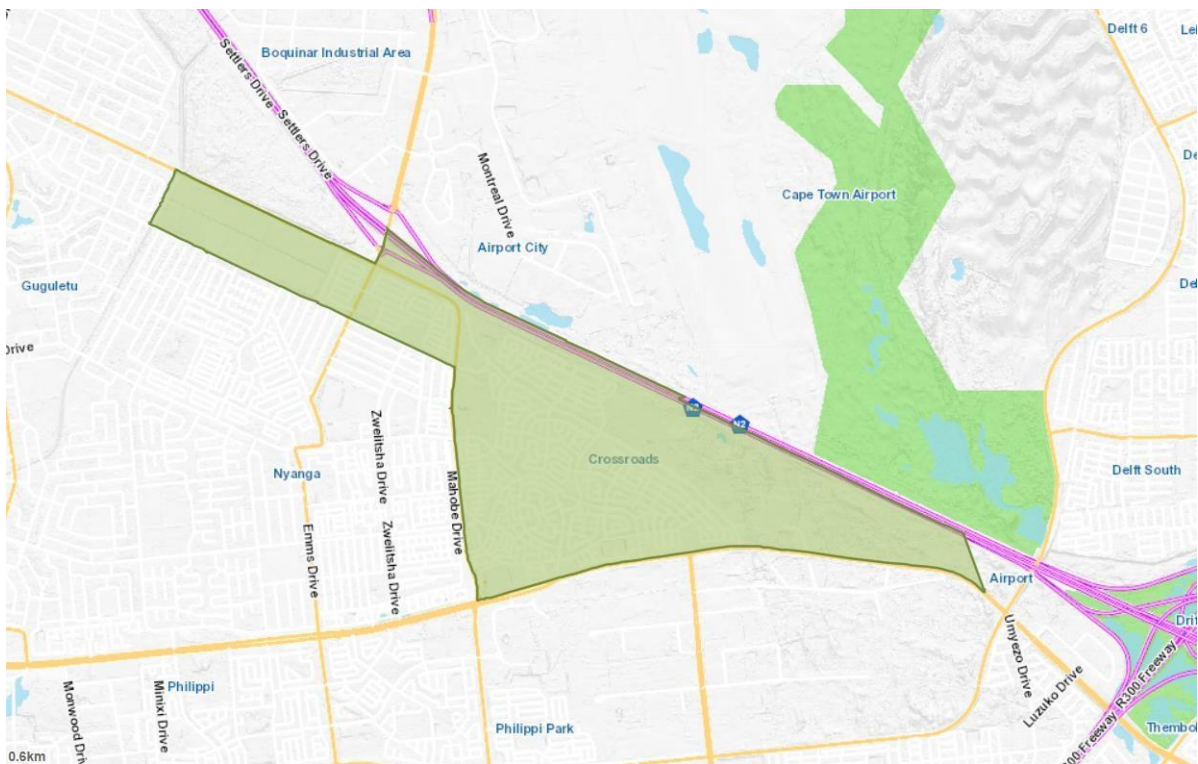


Figure 2.3: Locality Map of Lower Crossroads (Source: City of Cape Town website)

## 2.9 Theoretical Framework

In this study, the aim was to conduct a conditional assessment of the sanitation services within Nyanga, Samora Machel and Lower Crossroads, which are township developments in Cape Town. The main subjects of interest were the causes of dilapidation on the sanitation infrastructure in lower income areas as well as the effect of the sewer overflows on the lives of the people living in these areas. The theory that was used to help understand the topic of study was the Theory of Planned Behaviour (TPB). This theory was developed with the intention to explain all behaviours over which people have the ability to exert self-control (LaMorte, 2022). This theory has previously been able to predict and explain a wide range of human behaviours. Therefore, it was vital in

determining the reasons why residents in the selected area of study use sanitation services in the manner that they do. LaMorte (2022) further highlighted that this theory comprises of six constructs that lead to a person's control over their behaviour:

- Attitudes
- Behavioural intentions
- Subjective norms
- Social norms
- Perceived power perceived behavioural control

Parkpour et al. (2014) state that the theory of planned behaviour is not without its limitations as this theory does not account for other influences that can affect behavioural patterns such as fear, past experiences, mood or behavioural intention. Although the former may be true, the theory of planned behaviour could also be useful in understanding why communities exert themselves in certain ways. Therefore, this can help assist authorities understand why certain occurrences occur within township developments. Many actions or inactions are as a result of past experiences and this theory provided clarity in terms of why and how residents in the selected townships misuse sewer services in the manner that they do. It would be a fair assumption to assume that residents were and remain unaware of the correct use of sewer and other sanitation services.

The fundamental basis of the theory of planned behaviour is the assumption that intentions influence behaviour, and the way humans exert themselves. In contrast, a study conducted by Kor and Mullan (2011) found intentions to be a poor predictor of behaviour as there was an insignificant correlation between intentions and behaviours. A practical example would be the fact that although a person might have the intention to steal something, they might not carry through with such intentions as the consequences of such actions outweigh any possible gains of that action. The theory of planned behaviour was the theoretical framework upon which this research study was conducted.

## **2.10 Gaps in Literature**

The topic of service delivery and infrastructure dilapidation in South Africa is a complex topic that has attracted much attention. A vital strength of this research study is the fact that it was conducted using both a qualitative and quantitative approach. It assessed both the experiences of the local authority staff and that of the community members. Nkomo (2017) advocates for government and local authorities to collaborate in identifying amicable solutions to improve service delivery to township developments. This view is supported by Chikulo (2016) and is further supported by the

Municipal Systems Act. 2000 (Act 32 of 2000) that provides for community involvement in municipal planning and development. Such interactions are undertaken through Ward committees established in line with the aforementioned legislation. In addition to the above, previous research focused on other parts of the country negating township developments within the Cape Metro. This study focused purely on the Nyanga, Samora Machel and Lower Crossroads townships that have experienced a plethora of service delivery protests in recent times.

The results and observations of this study could lead to more research that focuses on specific services within the civil engineering discipline. Additionally, it could assist in shifting local authorities' focus on specific services within the service delivery spectrum. Previous research has categorised service delivery into a single umbrella however certain challenges are specific to certain services within the service delivery spectrum. For example, challenges with regards to sewer overflows cannot be compared to challenges with the provision of potable water. Sewer blockages and the resultant spillages have garnered much attention in South Africa and the focus of these studies have been to criticise government on the failures of the infrastructure post 1994.

Tscheikener-Gratl et al. (2020) have previously advocated for further research to be conducted focusing on sewer infrastructure and the high costs of maintenance associated with it. In South Africa, the rapid rate of infrastructure dilapidation and the common occurrence of sewer overflows have led researchers to believe that the government is not capable of managing the resources that were developed by the apartheid government. Such assertions may not be fair as the dynamics have changed significantly between pre- and post-Apartheid South Africa. Nevertheless, research that focuses on particular township developments and various settlements around the country could assist authorities to determine the root cause of the dilapidation that has been experienced on the civil engineering infrastructure intended to service the community. Sanitation services have been neglected in most parts of the country and authorities have experienced many challenges in the provision of such services. Therefore, research studies could offer solutions to improve the challenges faced in these areas.

## **2.11 Conclusion**

The issue of sanitation infrastructure dilapidation is one that has received global attention over the past few years. Many scholars have explored ways to improve the provision of sanitation services and alleviate the issues that have arisen over the years. The Nyanga, Samora Machel and Lower Crossroads townships have experienced severe cases of sewerage overflows in recent times. A significant proportion of townships were established decades ago and the general assumption from the public is that the local municipality is not doing enough to address their concerns. The

City of Cape Town has committed to increasing its budget for sewer rehabilitation, in order to replace old, dilapidated services.

Sewer overflows adversely affect the health and well-being of the residents in the affected communities. The condition of most sewer infrastructure in townships remains unknown and one of the main aims of this study is to ascertain the condition of the sewer infrastructure in the selected townships. This study also seeks to identify the causes of the dilapidation of sewer infrastructure in an attempt to propose solutions to address sanitation challenges experienced in the selected townships. The aim of this study is to determine the socio-economic impact of sewer spillages and overflows on people's lives.

The services that were installed by the apartheid government to service township developments was intentionally underdeveloped to ensure the continued oppression of certain segments of the population. These substandard services and the continued misuse of such services have resulted in substantial challenges that are prevalent in lower income areas. The effects of apartheid spatial planning policies are still visible in the present day as government, has not improved the quality of services as was intended at the dawn of the new South Africa. Significant population growth and the sporadic increase in informal settlements have further placed the sanitation services under significant pressure.

## CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

### 3.1 Introduction

This chapter outlines the research design and the methodology used to obtain data. Data analysis methods are discussed in depth in this chapter together with the various models used to analyse the data.

### 3.2 Research design

Spector (1981) describes research design as a summary of all the basic values of experiential and non-experiential design in social knowledge. On the contrary, Yin (2010) defines research design as a set of opening questions, which the research intends to address and give conclusions. The primary objective of this research study was to conduct a condition assessment of sanitation services in the selected townships. In order to do this, the following secondary objectives had to be attained:

- To assess the current state of sewerage infrastructure in the selected townships in Cape Town (Samora Machel, Nyanga and Lower Crossroads).
- To analyse the annual costs of protecting and repairing dilapidated sewerage infrastructure in the selected townships.
- To assess the causes of the dilapidation of the sewerage infrastructure in the Samora Machel, Nyanga and Lower Crossroads Townships.
- To explore the socio-economic impacts of the sewerage infrastructure dilapidation on the lives of people in Samora Machel, Nyanga and Lower Crossroads Townships.
- To explore and recommend possible solutions to remedy the dilapidation of the sewerage infrastructure in Samora Machel, Nyanga and Lower Crossroads Townships.

The selected study area was the Cape Metropolitan, and the selected townships were Nyanga, Samora Machel and Lower Crossroads. For the study to be completed, the following steps were taken and had to be completed in the following manner:

- A desktop study was undertaken to review data from other researchers. The researcher reviewed information obtained from academic books, journals, articles as well as the World Wide Web. Data from the City of Cape Town's database was also reviewed.



- Observations were then conducted at the various townships. The observations assisted in ascertaining the conditions on the ground and establishing the frequency of sewerage overflows in real time.
- Surveys and questionnaires were then distributed to ascertain the socio-economic impact of sewer overflows on peoples' lives. The questionnaires were distributed electronically in line with COVID-19 restrictions.
- The data was then presented after analysis which entailed comparing new and old data.

The methods used for each objective are outlined below:

**To assess the current state of sewerage infrastructure in the selected townships in Cape Town (Samora Machel, Nyanga and Lower Crossroads):**

The City of Cape Town's database of service requests logged to the city was used. This assisted in identifying trends in common causes of blockages in the affected communities. Closed-circuit television (CCTV) footage and reports of the sewer infrastructure in the study area were also used to determine the physical internal condition of the existing sewer infrastructure. This constituted a portion of the secondary data used in this research study, summarized using tables and graphs to ascertain the common causes of blockages. Consent to use the database was obtained from the City of Cape Town. The data of service requests is updated constantly to reflect information as accurately as possible. Therefore, data was collected from the database between the period January 2019 – October 2021. The database was obtained in the form of an excel spreadsheet and could be filtered to reflect maintenance done in a particular area within the Cape Metro. The service requests or sewer-related complaints logged for the selected study area between January 2019 – October 2021 were analysed.

**To analyse the annual costs of protecting and repairing dilapidated sewerage infrastructure in the selected townships in Cape Town (Samora Machel, Nyanga and Lower Crossroads):**

The City of Cape Town database was used to determine the annual cost of repairs to the sewer infrastructure from an operations perspective. The cost of all administration, labour, material, and supervision was extracted from the database. The database summarizes the resources used for each maintenance activity and attaches a cost to all maintenance activities. Costs involved in resolving each service request that was logged between January 2019 – October 2021 were added together for each respective financial year and summarized in the findings of this research project. This was done in conjunction with the first objective as the spreadsheet

summarized the information required and classified it into one single database. Data collected from the City of Cape Town's database was manually analysed.

**To assess the causes of the dilapidation of the sewerage infrastructure in the Samora Machel, Nyanga and Lower Crossroads Townships:**

This research study employed a mixed method approach that constitutes both qualitative and quantitative approaches. Interviews were held with ward-councillors and senior staff in the municipal sewer depots to determine the root cause of the dilapidation experienced in the sewer infrastructure. The ward-councillors and the municipal depot staff were familiar with the current condition of the sewerage infrastructure in the study area, therefore the interviews provided qualitative data and deep insight into the matter at hand. Three ward-councillors and six depot staff members were interviewed. The City of Cape Town's database was used to identify the root cause of the dilapidation experienced in the sewer infrastructure. The interviews were conducted between November and December 2021 after the rain period had passed. Sewer depots experience an influx of service requests during the rainy season, which could have limited the possibility of interviews. Information collected from the interviews was analysed using Atlas.ti.

**To explore the socio-economic impacts of the sewerage infrastructure dilapidation on the lives of people in Samora Machel, Nyanga and Lower Crossroads Townships:**

The study adopted a mixed research approach, therefore both quantitative and qualitative research methods were used. The quantitative research approach involved the statistical analysis of collected data (Muijs, 2010). A structured questionnaire was used to collect data on the socio-economic impact of sewer spillages on people's lives in the affected communities. The questionnaire was designed based on literature review and previous surveys, which were used to investigate similar aspects (see Appendix A). This data collection tool fell under the primary data collection method, which relied on data collected by researchers through fieldwork (McCrocklin, 2018). In addition, before the actual data collection exercise was undertaken, a pilot study was undertaken with community members from a different area as this helped to identify and address any potential problems. Ten residents from Khayelitsha, a township in Cape Town, were used during the pilot study as similar sanitation challenges exist in the township. The respondents from Khayelitsha community members that were willing to participate in the study. It is important to note that results from the pilot study were not used during the analysis of the data. This also offered an opportunity to verify the usability of the questionnaire and to identify ways to simplify it and ensure the survey is sufficient in gathering the intended information. The surveys were conducted between October 2021 and December 2021 to allow sufficient time to

distribute the questionnaire to 150 participants. Fifty participants from each of the three townships were requested to participate in the study. Data received from the surveys was analysed using SPSS version 27.

The researcher recruited a team of 3 fieldworkers that resided in the selected townships They were identified with assistance from the ward councillor The fieldworkers were trained in the distribution of the surveys and responding to participant's questions. The fieldworkers were encouraged to observe COVID-19 health protocols to remain safe during the fieldwork and prevent the spread of the Corona virus. The use of an online questionnaire was prioritized to prevent any physical contact between the fieldworkers and the participants. A Google form was created for the purpose of the study and was administered by the researcher.

Sampling, in the context of this study refers to selecting people from which data would be collected and analysed. Random sampling was used to select participants and participants participated on a willing basis and could withdraw from the study at any time. The responses received from this group of participants represented the whole population of the study area as most residents in this area were affected by the same challenges. Turner (2020) defines sampling as a process of selecting a group of the population of interest to include in a research study. It would not be feasible to conduct a study of everyone due to time and cost constraints. The survey was conducted using the non-probability convenience sampling method that allowed the researcher to consider participants that were willing and available to participate in the study. The sample consisted of residents from the selected townships that were willing to participate in the study. The townships that were covered by the study were perceived as dangerous and unsafe, therefore the researcher was required to mitigate all safety risks during the study. The surveys were created using Google documents and circulated to the residents electronically. The field workers assisted to ensure that the participants understood the questions asked. The ward-councillor assisted in identifying potential participants to partake in the study as the councillor resides in the study area and is familiar with the residents. Only participants that were accessible were interviewed during this study.

Before commencing with data collection, the participants were briefed of the contents of the study and were informed that participation in the study was voluntary. The participants were given the opportunity to withdraw from the study at any time and were informed that their personal information would be kept private and used for the purposes of the study only. The rights of the participants were respected at all times and no one was coerced to participate in the study against their will.

Isaac and Michael (1981) provide a table that is valuable in determining a representative sample size from a given population size. To achieve a 95% confidence level with a population size of 165,677, the researcher intended to collect data from a total of 150 participants from the three selected townships. This was achieved when 50 participants from each township participated in the study.

**To explore and recommend possible solutions to remedy the dilapidation of the sewerage infrastructure in Samora Machel, Nyanga and Lower Crossroads Townships:**

Possible solutions were recommended based on the findings of the root cause of dilapidation experienced in the sewer infrastructure. Best practise solutions were explored in this research study through a desktop study and summarized according to the main causes of blockages in the sewer infrastructure in the study area. This exercise was conducted during the period January 2022 – February 2022 once the main causes of blockages had been identified and ascertained. The researcher also analysed relevant sources and summarized the important key considerations from previous research to construct the literature for the study. Published document texts (secondary data) were the main input sources for the literature. This assisted the researcher in establishing debates surrounding the study's topic. Peer-reviewed journal articles, government policies and publications as well as internet sources were the main source of information for the literature of this study. Literature compiled by other researchers in different areas was used to identify trends that exist in particular regions as well as recommendations that were applicable for study.

Figure 3.1 illustrates how the research project was undertaken. The study employed a mixed approach to achieve the expected project outcomes. The study entailed conducting research into the causes of dilapidation on the sewer infrastructure in the selected townships and how sewer blockages and overflows affected the lives of the community members.

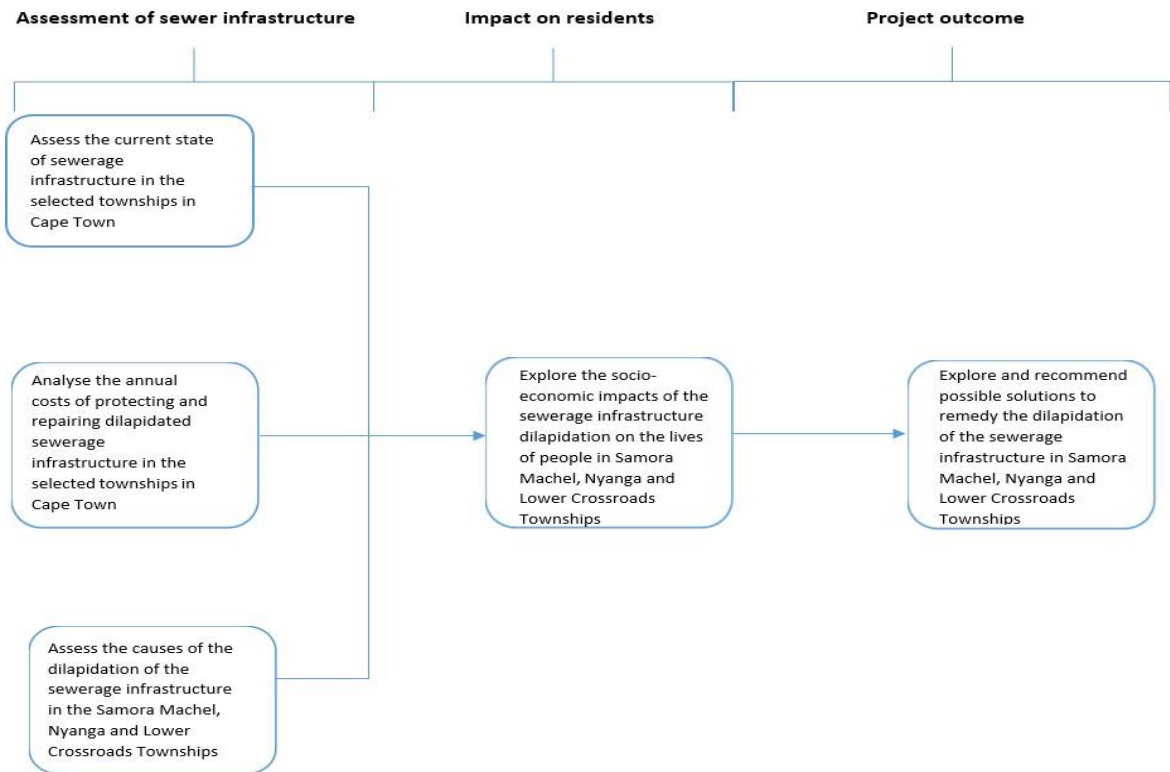


Figure 3.1: Summary of the research study

### 3.3. Sampling

No research can investigate all the parameters of a certain topic (Miles and Huberman, 1994:27). Quantitative research does not often use probability sampling but rather relies on some form of deliberate sampling. Purposive sampling was employed for this research study. Purposive sampling is sampling done in a deliberate way with an objective in mind. The sample group of people that participated in this research study consisted of people from various ethnic and social groups, which enabled the researcher to formulate suitable conclusions based on people from various backgrounds. Respondents of the questionnaires in this research study included residents residing in the selected townships, irrespective of their ethnic and social backgrounds.

Sample area refers to the area in which the study was conducted. This research study was limited to the three selected townships, which are Nyanga, Samora Machel and Lower Crossroads. These townships are in the City of Cape Town and were predominantly developed during the Apartheid era for black workers employed in the city. The study was limited to this sample area due to time constraints and project feasibility and manageability. These townships were selected for the following reasons:

- The townships were developed as a result of segregation policies and a significant portion of the sewer infrastructure in these townships was poorly developed and designed.
- The sewer infrastructure in these townships is at an advanced stage in its lifecycle and is showing some signs of dilapidation.
- The selected townships have experienced an exponential population growth in recent times. The number of backyard dwellers in these townships have also increased in recent times.
- The townships were developed predominantly for black people and the population has not diversified much, with a few exceptions in certain instances.
- The three townships were found to be located within Region 4 of the City of Cape Town's water and sanitation demarcations, which made data collection much easier.
- Numerous service delivery protests have occurred in these areas due to poor sanitation infrastructure.

### **3.4 Data collection**

Data refers to information that has been collected and processed into information that is understandable to a reader. The raw data used in this research study was collected through questionnaires as well as interviews conducted with councillors and depot staff working for the City of Cape Town. A questionnaire is a series of questions with a series of answers from which a person can select the most appropriate answer (McLeod, 2017). The two main types of questions employed in questionnaires are close-ended and open-ended questions. Close-ended questions are associated with quantitative research while open-ended questions are associated with qualitative data. In the context of this research, the questionnaires formed part of the quantitative research method while the interviews formed part of the qualitative research method. The researcher distributed the questionnaires electronically and was available to assist the respondents with any queries that they had. The researcher was also assisted by the ward councillors as well as members of the community that had an interest in the study. Voluntary participation was key, and participants were free to withdraw from the study at any time.

The broad ethics issues that could have potentially affected the research study were voluntary participation, informed consent, confidentiality, anonymity and potential harm to the participants. The participants were well informed of the study and could withdraw from the study at any given time. The study aimed at protecting the participants at all times and avoided causing any physical

or mental harm to the participants. Participants were also provided a consent form to be signed confirming that the contents of the study were explained to them thoroughly. The research study sought to cause no environmental damage and all questionnaires were distributed electronically to avoid and reduce the possibility of risk scenarios occurring. All potential conflicts of interest were monitored to ensure that the study remained objective and ethical clearance to conduct the research study was obtained from the Cape Peninsula University of Technology's Ethics Committee.

### **3.5 Research instruments**

Data was collected through questionnaires which were structured as follows:

- Part 1 – Demographic profile
- Part 2 – Sewerage overflow experiences
- Part 3 – Health problems caused by sewerage overflows
- Part 4 – Impact of sewerage overflows

The interviews were conducted by the researcher to gain insight into the socio-economic impact of sewer overflows on peoples' lives. There are four types of interviews, namely informal conversations, interview guide method, standard open-ended and close-ended questions (Paton, 1980). This research study used open-ended interview questions where the opinions and expressions of the participants is important.

### **3.6 Data analysis and presentation of results**

Data was analysed using the Statistical Package for Social Sciences (SPSS). This method of analysis is used to analyse quantitative data. SPSS is a comprehensive analysis tool used to analyse raw data. The system is able to capture data from any file and use the information to generate graphs and tables, plots of distribution and trends as well as descriptive statistics. The data collected through the questionnaires was analysed using SPSS and the data collected from the interviews was analysed using themes. Thematic analysis is used to identify, analyse and report patterns within data (themes). The findings were then presented using graphs and tables.

## **CHAPTER 4: RESULTS AND DISCUSSION**

### **4.1 Introduction**

The previous chapter described the research methodology, research instruments and the data analysis method. Chapter four presents results obtained from the questionnaires and surveys conducted on the three selected townships in Cape Town. This chapter focuses on the presentation of the research findings from the survey questionnaires through the use of tables, graphs, pie charts and descriptive summaries in line with the research objectives.

### **4.2 Demographic profile of respondents**

This section presents the demographic profile of the community members that reside within the affected communities. The aspects that were analysed in terms of demographics include gender, age, historical racial classification as well as highest level of education of the respondents.

#### **4.2.1 Gender**

Figure 4.1 below shows the gender distribution of the community members that reside in the selected townships that were willing to participate in the study. The gender distribution revealed that more females participated in the study as compared to males. This could imply that females are more concerned about community issues in their respective townships. In contrast, this could also imply that the males often have to work in industries in the city centre and have less time to interact with online surveys. The data was collected from 117 respondents. Research has shown that there has been a greater drive to include females in research studies, possibly due to the fact that females were previously disadvantaged in areas of education, research and policies (van der Graaf et al., 2018). Smith (2008) conducted a study which confirmed that females are more likely to participate in online surveys due to the manner in which the different genders interact with the internet. The findings by Smith concur with the observations made in this research study as 58% of the respondents were female while only 42% of males participated in the study.

In contrast, a study conducted by Otufowora et al. (2021) revealed no link between gender and participation in online surveys. The study also revealed that people participate in studies that interest them and found it difficult to correlate and generalize the link between gender and participation in online surveys.



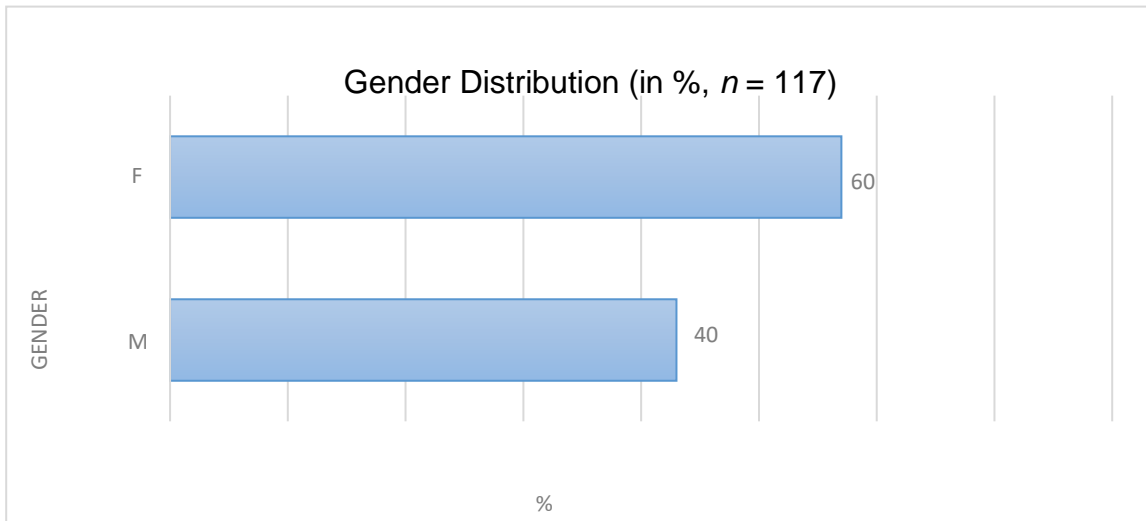


Figure 4.1: Gender distribution of the respondents

#### 4.2.2 Age of the respondents

Table 4.1 presents the age distribution of the participants that participated in the study. The participants' age ranged from 18 years - > 60 years with a mean age of (38). Examining the age group categories closely, it is clear that mostly middle-aged to more senior members of the community participated in the study. The study results suggests that the middle-aged to elderly population have a vested interest in finding solutions to reduce sewer spillages in the selected study area since only 21.3% of the respondents were aged between 18– 30 years. According to Statistics SA (2016) only 30% of the population in the City of Cape Town is aged between 31 – 50 years while the mean age is 29 years. In this research study, an overwhelming percentage of the respondents were aged between 31 – 50 (68.4%)

Table 4.1: Age of the respondents

Age	Frequency	%
<20	2	1.7
21 – 30	23	19.6
31 – 40	43	36.8
41 – 50	37	31.6
51 – 60	11	9.4
>60	1	0.9
Mean = 38 years		

### 4.2.3 Historical racial classification

Figure 4.2 gives an indication of the racial classification of the respondents residing within the three selected townships. Racial classification data presented below was taken from the chosen sample size and the study was conducted with the intention of ensuring representation of all races. In Cape Town, the common racial classification groups are Black, White, Coloured, Indian, Asian and other. The results revealed that an overwhelming majority of the respondents were Black (n=117); 85.5%) while the remaining respondents were Coloured (14.5%, n = 117). This is consistent with the findings of Sotashe (2021) that townships were predominantly developed to accommodate black people employed in industries in the City Centre. No White, Indian and Asian people participated in the study, and none were observed during visual inspections conducted in the area of study.

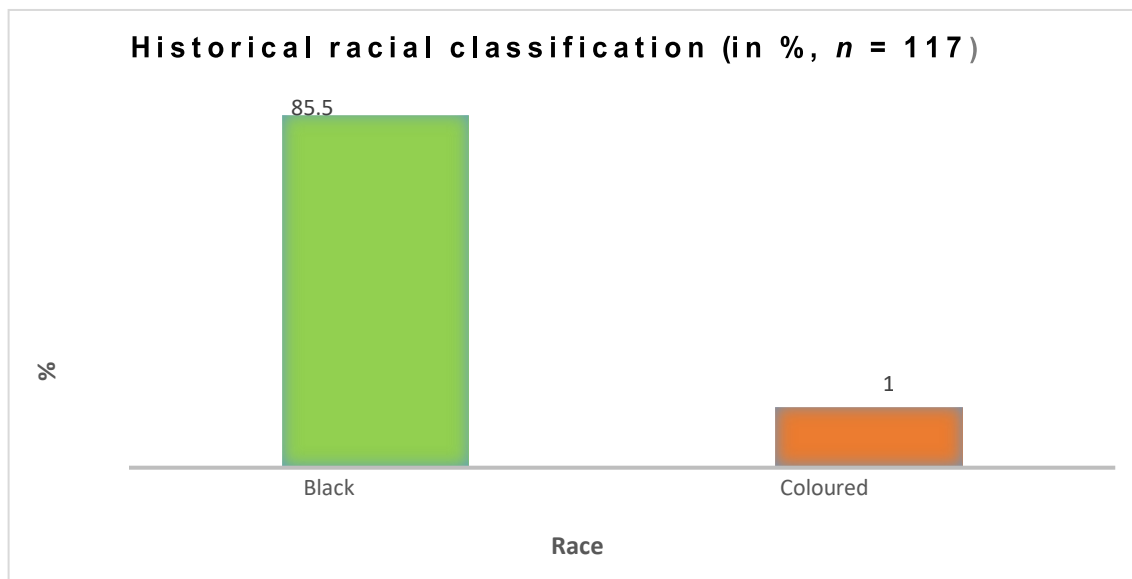


Figure 4.2: Historical racial classification of the respondents

### 4.2.4 Highest level of education

The respondents were asked by the researcher to comment on the highest level of education received. Figure 4.3 below depicts the answers given by the respondents.

Kim and Chalip (2004) observed the role education levels play in informing decisions and behaviour. Higher education levels allow the respondent to grasp concepts that affect communities and motivates them to participate in online surveys intended to provide solutions to challenges that affect them daily. Upon closer observation, 47% of the participants in this research study had completed their secondary schooling while another 31% had completed their diplomas. A community survey conducted in 2016 in the City of Cape Town revealed that 36% of the general

public in Cape Town had completed their secondary schooling while only 6% of the population had completed their undergraduate studies (The Institute for Security Studies, 2019). This is in contrast to the results of this research study as 31% of the respondents confirmed obtaining their undergraduate qualifications. Education levels also play a pivotal role in the manner in which the general public uses or misuses critical infrastructure intended to service their respective communities (Limberg, 2021).

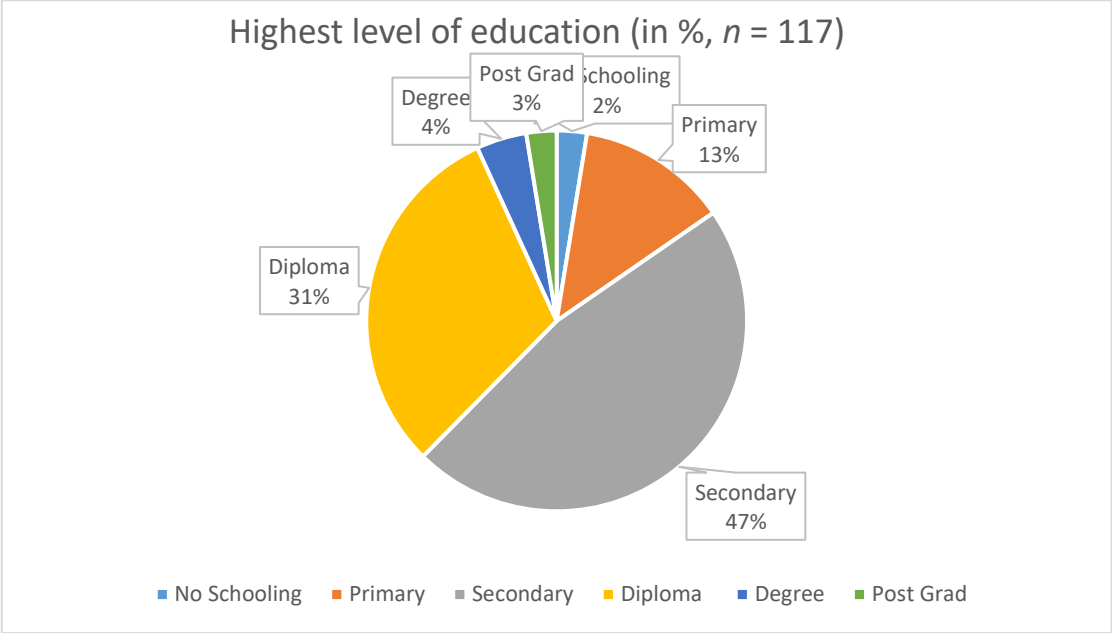


Figure 4.3: Highest level of education received by the respondents

**4.2.5 Place of residence**

The researcher requested the participants to indicate their respective places of residence in order to ascertain the representation of each township in this research study. Figure 4.4 below gives an indication of the representation of respondents from each township. The respondents were almost evenly spread across the three selected townships as 31.7% of the participants resided in Samora Machel while 35% resided in Nyanga and the remaining 33.3% resided in Lower Crossroads.

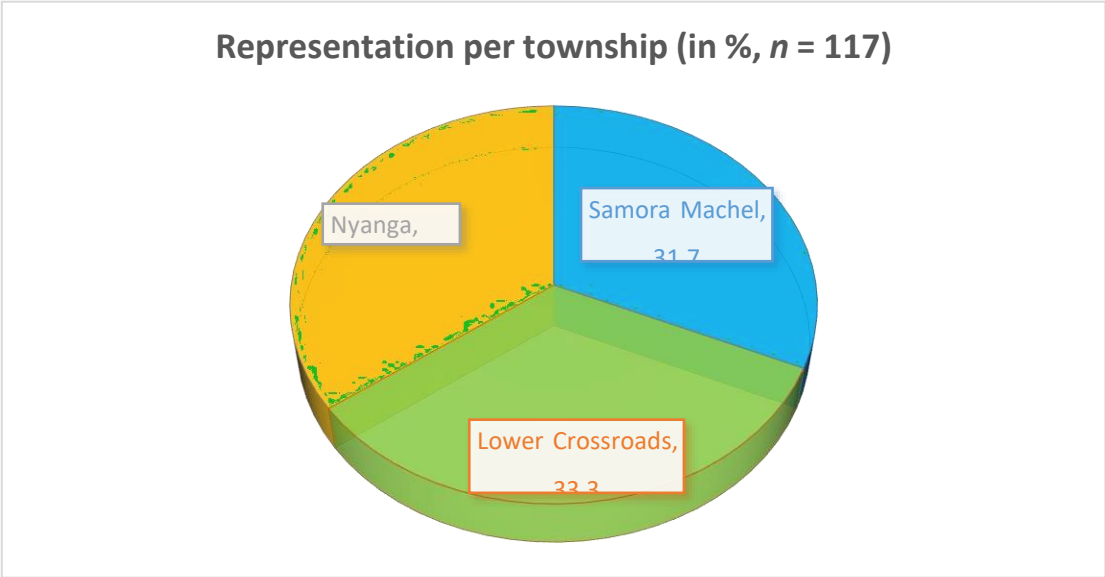


Figure 4.4: Representation per township

The respondents were also asked to comment on the duration of their residency in their respective township settlements to determine how long they had faced these sanitation challenges. The majority of residents have resided within the selected area for a period longer than 5 years, therefore it could be assumed that these residents have been faced with these challenges for some time. Figure 4.5 below gives an indication (in %) of the various periods during which the participants have resided in their respective township. 47.9% of the respondents have resided within the study area for a period greater than 10 years while only 0.8% of the respondents have stayed within this area for a period less than or equal to a year.

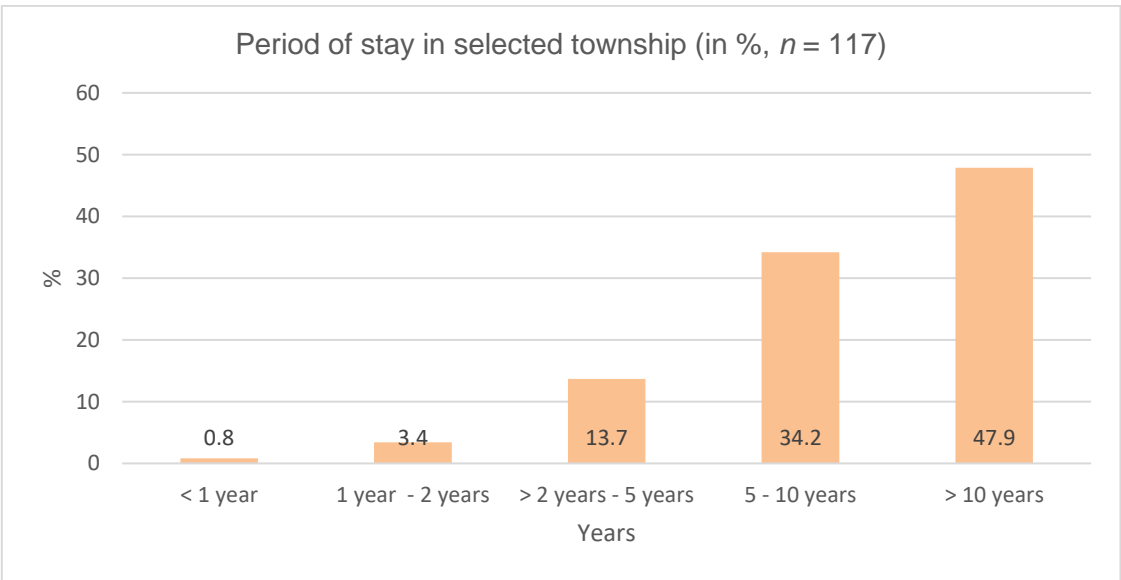


Figure 4.5: Period of stay in respective townships

### **4.3 Assessment of the sewerage infrastructure in the selected townships:**

This section focuses on the state of the sanitation services in the selected townships. The most common indicators of dilapidation of the sewerage infrastructure are presented in this section and the tables and graphs were aligned with the research aims and objectives of the study.

#### **4.3.1 Current state of sewerage infrastructure in the selected townships in CapeTown**

Figures 4.6, 4.7 and 4.8 represent the C3 notifications that were logged for the Lower Crossroads, Samora Machel and Nyanga townships respectively. The figures give an indication of the number of complaints that were logged to the City as a result of sewer-related faults. The complaints were logged by the residents using the relevant fault-logging channels provided by the City of Cape Town, which include WhatsApp, SMS, landline as well as the City App. All three townships were found to drain to various interceptor sewers and so the challenges experienced in the townships were independent of one another.

The most common sewer-related challenges experienced in the townships are foul smell, broken pipes, faulty pump stations, sewer overflows and missing manhole covers. Most of the sewer overflows in these areas are caused by rags and foreign objects, which are disposed by residents into critical sewer infrastructure. The rags entwine and form a compacted bundle that lodges so firmly in the sewer that it takes several days to clear the blockage. In extreme scenarios, the blockages caused by rags in the sewers cannot be unblocked, requiring the teams to excavate several meters down to the pipe to remove the section blocked with rags. This is self-inflicted damage by the residents, which takes critical water and sanitation resources away from other proactive maintenance activities. The rags also entwine with critical infrastructure in sewer pump stations, which results in a malfunction of the pump station and results in exorbitant expenditure to fix the pump stations.

Upon close observation, the results reveal that sewer overflows have been the leading challenge experienced on the sewer reticulation infrastructure in the selected townships. In 2019, Lower Crossroads observed 194 sewer overflows, while Samora Machel observed 53 sewer overflows and Nyanga observed 836 sewer overflows. In 2019, a report submitted by Region 4: Wastewater Conveyance to Subcouncil 14 confirmed that there were no capacity constraints on the sewers in the Nyanga and Gugulethu area and that 1244 sewer-related notifications submitted to the City were as a result of rags in the sewer line. Again, this is due to the misuse of sewer services by the residents.

In 2020, Lower Crossroads observed 101 sewer overflows while Samora Machel observed 245 overflows and Nyanga observed 67 overflows. Several informal settlements emerged during 2020 when the country was placed on lockdown to curb the spread of the COVID-19 virus. Many of these settlements were seen throughout Lower Crossroads and Samora Machel as Nyanga is one of the oldest townships in Cape Town and most of its land has already been developed. In 2020, informal settlements in Cape Town represented 4.2% of the developed inhabitable areas where people lived, and this number is expected to rise in the near future due to accommodation challenges experienced through most metros in South Africa (Cinnamon & North, 2023). A motion of exigency tabled by Subcouncil 14 for the sewer spills in Nyanga and Gugulethu also revealed that more response teams had been allocated to or utilised in the Nyanga area, which included a jet-machine, a combination unit and two crew cabs with a minimum of 4 people on board equipped with steel plumbing rods to manually unblock pipelines. This reduced the overflows experienced in Nyanga significantly.

In 2021, Lower Crossroads observed a record-breaking 2338 sewer overflows reported in a single year. This coincides with a total of 48 days of loadshedding that was experienced throughout the year in 2021. All sewer reticulation in the Lower Crossroads area drains towards various pump stations in this area and rampant loadshedding definitely had an impact on the operations of the pump stations. Numerous residents in these townships were retrenched or shifted to remote work, which could imply that more illegal dumping of foreign objects into sewers could have been experienced. In 2021, Samora Machel observed 57 sewer overflows while Nyanga observed 469 sewer overflows. This meant that sewer overflows were on the rise in Nyanga and significantly lower in Samora Machel. A number of sewer repairs and rehabilitation projects had been undertaken in the Samora Machel area while community unrest in the Gugulethu/Nyanga area had led to the disruption of a critical sewer rehabilitation project in 2021 (Limberg, 2021). Disruptions to planned sewer rehabilitation projects delay service delivery and result in fruitless and wasteful expenditure.

Due to the high volume of C3 service requests within the region, many of the operations teams were working on a reactive basis without having any additional resources to work proactively by doing programmed cleaning of sewers.

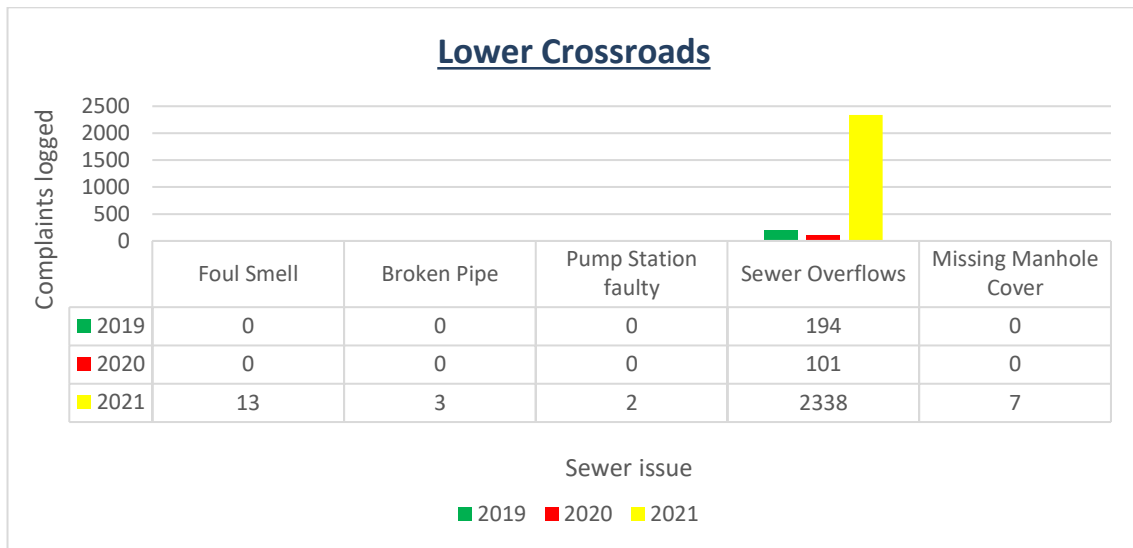


Figure 4.6: number of C3 complaints logged in Lower Crossroads between 2019 – 2021

The C3 notification data captured in Figures 4.6, 4.7 and 4.8 is largely dependent on the customers logging faults through the City’s platforms, this is the only way in which the teams can be aware of the faults in the various areas. The City of Cape Town’s C3 process is as follows:

- Customer will observe an overflow and log a call through the City’s channels.
- The call centre will receive the call and generate a reference number, which is sent to the client for status reports on the fault reported.
- The Technical Operations Centre will receive the call and dispatch it to the relevant depot.
- The depot will receive the request and assign a team to investigate. Once complete, the teams will report on the cause of the blockage and close the request. The client is kept up to date on the progress of the request.

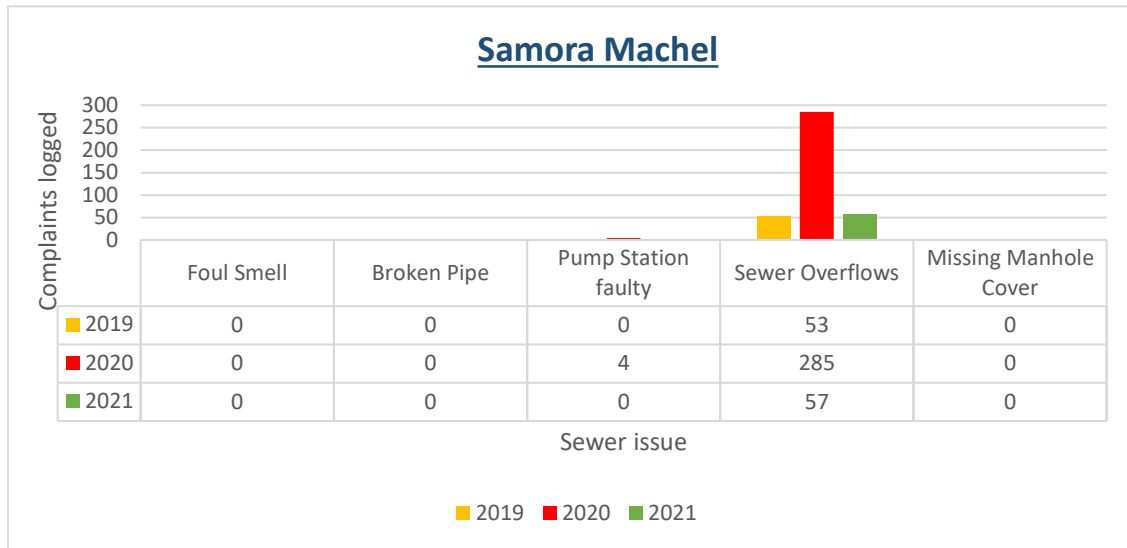


Figure 4.7: Number of C3 complaints logged in Samora Machel between 2019 – 2021

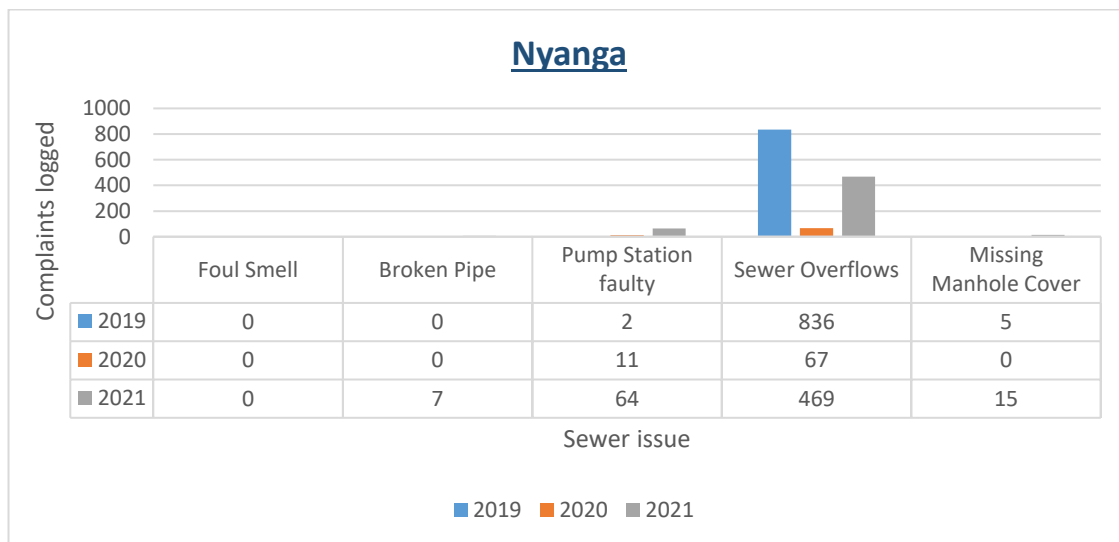


Figure 4.8: number of C3 complaints logged in Nyanga between 2019 – 2021

The C3 notifications summarized above for the various townships could be perceived as being biased based on the number of complaints logged by the residents therefore, the researcher then asked the residents to comment on the overflows they experience in their respective areas. 35.9% of the respondents confirmed that they observe sewer overflows at least once a week in their areas of residence, while 64.1% of the respondents stated that they observe sewer overflows more than once a week in their respective areas of residence (as evident in figure 4.9 below). As mentioned previously, a number of factors can contribute towards sewer blockages, the most common the disposal of foreign objects into sewers. Although overflows do not necessarily translate to a dilapidated sewer network, the overflows observed in the selected townships are overwhelming and require attention to prevent reoccurrence. The sewer overflows threaten the



well-being of the residents in the affected areas and results in unsightly and unhygienic conditions that people should not reside in. The City of Cape Town has requested residents to be conscious of the items they dispose into the sewer network as foreign objects have been found to be the leading cause of overflows in various areas across the metro. Sewers were not designed to carry heavy, insoluble items as these often get stuck along pipe fittings and result in overflows.

As a precaution, most sewers are designed to overflow into the storm water network to reduce the effects of the overflow however this practice commonly results in the contamination of water bodies to which the storm water network drain into. The City of Cape Town’s Service Charter details the response times provided to the operations teams to deal with various faults along the sewer network and the teams are only provided 24 – 48 hours to respond to overflows throughout the metro. As mentioned previously, the City of Cape Town has taken steps to try and address service delivery as efficiently as possible however the community is also required to take ownership of the services to prevent further damage to the network and reoccurring overflows that threaten their well-being.

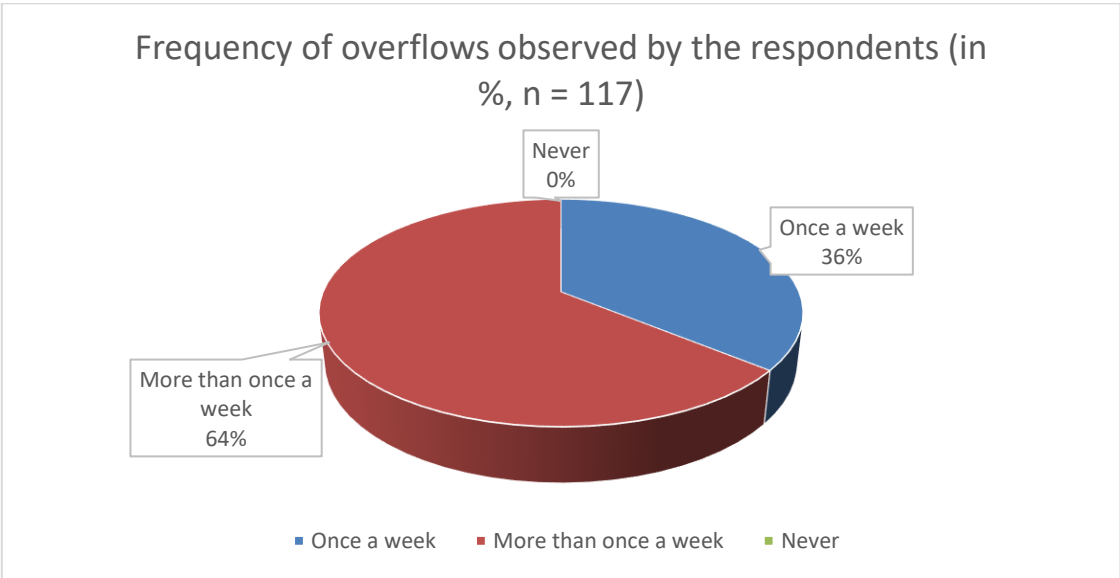


Figure 4.9: Frequency of sewer overflows in areas of residence

The residents were requested to comment on whether they commonly observe sewer overflows in their area of residence. 96% of the residents confirmed that they commonly see sewer overflows in their respective townships. Although this could suggest that the sewer network is of a sensitive nature and requires constant maintenance. Human misbehaviour and the continued misuse of sewers has often been found to be the leading cause of sewer overflows in lower income areas, particularly the selected townships in this research study. Figure 4.10 below summarized the responses that were obtained with regards to physical observations by the residents in terms of sewer overflows.

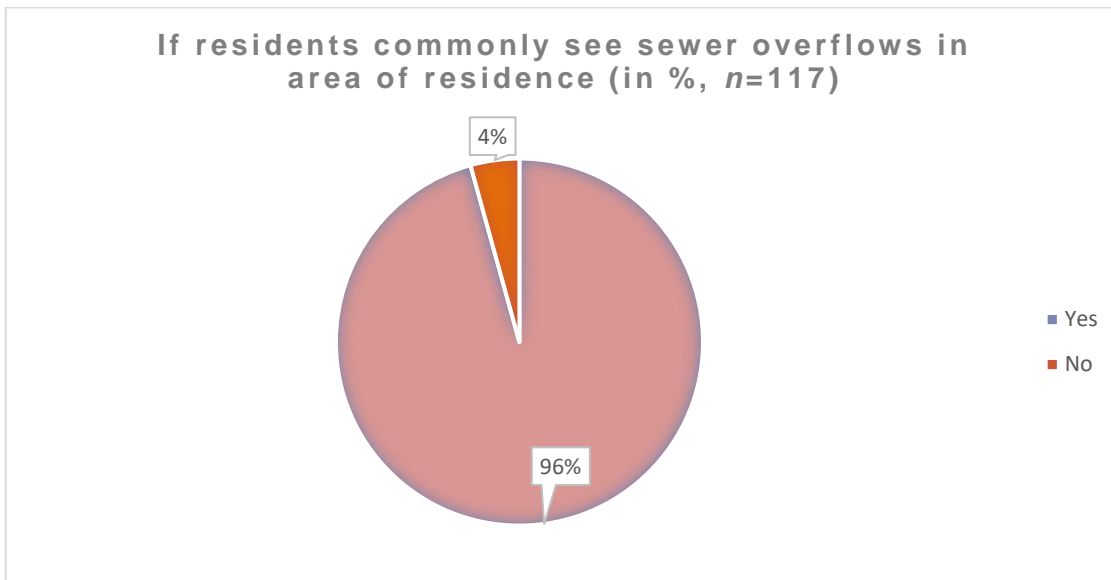


Figure 4.10: If residents commonly see sewer overflows in area of residence

The researcher also requested the participants to comment on whether they were satisfied with the level of service received from the City of Cape Town’s operations teams. Based on the challenges faced by the department, an overwhelming majority (73%) of the residents confirmed that they were satisfied with the services received from the City’s water and sanitation services while only 27% of the residents expressed disappointment in the level of services received. Based on this information, it is safe to assume that the City is making the necessary arrangements to provide service delivery in lower income areas across the metro. Figure 4.11 below confirms that the operations teams are complying with the requirements of the service charter as adopted by the City of Cape Town and that the municipality is committed to the mandate of service delivery from a water and sanitation perspective.

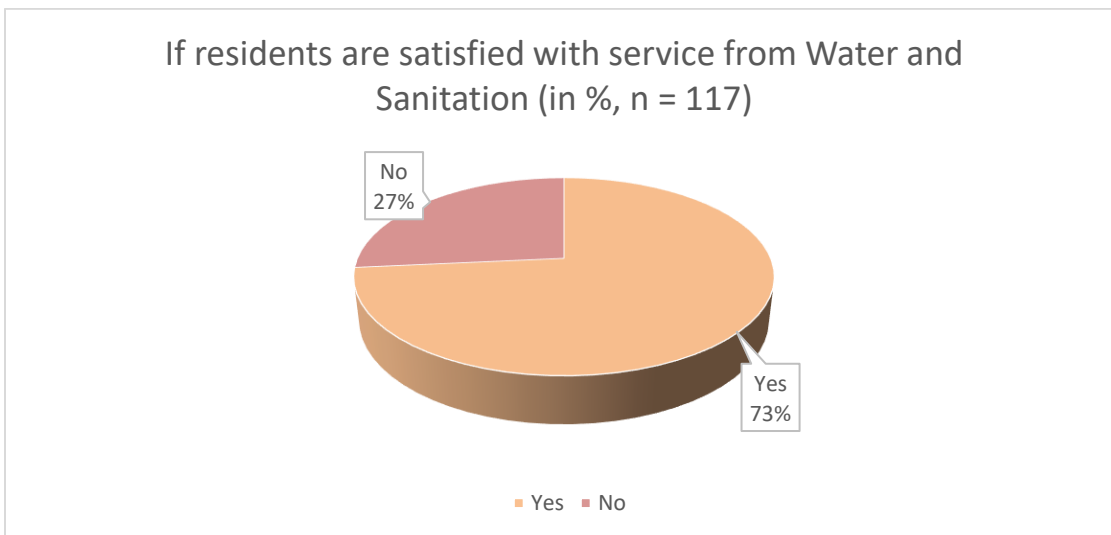


Figure 4.11: If residents are satisfied with level of service from water and sanitation

In addition to the information above, figure 4.12 below summarizes the reactions of the respondents when faced with sewer overflows. Most of the respondents do not report sewer overflows, which further delays service delivery as the teams can only respond once reports have been made through correct channels. 33,3% of the respondents notify the Ward Councillor when sewer overflows occur, however the Ward Councillor’s involvement is limited with regards to the administrative functions of the City staff as there is a separation of powers between political office bearers and officials employed within a municipality. 48% of the respondents confirmed that they do not take any action when they observe sewer overflows. This could possibly be attributed to the fact that the residents are not aware of the faultlogging channels provided by the City to report faults on any infrastructure. These fault-logging channels have been meticulously developed by the City to improve service delivery and these channels are readily available on the City’s website for ease of reference.

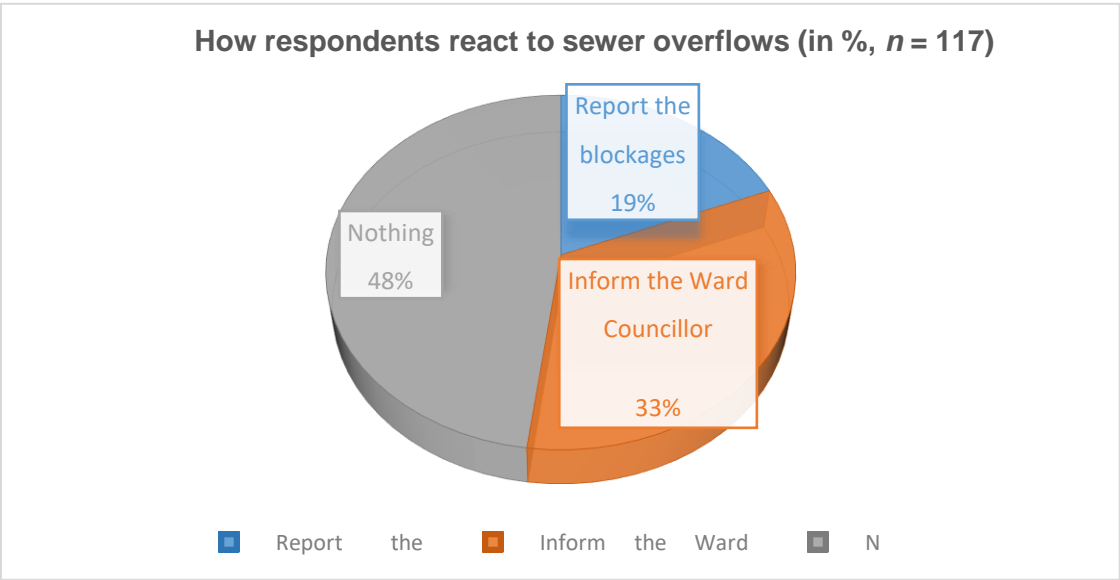


Figure 4.12: Responses of residents to sewer overflows

Figure 4.13 below gives an indication of whether the respondents were aware of the City of Cape Town’s fault logging channels. 76.5% of the respondents confirmed that they do not know how to log faults at the City, which corroborates the 46% statistic of respondents who do not take any action when faced with sewer overflows (figure 4.12 above). As part of the City’s awareness program, the City could possibly look at educating the residents on the use of fault logging channels as they are fairly simple to interact with.

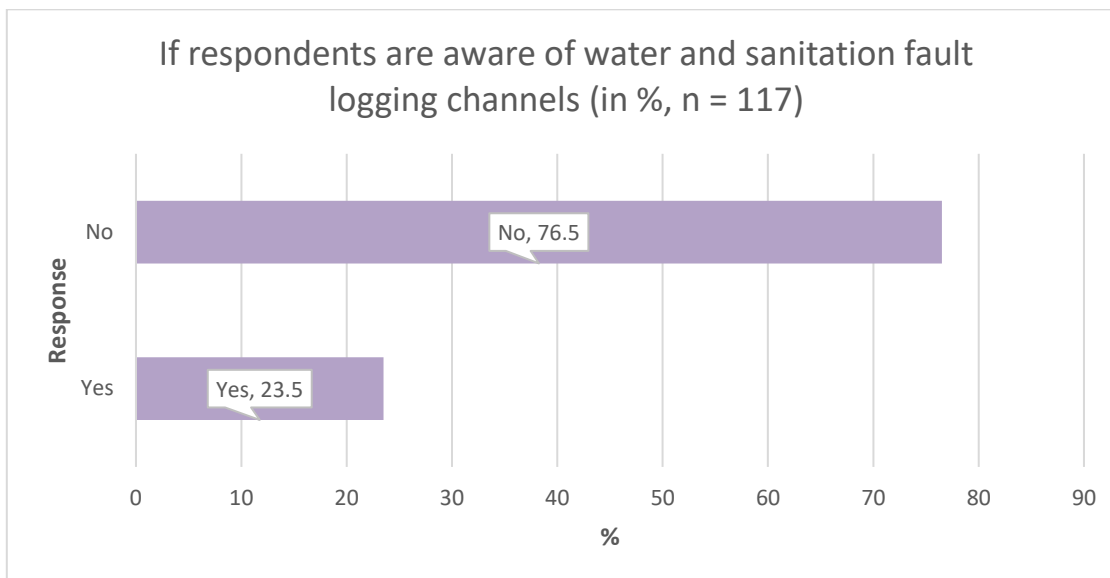


Figure 4.13: If residents are aware of fault logging channels

#### 4.3.2 Annual cost of repairs to sewers in the selected townships:

Table 4.2 illustrates the maintenance cost of repairs to sewers in Region 4 of the City of Cape Town, which includes the three selected townships. The data presented below was collected from 2019 – 2021 and represents the planned cost versus the actual cost of repairs. Table 4.2 below also illustrates the variation amount (and %) of the difference between planned and actual cost.

Upon closer inspection of the results, one can ascertain that the planned maintenance costs were exceeded exponentially in all areas. The City of Cape Town uses both internal teams as well as private contractors to repair and maintain sewer services throughout the city. The planned cost for outsourced services was R42 660 470.34 however the actual cost amounted to R81 049 690.65, which was an 89.9% variation between planned and actual cost. Outsourced services include the hiring of private jet-machines to clean sewers, bucketing equipment to clean bulk sewers as well as contracting services for physical repairs to sewer pipelines. In contrast, R45 99 996.14 was the planned cost for internal maintenance and repairs however actual cost amounted to R84 278 849.17, which resulted in a variation of 83.25% between planned and actual cost. In total, R165 328 540.12 was spent by the City of Cape Town for maintenance and repairs to sewer infrastructure over 2019 – 2021, which supports Tscheikener-Gratl et al (2020) view that sewer rehabilitation and maintenance is relatively expensive and alternative solutions should be explored by authorities. These costs are worsened by vandalism to critical sewer infrastructure caused by criminals in an attempt to sabotage the City's efforts.

Table 4.2: Operations (Sewer maintenance) costs between 2019 – 2021

Cost Elements	Act. Costs	Plan Costs	Var.(Abs.)	Var.(%)
673050 453050 - R&M Contracted Serv Building	80 729 545.68	41 494 760.79	39 234 784.89	94.55
673170 453170 - R&M Maintenance of Equipment	316 866.72	1 165 709.55	- 848 842.83	- 72.82
Contractors: Repairs & Maintenance	81 046 412.40	42 660 470.34	38 385 942.06	89.98
671550 411550 - R&M Cleaning Costs	3 278.25	-	3 278.25	-
<b>Outsourced Services: Repairs &amp; Maintnce</b>	<b>3 278.25</b>	<b>-</b>	<b>3 278.25</b>	<b>-</b>
<b>Contracted Services: R&amp;M</b>	<b>81 049 690.65</b>	<b>42 660 470.34</b>	<b>38 389 220.31</b>	<b>89.99</b>
671350 411350 - R&M Chemicals	2 850.09	-	2 850.09	-
673000 413000 - R&M Mat General & Consumables	3 226 308.43	3 331 525.80	- 105 217.37	- 3.16
<b>Materials: R &amp; M</b>	<b>3 229 158.52</b>	<b>3 331 525.80</b>	<b>- 102 367.28</b>	<b>- 3.07</b>
<b>Repair &amp; Maintenance Primary Cost</b>	<b>84 278 849.17</b>	<b>45 991 996.14</b>	<b>38 286 853.03</b>	<b>83.25</b>
679110 600110 - R&M Labour to Operating	38 944 736.23	28 612 876.03	10 331 860.20	36.11
679140 600140 - R&M Plant & Equip to Operating	5 763 285.35	2 093 369.84	3 669 915.51	175.31
679160 600160 - R&M Radio Maintenance	68 887.00	57 456.00	11 431.00	19.90
679240 600240 - R&M Vehicles to Operating	1 790 725.41	1 608 442.88	182 282.53	11.33
<b>Repair &amp; Maintenance Secondary Cost</b>	<b>46 567 633.99</b>	<b>32 372 144.75</b>	<b>14 195 489.24</b>	<b>43.85</b>
<b>Debit</b>	<b>130 846 483.16</b>	<b>78 364 140.89</b>	<b>52 482 342.27</b>	<b>66.97</b>
<b>Over/Underabsorption</b>	<b>130 846 483.16</b>	<b>78 364 140.89</b>	<b>52 482 342.27</b>	<b>66.97</b>

### 4.3.3 Common causes of blockages on the sewers

Table 4.3 illustrates the common causes of blockages, which often lead to the dilapidation of the sanitation services in the selected townships. Six operational staff members working at the sewer depots in the study area were interviewed and three political office bearers were interviewed during the study. Voluntary participation was key and the participants were welcome to withdraw from the study at any time.

Upon closer inspection of the results, the consensus was that most of the blockages experienced in the study area are caused by disposal of foreign objects into the sewer line by the residents of the affected area. Foreign objects are a broad term that refers to objects that would not be expected to be in the sewer system on a normal basis. A report submitted by the City of Cape Town to Subcouncil 7 defined foreign objects as being heavy, non-disintegrating solids which often result in stubborn blockages. Sewers were not designed to convey such materials however residents often treat the sewer network as a dumping facility. Such objects include rags, fats, building rubble, sand, newspapers, stones and other objects that should not be in the sewer system. The leading causes of blockages in the study area include fats and rags from both surrounding industries as well as households. The fats solidify on the walls of sewer pipes, often resulting in blockages and the reduced capacity of sewers in certain places along the length of the network. The City is often required to use high pressure jetting equipment to remove the fats that solidify on the walls of the sewers however, continual jetting of sewers often results in damage to the sewer pipes, as many sewers in the study area are vitrified clay, which is easily damaged by high pressure jetting.

Table 4.3: Common causes of blockages in the study area

<b>Sewer-related fault</b>	<b>Frequency</b>
Foreign objects	9
Fats	6
Rags	6
Sand/siltation	5
Illegal dumping	2
Pump stations	3
Building rubble	5
Stolen manhole covers	2
Newspapers and plastics	3
Broken pipes	3
Pipes under capacity	1
Stones	1

#### 4.3.4 Socio-economic factors

Baker (2014) defines socio-economic status as being a measure of a person's economic and social status within a society. The socio-economic challenges that define South Africa are often crime, inequality, poverty, and corruption (Herbig, 2019). A review of the Integrated Development Plan conducted by the City of Cape Town in 2006 identified poverty, housing backlog, health issues and crime as the leading societal challenges within the City. The housing backlog challenge is still persistent in the City of Cape Town and has resulted in informality and the widespread development of informal settlements within the City's boundaries (Findley & Ogbu, 2011). Herbig (2019) found that informal settlements place a tremendous strain on the sewerage infrastructure as these settlements were not catered for in the initial design of the infrastructure. Nyanga, Lower Crossroads and Samora Machel are all affected by rising informal settlements, which all contribute to the deterioration of the sewer infrastructure in these areas.

Poverty is often linked to crime as people in township developments often resort to crime as a result of poverty and a lack of resources (World Bank, 2014). Limberg (2021) stated that one of the key challenges that affects the sewer network in lower income areas is the theft of vital infrastructure. Manhole covers are often stolen and sold for scraps at illegal scrapyards that operate across the City. The exposed sewer manholes often create a safety hazard for pedestrians and motorists; however, the biggest concern is that these exposed manholes become a dumping place for unwanted waste and goods. These foreign objects, when disposed into the sewer network, often result in reoccurring blockages and overflows. Sand, stones and rubble also gets into the sewer network via exposed sewer manholes and such materials settle at the bottom of sewers, resulting in further blockages along the network. The phenomenon of siltation may be described as the process of blocking an object with sand or soil and this occurrence is prevalent in sewer networks in lower income areas. The operations teams are often required to spend a large amount of time clearing silt from sewers, and this takes vital resources away from planned maintenance activities. Bucketing equipment or high-pressure jetting equipment are the preferred method of choice to reduce siltation inside sewer pipelines, depending on the size of the sewer line in question.

Figure 4.14 summarizes the responses that were received regarding manhole covers in the area of study. About 61% of the residents confirmed that most manholes do not have covers in their respective places of residence while only 39% of the respondents confirmed that all manholes have proper covers within their respective townships. It has been discovered that the cast iron covers are stolen by criminals and sold to scrapyards. In terms of the City's service charter, the teams are provided only 24 hours to respond to C3 notifications for manhole covers. However, occurrences such as the Covid-19 pandemic have caused a supply issue which delayed service

delivery. The residents are encouraged to take ownership of their services by reporting all theft of critical sewer infrastructure to law enforcement agencies.

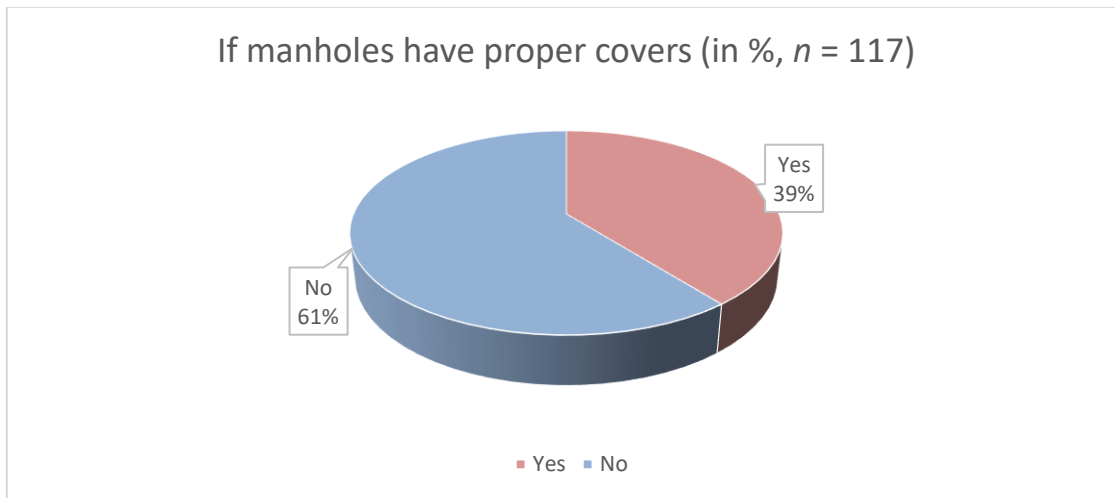


Figure 4.14: If manholes have proper covers

City staff members continue to be intimidated by criminals residing in the selected townships when conducting maintenance activities in these areas (Limberg, 2021). These further delays service delivery as the operations crews often need to be accompanied by Law Enforcement officials when working in these areas. There are only a limited number of law enforcement officials assigned to the water and sanitation department, which results in a backlog of requests each time a report is submitted. The residents have previously shielded criminals from these areas in fear of being targeted however residents are encouraged to report all acts of crime perpetrated against City officials for better service delivery. The City of Cape Town is mandated to provide service delivery to the residents however the City will always prioritize the safety of workers and will try by all means to protect officials from harm.

The City of Cape Town has implemented an awareness programme to educate residents on the correct usage of sewer infrastructure, as the behavioural patterns of the residents have a direct impact on the use of the sewers. Sutherland (2020) found that residents are required to take ownership of critical sewer infrastructure in order to protect such infrastructure from damage. Residents are encouraged to report any cases of vandalism to the nearest local authorities for remedial action to be taken against the perpetrators. Although most sewers are designed to have a lifespan of approximately 50 years, constant misuse and abuse of the sewer infrastructure reduces the design lifespan, resulting in a fragile network that requires constant maintenance and monitoring. An adjustment in the way people interact with and use sewer infrastructure could increase the lifespan of the infrastructure and reduce the maintenance costs associated with repairs to infrastructure in lower income areas.



Figure 4.15 gives an indication of the responses received from the residents regarding the type of items that they dispose into the sewer network. About 73.5% of the residents confirmed that they only dispose of tissues into the sewer system. However, 26.5% of the respondents confirmed that they dispose foreign objects into the sewer system. The foreign objects disposed into the sewer system result in blockages and damage to the sewer network, resulting in reoccurring blockages and overflows in such areas.

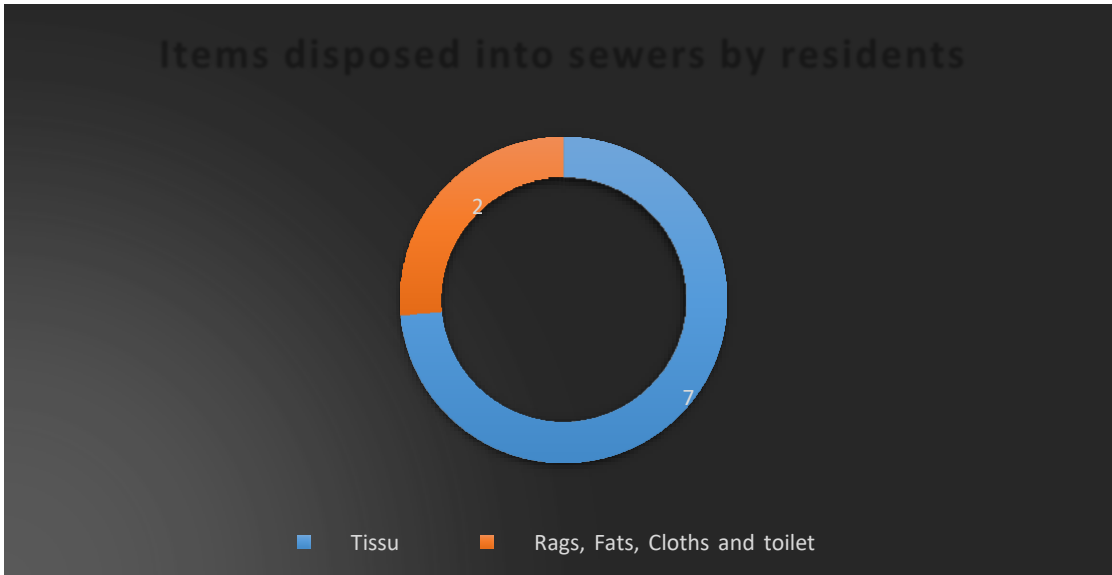


Figure 4.15: Items disposed into sewers by residents

### 4.3.5 Engineering

#### 4.3.5.1 Sewer asset management

The City of Cape Town has developed models to monitor sewer assets across the city. The models are able to identify bottlenecks or constraints on the sewer network and advise where sewer replacement upgrades are required. The city has also updated the design standards and no longer utilises midblock sewers. Figure 4.16 below illustrates a midblock sewer and the typical configuration of such sewers through peoples' property. Such sewers have been excluded from acceptable design standards in the City's water and sanitation department due to the operational constraints associated with maintenance of midblock sewers. The repair and maintenance challenges and the accompanying costs outweigh the initial cost-saving initiative of installing midblock sewers. In the case of the Nyanga, Samora Machel and Lower Crossroads, the high frequency of blockages on midblock sewers requires daily access to such sewers located at the rear of people's properties. The maintenance of midblock sewers is severely hindered and delayed by informal backyard dwellings constructed over the sewer manholes. It has become common practise for the occupants of these informal structures to use sewer manholes for their waste disposal.



Figure 4.16: Illustration of midblock sewer line ( Source: City of Cape Town GIS Viewer)

#### 4.3.5.2 Sewer design and capacity evaluation

The design of sewer systems is not only limited to meet the demands of the proposed development but also provides capacity for every conceivable development that could take place within an area. All bulk sewers increase in hydraulic capacity along the length of the network to accommodate possible future development, based on the zoning of the land parcels in question. The sewer systems of the three townships in question were developed to adequately accommodate the formal developments in the area however increases in informal settlement and the continued misuse of sewers often resulted in the reduction of the available capacity within the sewer network.

#### 4.3.5.3 Infrastructure Asset Management Software

The City of Cape Town has employed the services of the Integrated Quality Management System (IMQS) to develop Geographic Information System (GIS) centred software for Infrastructure Asset Management in real-time. The software is developed using formulae and is able to advise on assets that need replacement/upgrades based on theoretical flows. This is calculated using the zoning of the properties within a particular catchment. The software is a useful tool in determining sewers that require replacement where capacity constraints exist along the sewer network. Figure

4.8 below gives an indication of the absolute spare capacity available in the sewer network in Samora Machel. The sewer lines are represented by the differently coloured lines and the different

colours represent the varying capacity available within the network. Red lines represent sewers with no spare capacity, while pink represents sewers with an absolute spare capacity between 0 – 15%. Blue represents sewers with an absolute spare capacity of 15 – 30%, while light blue represents sewers with an absolute spare capacity of 30 – 60%. Green represents sewers with an absolute spare capacity of 60 – 90% while yellow represents sewers with a capacity greater than 90%. Figure 4.17 below gives an indication that the sewers in Samora Machel have sufficient spare capacity and are adequately sized to accommodate the township development. The collector sewer line running parallel to Jakes Gerwel Drive has been incorrectly captured as a 150mm sewer line, which is why the system has flagged this sewer line as having no spare capacity. Human error is unavoidable, and assumptions have to be made where no records exist.

The IMQS records for Lower Crossroads and Nyanga also show that the sewers have sufficient capacity to accommodate future development in these areas (please refer to Appendix E and F). The sizing of sewers is done through hydraulic analysis, which is based on Manning's formula. Manning's formula may be summarized as follow:

$$V = \left(\frac{1}{n}\right) R^{2/3} S^{1/2} \text{ and } R = \frac{A}{P}$$

Where: V – Velocity (m/s)

n – Roughness factor

R – Hydraulic Radius

A – Cross-sectional area

P – Wetted perimeter

S – Slope/gradient

Source: Redbook Section K 4.3.2

The formula to calculate absolute spare capacity within a gravity sewer network may be summarized as follows:

$$\text{Absolute spare capacity (\%)} = \frac{\text{Full flow pipe capacity } \left(\frac{L}{S}\right) - \text{Max flow (IPDWF)} \left(\frac{L}{S}\right)}{\text{Full flow pipe capacity } \left(\frac{L}{S}\right)}$$

Source: Redbook Section K4



Manning's formula as well as the formula to calculate the absolute spare capacity are just examples of formulae on which IMQS software is based on. Such software is vital in monitoring the City of Cape Town's sewer assets if used correctly. Figure 4.17 below illustrates a typical Master Plan from IMQS software.

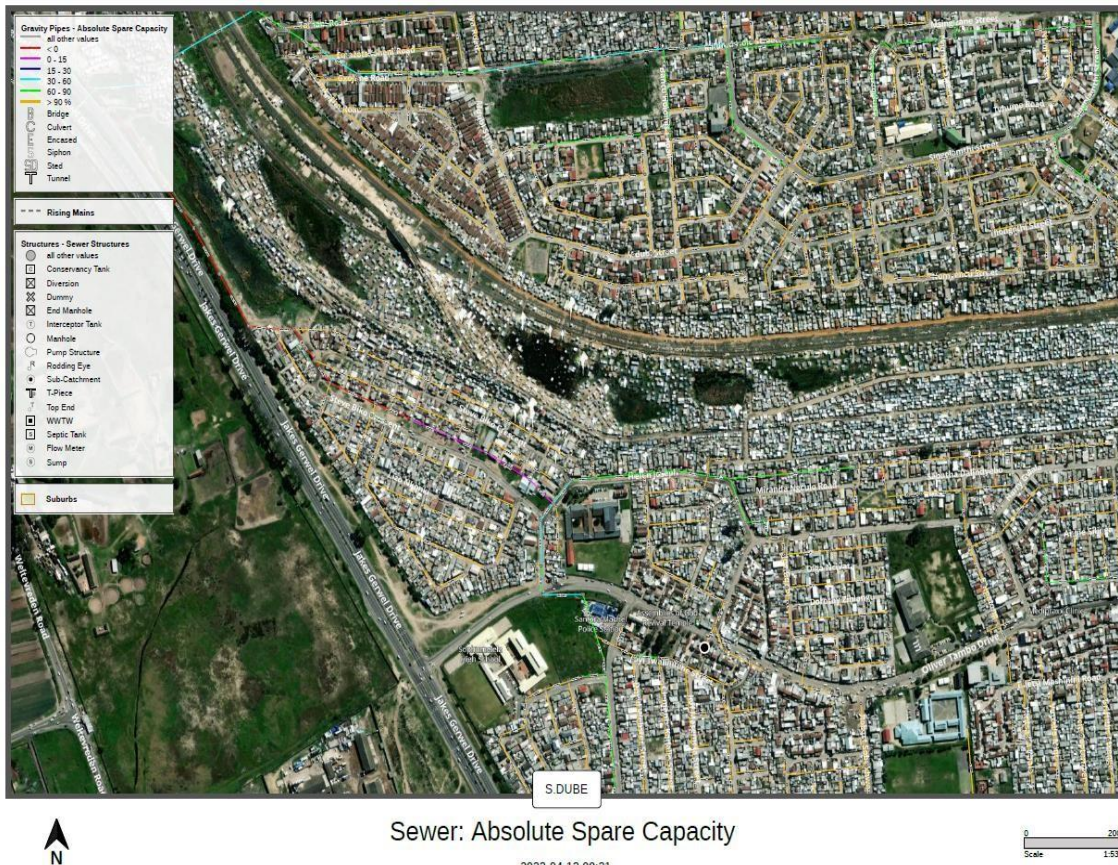


Figure 4.17: Typical IMQS Sewer Master Plan

#### 4.4 Social challenges and possible solutions

The matter of sewer infrastructure and sanitation services dilapidation is one that cannot only be viewed from an engineering perspective. Both the community and the local authority have a role to play in the resolution of such challenges. Below is a summary of the various inputs into an effective sewer network and the current challenges facing each of the social structures. Both the community and the municipality are required to identify solutions to address challenges affecting the conveyance of wastewater.

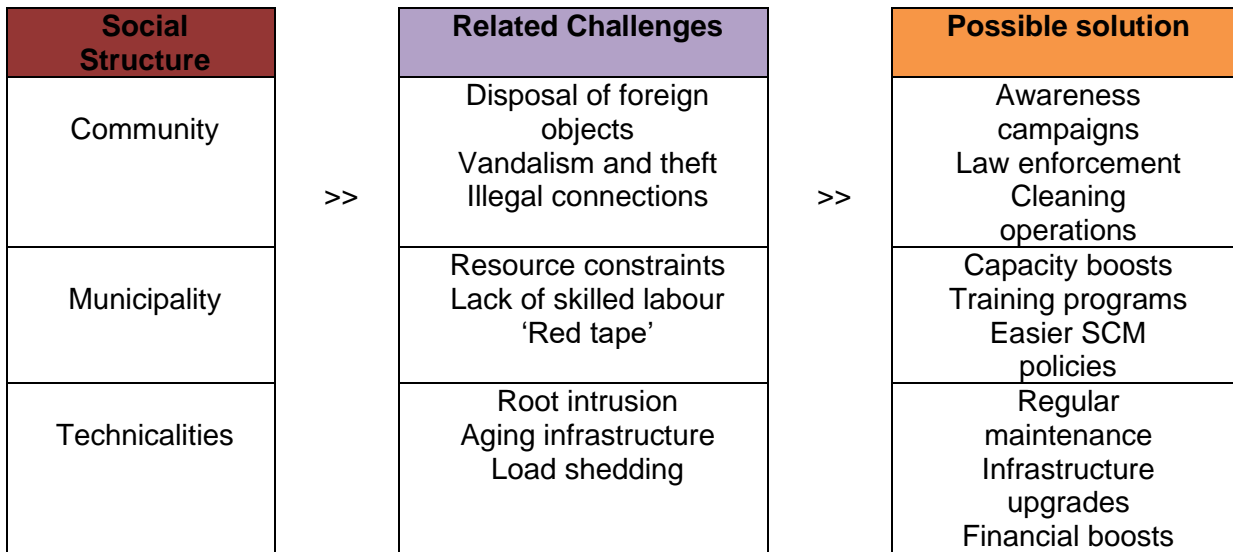


Figure 4.18: Social challenges facing the sewer network

#### 4.4.1 Sewerage overflow experiences of the public

Sewer overflows impact negatively on people's lives. The impact of sewer overflows varies depending on the severity of the sewer overflow and its proximity to public facilities. Raw (untreated) sewerage contains *E. coli*, which is a harmful bacterium that causes severe illnesses in humans. Raw sewerage also results in other water-borne diseases that are harmful to human beings and pets. The severity of the consequential illness that results from exposure to raw sewerage depends on the extent of exposure as well as any other pre-existing conditions that a person may have.

Upon closer inspection of the survey results, it is evident that a large portion of the population living in low-income areas are affected by sewer overflows. The participants were requested to comment on whether they were personally affected by sewer overflows in their respective areas of residence. Figure 4.19 illustrates the fact that 95.7% of the respondents were found to be affected by sewer overflows in their respective areas of residence while only 4.3% of the respondents confirmed that they were not affected by sewer overflows. Sewer overflows affect people in various ways, and this is dependent on a number of factors. Some residents in lower income areas confirmed that they sell food along the streets and their businesses rely on a clean and hygienic environment to attract customers. Food vendors selling takeaways along the street often have to find alternative places to sell food and this affects their daily lives. In certain instances, shops and other public facilities were required to close due to sewerage running through the streets in affected areas. This results in an avoidable inconvenience to the public, which can be addressed by better sanitation infrastructure.

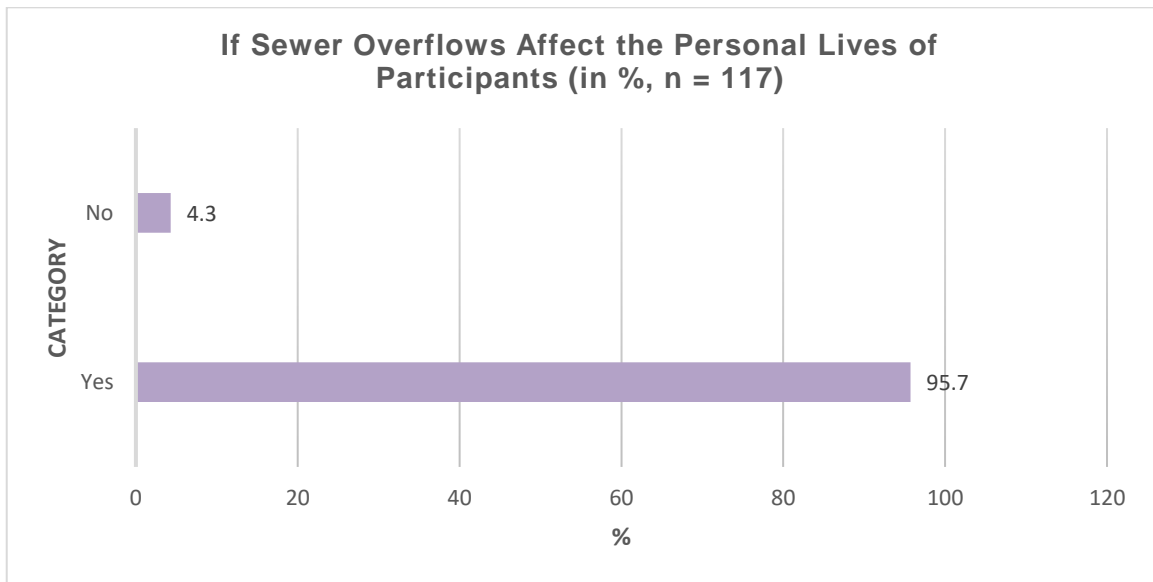


Figure 4.19: If sewer overflows affect the lives of the respondents

Stagnant greywater or sewerage was also found to contain an undesirable odour, which many residents in lower income areas have become accustomed to. The sewerage flowing through the streets also created an unsightly mess and resulted in residents adopting a negative outlook on services delivered by the municipality in lower income areas.

The participants were requested to comment on whether they were affected by bad smells in their respective areas as a result of sewer overflows. 93.2% of the respondents confirmed that they were affected by bad smells in their respective areas due to sewer overflows while only 6.8% of the respondents confirmed that they were not affected by bad smells in their area as per figure 4.20 below. This can easily be confirmed by driving through lower income areas which are heavily affected by sewer overflows.

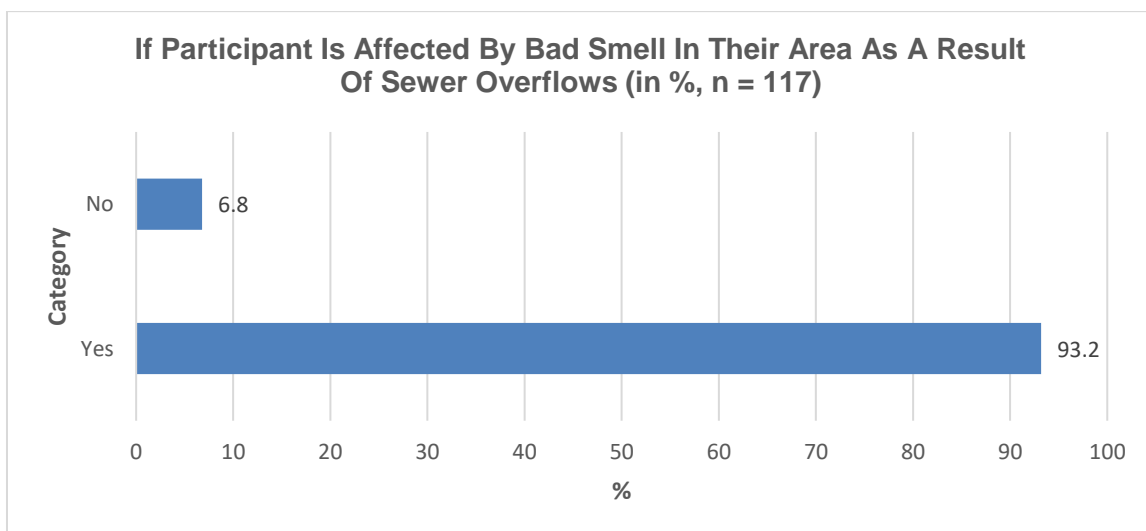


Figure 4.20: If participants were affected by bad smells in their areas.

The consequences of sewer overflows often transcend nuisances such as the presence of a bad odour and result in more serious situations such as the contamination of water bodies intended to service the community. Sewer overflows often result in sewerage getting into storm water structures, which ultimately discharge into larger water bodies. This then often results in water borne illnesses that plague lower-income communities. Unfortunately, many residents are unaware of the effects and risks associated with sewer overflows.

Figure 4.21 below summarizes responses that were received from the participants and further confirms the fact that a large majority of the residents were unaware of the risks of exposure to raw sewerage. Most of the community members had become accustomed to seeing raw sewerage flowing through the streets, which should not be the case due to the many challenges that accompany sewer overflows. Numerous awareness campaigns such as the “Bin it, don’t blockit” was initiated by the city and intended to improve the way in which community members interact and dispose solid waste items. Members of the community were encouraged to dispose solid waste into the dustbin and other waste facilities and not into sewers. Such campaigns were aimed at increasing awareness in terms of waste disposal and aimed at reducing the misuse of sewer services. The burden of responsibility in terms of the correct use of sewer services rests with the affected community members and members of the public are required to take responsibility and ownership of the services that cater for their needs. Community members are required to take note of awareness campaigns and reduce the misuse of services intended to service them.

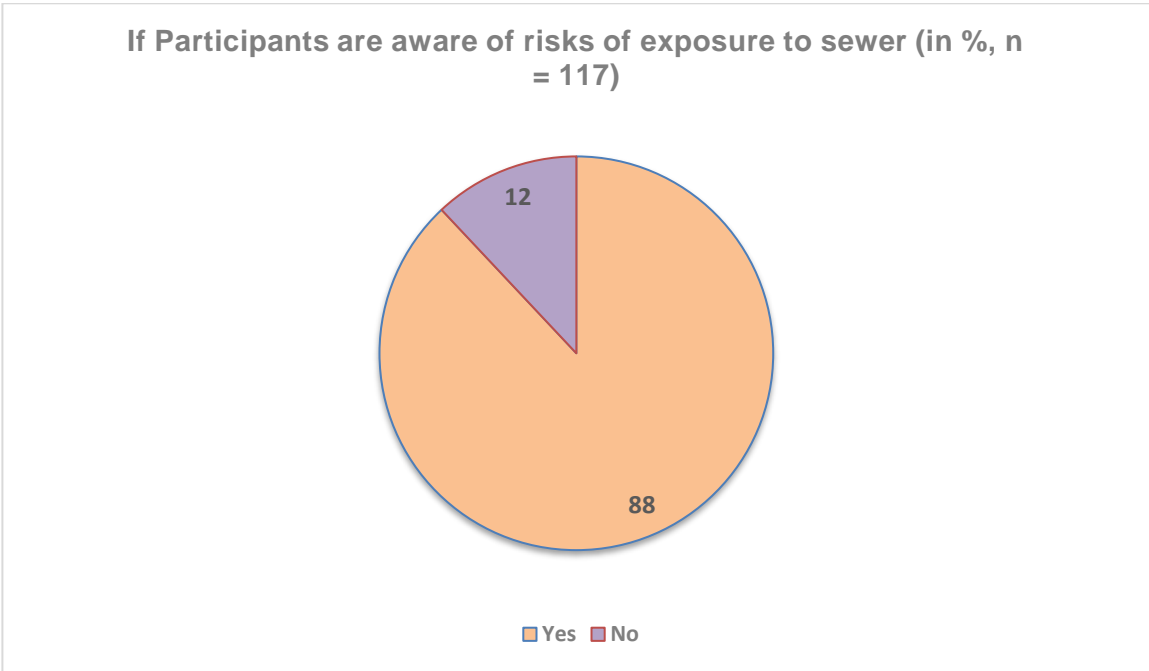


Figure 4.21: If participants are aware of risks of exposure to sewer

The advent of technology has allowed greater access to services for the general community. People that were previously disadvantaged have been provided the opportunity to access information through it. Many campaigns that were previously run by the city were shared through technology however the communities in disadvantaged communities still struggle with access to basic technological advancements. The “Bin it, don’t block it” campaign was shared through electronic posters and printed media however this required a certain level of access to technology to access it. Unfortunately, the participants in the selected study area confirmed that they had not been informed of the correct use of sewer infrastructure. A closer evaluation of the results revealed that only 12% of the residents had confirmed that they were informed about the proper use of sewers through awareness campaigns while the vast majority (88%) of the respondents were not informed about the proper use of sewer infrastructure. Table 4.4 below summarizes the responses received from the participants.

Table 4.4: If participants were informed about the proper use of sewers

Category	%
Yes	12.0
No	88.0

#### 4.4.2 Health problems caused by sewerage overflows

The health risks associated with exposure to raw sewerage vary and take many forms depending on the severity and nature of the overflow that occurs. Raw sewerage contains numerous microorganisms, which include viruses, parasitic bacteria, pathogenic bacteria and saprophytic bacteria. These germs and microorganisms have previously been linked to illnesses such as diarrhoea, cramps, nausea, headaches as well as liver and intestinal illnesses that cause damage to humans (Roe *et al.*, 2008). The health care facilities in lower-income areas often lack sufficient capacity to deal with the demand for health-care services and sewer overflows further deteriorate the health of the residents in the affected areas.

Table 4.5 presents the findings of the survey administered to the community members in the selected study area. Each respondent was required to confirm whether they had ever fallen ill as a result of exposure to raw sewer. 76.1% of the respondents confirmed that they had never fallen ill from exposure to raw sewerage while 23.9% of the respondents confirmed that they had fallen ill from exposure to sewerage. The illnesses vary and include common illnesses include cramps, headaches, intestinal illnesses and diarrhoea. The smell associated with sewerage causes



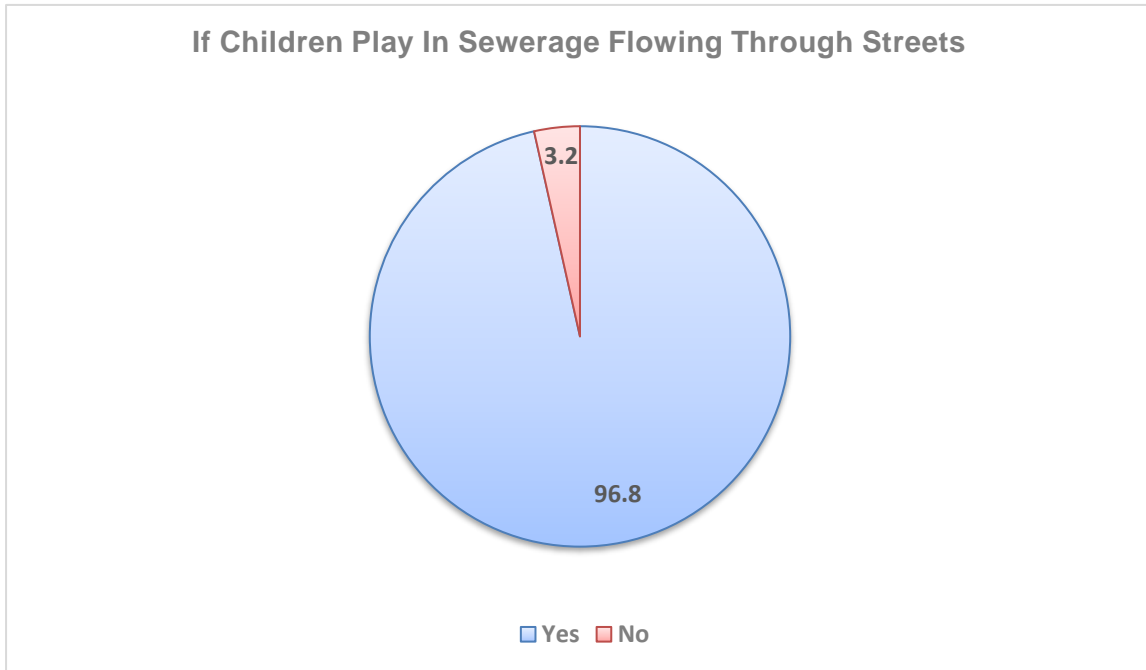
community members to feel nauseas and this unfortunately has become a common issue in lower income areas. The health risks associated with sewer overflows should be highlighted to community members in lower-income areas as they often suffer the most.

Table 4.5: If residents have been sick as a result of exposure to raw sewerage

Category	%
Yes	23.9
No	76.1

As mentioned previously, bacteria and exposure to harmful microorganisms has an effect on the human nervous system and health in general. The pathogenic species that are released as a result of raw sewerage include waterborne bacteria, enteric pathogens and environmental bacteria. Waterborne bacteria rely on water to spread infections while enteric pathogens generally require a host to survive, particularly in the intestinal system of humans and pets (Ketley, 1997). Environmental pathogens may be defined as microorganisms that can survive outside of a host, but cause diseases and illness once introduced into humans and pets. Pathogens have evolved over the years and have become resistant to antibiotics (Roe, *et al.* 2008). These microorganisms have been found to be the leading cause of illnesses linked to sewer overflows.

Children are disproportionately affected by the exposure to raw sewerage. Participants were requested to comment on whether children in their respective areas of residence play in puddles of stagnant and overflowing sewers. 96.8% of the respondents confirmed that children play in such puddles while only 3.2% of the respondents confirmed that children do not play in such puddles. The immune systems of children are generally assumed to be more susceptible to illnesses and exposure to raw sewerage which could have devastating effects. A respondent confirmed that she was required to relocate her children back to the Eastern Cape as one of her children fell ill from alleged exposure to raw sewerage in the area of study. Cases of this nature encourage researchers to conduct more studies into the causes of dilapidation on sewer services to determine the root cause of these overflows and provide permanent solutions. As previously mentioned, the issue of sewer dilapidation in lower income areas has transcended the engineering arena and requires a collaborative effort from both the community and law makers. A general assumption that can be made is the fact that an improvement in the maintenance of sanitation infrastructure can potentially reduce the illnesses that are experienced in lower-income areas.



*Figure 4.22: If children play in sewerage flowing in the streets*

Previous awareness campaigns have recommended the following steps in order to reduce the severity of the illnesses that result from sewer overflows:

- People were encouraged to refrain from touching their noses, mouths, ears or eyes after exposure to raw sewerage and were further encouraged to wash their hands after touching sewerage.
- People were advised to refrain from touching sewerage or let sewerage get into cuts and sores or wounds. Sewerage contains harmful bacteria that causes illnesses once introduced to the human body.
- People were encouraged to refrain from walking barefoot where the risk of exposure to raw sewerage existed. Any cuts on the feet could pose a potential risk and create a vulnerable spot through which bacteria can enter the body.
- The public was advised to keep fingernails short to avoid bacteria and germs hiding underneath fingernails. In addition to this, people were advised to avoid eating fingernails.
- The public was advised to keep all dirty and contaminated clothes separate from other dirty laundry. This was advised to avoid the possibility of a spread of these microorganisms.

- Employees that work in sewer-related environments were encouraged to wear waterproof gloves when working with raw sewerage and they were encouraged to take the Hepatitis A injection as required. This step is essential to avoid illness and disease.
- The public was also encouraged to consult their health care professionals on advice on how to identify illnesses and symptoms linked to exposure to raw sewerage.
- People were encouraged to take regular showers to avoid falling ill or spread the pathogens and microorganisms that result from sewerage.

These recommendations were aimed at reducing the impact of exposure to raw sewerage on communities affected by regular sewer overflows, as is the case in the selected area of study.

Research in the past has also confirmed the presence of sulphuric acid and bacteria in sewers. Sulphuric acid has been found to be an aggressive by-product from sewers and has been found to pose the ability to corrode concrete structures within sewer infrastructure. This acid reduces the lifespan of concrete pipes and results in the exposure of aggregate and reinforcement within concrete structures. The risks of exposure to sulphuric acid and the resultant consequences are worsened when humans are exposed to sulphuric acid. Sulphuric acid generally attacks the eyes, throat and lungs and has the potential to kill or permanently disable humans.

The strong odour released in sewers results from Hydrogen Sulphide. This colourless gas is the reason why sewers smell like rotten eggs and is highly corrosive (Roe, *et al.*2008). This gas is present in human waste and is also present in rain drops. The common illnesses that result from exposure to Hydrogen Sulphide include nausea, irritation of skin, headaches and even death when exposed to high doses.

Direct skin contact and exposure to hydrogen sulphide can result in minor skin irritation to pain and swelling in severe situations. Skin and eye burns as well as blindness were found to be some of the severe conditions that may result from exposure to hydrogen sulphide. Ingestion of hydrogen sulphide results in poisoning and the effects thereof vary from abdominal pain to death. Other risks of exposure to hydrogen sulphide were found to be the risk of inhalation, causing significant damage to lungs, the respiratory tract and shortness of breath. Disadvantaged communities that were regularly subjected to sewer overflows were found to be at great risk of exposure to the aforementioned illnesses. In this study, residents were unfortunately found to be unaware of the risks of exposure to raw sewerage.

A significant proportion of the residents were under the impression that sewer overflows only occur along the sewer mainline and that the risk of exposure to raw sewerage was only eminent when street overflows occurred. Sewer overflows and blockages that occur in the residence of community members also present the risk of exposure to sewer. These sewer overflows, although localized, possess the potential to cause damage to the health of humans and pets. Awareness campaigns have enabled local authorities to advise residents on the proper clean up procedures after a sewer overflow has occurred. Residents were encouraged to use a chlorine solution to disinfect their properties after severe overflows.

#### **4.4.3 Impact of sewerage overflows on people's lives**

The impact of sewer overflows has become a topic of contention. The failures of sanitation infrastructure were found to impact residents in various ways, including posing significant health risks. Numerous scholars have often argued that the lack of political will, inadequate knowledge and skills have hindered government departments to take swift action to combat sewer overflows and spillages. Sewer spillages and overflows often inconvenience the communities by contaminating water bodies intended to service communities, spreading illnesses that may be life threatening, creating a nuisance in terms of bad odours and an unsightly mess emanating from sewer spillages. The impact and consequences of such overflows is dependent on the severity of the spillage and the proximity of the spillage to residential homes and other facilities.

Sewer overflows and spillages have also affected residents in ways that go beyond physical illness and disease. Local authorities often need to spend exorbitant amounts of money to rectify and fix sewer overflows and blockages. Limberg (2021) confirmed that the City of Cape Town spent approximately R270 million between 1 July 2020 and June 2021 to clear sewer blockages across the metro due to vandalism and the disregard for City by-laws. This funding could be utilized to improve the quality of life of the residents in the affected areas and create jobs to help sustain the residents. The continued misuse and vandalism of critical sewer infrastructure takes vital resources away from communities and results in local authorities spending time on matters that could be avoided through the appropriate use of sewers.

Although it is plausible to assume that residents have a sense of urgency with matters relating to sewer overflows, a perception that can be adopted is the fact that lower-income areas are severely affected by sewer overflows. Previous scholarly research confirms that residents in lower income areas were more willing to spend time on resolving issues relating to sewer spillages and overflows since they were the most affected. Many residents in low-income areas confirmed their awareness of the fact that the illegal dumping and improper disposal of waste products contribute to the sewer overflows. While residents were of the perception that the city only provides proper services to

upmarket areas, the responsibility still rests with the residents to ensure that the services are well maintained and that refrain from the misuse of sewer services.

A growing population and the rapid expansion of metros have placed tremendous strain on civil services and engineering infrastructure in most urban areas. Rural to urban migration has been found to be the leading cause of the housing issues and challenges experienced in lower income areas. The rise in backyard dwellers and informal structures in low-income areas have contributed to the sanitation challenges experienced in the area of study. Previous studies have confirmed that population growth and an increased rate of influx of people from other provinces continues to occur in Cape Town. The city is constantly placed under pressure to contend with a growing population. Numerous attempts have been made by the City to combat the issue of sewer spillages and the misuse of sanitation infrastructure.

The residents in the selected area of study were found to be affected by sewer overflows in the following ways:

- Sewer overflows contaminated drinking water sources. Other scholars noted that authorities were required to spend enormous amounts of money to rehabilitate and disinfect such water bodies.
- The contamination of oceans, rivers and seas which potentially affect tourism, and affects the poverty level in the country considering that a significant proportion of employees in the CBD are residents from lower income areas. Tourists would not enjoy visiting a site that suffers severe sewer overflows.
- Sewer overflows contaminate facilities such as swimming pools. Swimming in contaminated water could result in gastrointestinal illness amongst other severe illnesses.
- Direct contact with sewerage resulted in skin irritation and burns to the eyes in severe cases.
- The inhalation and skin absorption of fumes from sewer overflows resulted in bodily harm and infections.
- Sewer overflows result in damage to properties and reduced the value of affected properties.

Many of the aforementioned challenges directly affected residents in the selected study area. Municipalities and local authorities are urged to collaborate with the residents to resolve all challenges.

Figure 4.15 illustrates the fact that a segment of residents in lower income areas lack adequate knowledge regarding how sewer systems work, specifically which items can be disposed into the sewer. The assertion that some residents are unaware of items that contribute towards blockages is further supported by Figure 4.4 above where 88% of the respondents confirmed that they have not been educated on the proper use of sewers. Simple awareness campaigns can improve these statistics and reduce the impact and severity of sewer blockages and spillages. When asked to comment on whether participants were negatively affected by sewer overflows, 96.6% of the respondents confirmed that they indeed were while only 3.4% of the respondents confirmed that they were not as per figure 4.23 below. This unfortunately indicates that these residents have had to endure sewer overflows for a long period and supports the idea that proper service delivery is reserved for upmarket developments. Visual inspections and site visits to the townships in the selected area of study have revealed the fact that sewer overflows and stagnant water from various water sources have plagued the lower income areas.

Municipalities and local authorities cannot effectively resolve these matters without the assistance and support from residents. Residents cited the unsightly mess and bad odour as their main concern with regards to sewer overflows. In addition, they highlighted unhygienic conditions as the second concern and lastly the spread of diseases. It is plausible to argue that the residents presented their concerns in this order of priority as they were unaware of the health risks associated with exposure to sewerage. Various illnesses can be attributed to sewer overflows. The most common illnesses are as follows nausea and vomiting; headaches; stomach cramps; skin irritation; and illnesses linked to the gastrointestinal tract. The severity of these illnesses is dependent on numerous factors, and prolonged exposure to sewers can have devastating consequences on individuals exposed to them.

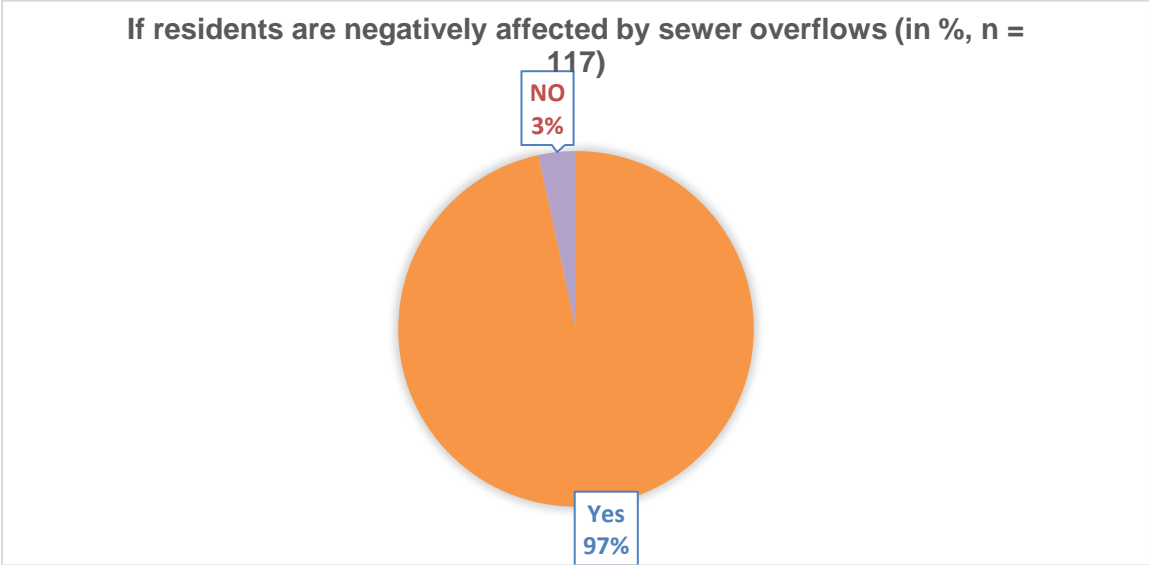


Figure 4.23: If residents are negatively affected by sewer overflows

## **4.5 Responses from city officials**

Interviews were conducted with City officials to gather further insights on the causes of blockages and sewer overflows experienced in the selected area of study. The foremen and superintendents responsible for the respective areas were interviewed numerous concerns were raised by the City officials, with the majority of concerns identifying misuse of the sewers in these areas.

### **4.5.1 Common causes of blockages**

The misuse and disposal of foreign objects have been found to be the leading cause of sewer spillages and overflows. The officials confirmed that the misuse of these services were the leading causes of sewer spillages, and this was exacerbated by theft and vandalism of critical sewer infrastructure. An official highlighted that sewer pump stations are often vandalised, and the back-up generators and other smaller components required for the operations of the pump station are stolen. This therefore leads to sewer overflows as pump stations facilitate the conveyance of sewerage from a particular area. Furthermore, repairs to sewer pump stations are relatively expensive and utilise critical resources that can be allocated to different tasks. This self-inflicted pain further subjects residents to inhumane conditions, with sewer flowing at their doorsteps on a daily basis.

All the 9 officials interviewed (6 city officials and 3 councillors), stated that foreign objects were the leading causes of blockages (see also Table 4.3). The 6 officials from the city further stated that the disposal of fats into the sewer system also causes blockages. These fats are commonly disposed into the sewer system through kitchen sinks and gullies. To be more specific, residents dispose of cooking oil and other fatty products into the sewer system. These fats harden and solidify in the system, causing recurrent blockages. Fast-food outlets and industries are often the main cause of the disposal of fats into the system. However, an accumulation of fats in the system from normal kitchen sinks and gulleys could also contribute towards sewer blockages.

Figure 4.24 illustrates objects that were removed from a sewer line in Nyanga due to recurring blockages. The items that were removed include rags, underwear, condoms, plastic objects, pipes, stones, sand and plastic bags, amongst other items. This phenomenon has become a common occurrence in lower income areas, which further contributes to sewer blockages and the resultant overflows.





*Figure 4.24: Foreign objects removed from sewers in Nyanga*

One political office bearer (also considered as an official) opined that the recurrent spillages were as a result of insufficient capacity of sewer pipes to accommodate the large numbers of residents. All sewers are designed to have a design lifespan of at least 40 – 50 years. Other design considerations cater for any conceivable development that can take place within a suburb based on the zoning rights of the various properties in the catchment area. This view therefore eliminates the suspicion that sewers are under capacity in the area of study. The City of Cape Town uses IMQS software to determine whether the sanitation infrastructure is adequately sized to accommodate all the residents in a particular catchment. The challenges currently facing water and sanitation teams with regards to sewer overflows vary and take many shapes and forms.

#### **4.5.2 Challenges faced by Water and Sanitation teams**

The city officials were requested to comment on the common challenges that they face in their respective areas. The challenges identified are summarized as follows:

- **Crime and gangsterism** – the officials highlighted or stated that they are often targeted when attending to blockages in lower-income areas. Criminals target City officials as they are aware that officials attend to blockages unarmed and sometimes without protection from law enforcement officers. Furthermore, the theft of manhole covers was found to be a common occurrence in low-income areas, exposing sewers to illegal dumping. Gang



activities and fights between rival gangs occur in many areas in Cape Town, delaying service delivery. Services were often withdrawn from areas where gang violence was reported, as team members were often requiring to hide and flee for their safety after fights erupt.

- **Stubborn blockages caused by foreign objects** – stubborn blockages caused by foreign objects disposed were identified as another challenge. These stubborn blockages have often been discovered once a spillage has occurred. The officials reported that these blockages took a substantial amount of time to clear. Excavations to remove the foreign objects were often required where high-pressure jetting or steel rods could not clear them.
- **Protest and strike action** – protests have been found to be a common occurrence in certain areas throughout the City. The residents regularly participated in protests and pickets in response to alleged poor service delivery which further impacted sewer operations in the area. Where protests were observed, water and sanitation services were withdrawn until the area became safe to access. The City of Cape Town has no intention of compromising on the safety of its workers.
- **Stolen manhole covers** – manhole covers were often stolen and sold to scrapyards. This leaves the sewer network vulnerable to illegal dumping and the disposal of insoluble items. The replacement of such manhole covers has a cost implication and affects the operations of the teams on site.
- **Vandalism** – cable theft was also found to be one of the factors that contribute to sewer spillages in certain areas. Pump stations and other specialized sanitation facilities rely on a steady supply of electricity to operate optimally. Cable theft and the theft of critical sewer infrastructure has further worsened the spillages and overflows that occurred in these areas.
- **Limited access to sewers** – encroachments onto City land and the erection of informal structures over sewer infrastructure severely impacts on the operations of the water and sanitation teams. The officials highlighted or stated that residents were often unhappy and resorted to violence when illegal structures erected over sewer infrastructure were removed. This further delayed service delivery and affected the execution of the tasks by the team members.

The officials encouraged residents to take ownership of their services and report any misuse of sewers in all areas throughout the metro. The reduced misuse of sewers can reduce the spillages observed in the road and improve the residents' quality of life.

## 4.6 Conclusions

The City of Cape Town boasts an extensive network of sewer pipes in excess of 9 000 kilometres and over 200 000 manholes. The City has sewer pump stations in excess of 400 and a number of sewer rehabilitation projects across the Metro. The resolution of sewer-related challenges transcends the engineering arena and relies on a combination of engineering and social behaviour.

Sewers are designed to accommodate every conceivable development that can take place within a land parcel, based on the zoning of the land parcel. Human misbehaviour often negatively affect the operations of critical sewer infrastructure in lower income areas. Most sewer overflows and blockages in Samora Machel, Nyanga and Lower Crossroads are attributable to the disposal of foreign objects into the sewer network by the residents. These foreign objects include rags, fats sand, stone, building rubble, broken manhole covers and tyres amongst others. Rags were found to be the most common foreign object which finds its way into critical pump station infrastructure, causing it to malfunction.

Theft and vandalism of sewer infrastructure also contributed to the deterioration of sewer networks in lower income areas. Crime is a prevalent socio-economic challenge that characterizes most township developments in South Africa. This in turn has affected the water and sanitation operations within the selected townships. The maintenance costs associated with repairs to sewer infrastructure were found to be exorbitant and constituted a large portion of the budget allocation from National Treasury. These costs were exacerbated by crime and vandalism and residents were encouraged to report the perpetrators of such acts.

## CHAPTER 5: INTERPRETATION AND LIMITATIONS OF THE FINDINGS

### 5.1 Introduction

This chapter delineates the connections between the literature review in Chapter 2 and the research findings, providing interpretations and insights. The main objective of the research study was to conduct a conditional assessment of the sewerage infrastructure in the selected townships in the City of Cape Town. To achieve this, the following objectives were proposed:

- Assess the current state of sewerage infrastructure in the selected townships in Cape Town (Samora Machel, Nyanga and Lower Crossroads)
- Analyse the annual costs of protecting and repairing dilapidated sewerage infrastructure in the selected townships.
- Assess the causes of the dilapidation of the sewerage infrastructure in the Samora Machel, Nyanga and Lower Crossroads Townships.
- Explore the socio-economic impacts of the sewerage infrastructure dilapidation on the lives of people in Samora Machel, Nyanga and Lower Crossroads Townships.
- Explore and recommend possible solutions to remedy the dilapidation of the sewerage infrastructure in Samora Machel, Nyanga and Lower Crossroads Townships.

The results from the quantitative aspect of the study were presented and discussed in the previous chapter. This chapter aims to establish the correlation between the study's findings and the literature presented in Chapter 2. It summarizes and compares findings from other studies with those of the current research. Each objective is analysed, and the findings are interpreted in conjunction with the reviewed literature. The chapter concludes with a summary of key insights.

### 5.2 Interpretation of the results

Each objective was interpreted as set out in the research objectives:

#### **Objective 1: Assess the current state of sewerage infrastructure in the selected townships in Cape Town**

In order to assess the current state of sewerage infrastructure in the selected townships in Cape Town, data was sourced from the City of Cape Town's database. The database features complaints logged between 2019 – 2021 highlighting the causes of the blockages that were discovered by the teams. In addition to this, data from the residents was used to ascertain the frequency of sewer blockages in the respective areas. Based on the findings obtained, it is clear

that specific challenges exist within the sanitation infrastructure in the selected townships. A total of 1 476 sewer-related complaints were logged for the Nyanga township between 2019 – 2021, while only 399 complaints were recorded for the Samora Machel township. Lower Crossroads recorded the highest sewer-related complaints in this period with a total of 2 658 complaints. This confirms the view by Herbig (2019) that most of the sewerage infrastructure in South Africa is rapidly deteriorating and requires urgent attention. The causes of the failure on the sewerage infrastructure were mostly attributed to the disposal of foreign objects into the sewer system, resulting in blockages and the subsequent spillages. Sutherland et al. (2020) reported that the communities are required to take ownership of the services that cater for their needs them to prevent misuse of the services in question. The misuse of sewer services further subjects people to appalling inhumane conditions where they are expected to live in areas affected by severe overflows.

***Expectations:***

In light of the frequent service delivery protests and the continued criticism of government's failure to provide adequate services, it was expected that the sanitation services in the selected area of study would be dilapidated. The overcrowding experienced in these areas and the rapid development rate of informal settlements in these townships also pointed to the possibility of significantly deteriorated services in lower income areas. Nkomo (2017) advocates for government to conduct meaningful community engagements to resolve service delivery challenges, which is applicable in this case and is therefore recommended.

A study conducted by the Columbia University, focusing on the sanitation infrastructure in the City of Cape Town found that over 7000 blockages were reported per year throughout the entire City between January 2019 – December 2021. The study also identified sand and foreign objects as the leading cause of blockages on the sanitation infrastructure in Cape Town. The aforementioned findings indicate that the sanitation infrastructure, particularly in lower income areas is deteriorating at a rapid rate due to over population, misuse of sewers, vandalism and theft of critical sewer infrastructure.

**Objective 2: Analyse the annual costs of protecting and repairing dilapidated sewerage infrastructure in the selected townships.**

The City of Cape Town has spent a significant amount of money to resolve and maintain sewer blockages and overflows throughout the City. Based on Table 4.2 above, a total of R165 328 540.12 was spent by the local authority to maintain sewer infrastructure in Region 4 of the City. This is a substantial amount of money. It supports Tscheikener-Gratl et al (2020) view that

the repairs and maintenance of sewer infrastructure is relatively expensive and constitutes a large portion of the annual budget. Herbig (2019) argues that these costs are exacerbated by corruption and maladministration and can be reduced significantly by hiring experts in the sector. The City of Cape Town has been voted as one of the best cities to live in in South Africa and allegations of maladministration and corruption in the metro have been limited to a few isolated incidents.

***Expectations:***

Considering the literature and communication received from City officials, it was anticipated that the costs associated with the maintenance of sewer infrastructure would be significantly high and constitute a large portion of the budget. Limberg (2021) alluded to the fact that vandalism increased the costs of maintenance which was the case with the vandalism incident in Khayelitsha (Site B) pump station. Criminals vandalised the pump station, which left parts of Khayelitsha experiencing spillages and overflows. In addition to this, a total of R6 million was spent to rehabilitate the pump station and this money could have been utilized for other essential services.

**Objective 3: Assess the causes of the dilapidation of the sewerage infrastructure in the Samora Machel, Nyanga and Lower Crossroads Townships.**

Based on discussions with city officials as well as previous awareness campaigns, the main causes of dilapidation of the sewer infrastructure in the selected townships was the disposal of foreign objects into the system. The use of newspapers in lieu of toilet papers is often one of the reasons why sewers block frequently. Newspapers were never intended to be utilized as toilet paper. Newspapers do not dissolve in the manner that toilet paper does. The risk of the newspapers accumulating and causing a blockage is very high as seen in many instances. The disposal of household waste into sewers have also resulted in recurring blockages that subsequently cause spillages and overflows. This is a human behavioural issue that requires urgent attention. Numerous studies in the past have often looked at the inactions of the local authorities without delving into the contributory role of residents that result in spillages and overflows. Herbig (2019) found that many of the wastewater treatment plants and facilities throughout the country are not equipped to handle treatment of sewerage. Untreated water is therefore often discharged back into water bodies, and this further contaminates the drinking water sources intended to service communities.

***Expectations:***

Considering the literature and frequency of overflows in the area of study, it was clear that certain factors exacerbate the frequency and occurrence of overflows in the area of study. It was anticipated that human behaviour and the misuse of the sanitation infrastructure by the end users

were the main causes of the sewer spillages. A study conducted by the University of Columbia found that foreign objects account for over 80% of the blockages on sewers throughout the city and these foreign objects are disposed into the system by the residents. The study found that the foreign objects in sewers were more prevalent in lower income areas, however the disposal of foreign objects was also found in higher income areas. Ngcamu (2019) stated that residents of lower income areas were very vocal in demanding better service delivery, however their misuse of critical infrastructure further agitated the deterioration of the infrastructure intended to service them.

**Objective 4: Explore the socio-economic impacts of the sewerage infrastructure dilapidation on the lives of people in Samora Machel, Nyanga and Lower Crossroads Townships**

Residents in lower income areas often suffer the consequences of sewer infrastructure dilapidation due to their lack of capacity to address them. Residents in lower income areas often rely on government for the provision of basic services and cannot afford paying for alternative private services. The survey results indicated that a large portion of residents in the area of study are significantly affected by sewer overflows. Some street-side vendors often have to relocate their stalls to avoid sewer overflows as hygiene is often a big challenge with fast food businesses. Water bodies are also contaminated by spillages, resulting in the contamination and reduced quality of drinking water in these areas. Raw sewerage also contains very harmful bacteria that results in serious illnesses and could lead to death in extreme cases. Many children often find themselves playing in raw sewerage without comprehending the implications of this (Herron, 2021).

***Expectations:***

Sewer overflows are an unwelcome nuisance, and it was anticipated that sewer overflows negatively impact residents in lower income areas. The extent of the effects of sewer overflows on people's lives can be established through engagements with the affected residents. A study conducted by the University of Columbia found that some residents had fallen ill as a result of sewer spillages. Furthermore, it found that the inconvenience of sewer spillages also affected residents' perceptions of the quality of services received from local governments. In many cases, residents are unaware of the impact of improper waste disposal. Therefore, awareness campaigns and meaningful engagements between government and the residents can address this. The study conducted by Columbia University also urged local authorities to incentivise proper waste disposal.

## **Objective 5: Explore and recommend possible solutions to remedy the dilapidation of the sewerage infrastructure in Samora Machel, Nyanga and Lower Crossroads Townships**

The recommendations are presented in Chapter 6. Sutherland et al. (2020) state that the most meaningful way to minimise sewer spillages and safeguard infrastructure is by the communities taking ownership of the services intended to meet their needs. The best way to resolve the matter of sewer spillages is by addressing human behaviour and the misuse of the sanitation infrastructure.

### **5.3 Limitations of the Study**

The study focused on three townships within the City of Cape Town, focusing particularly on sewer related faults between the period of 2019 – 2021. Only 117 respondents were willing to participate in the study as opposed to the intended 150 participants. The study aimed for voluntary participation, ensuring that individuals could not be compelled to participate in the survey against their will. An expanded study group could have provided much more insight into the challenges experienced by people throughout the city with regards to sewer spillages and overflows. The questions with fixed responses might have been misleading since they did not permit respondents to offer an explanation or elaborate further.

The study did not specifically address legislative requirements and 'red tape' hurdles that are known to impede service delivery. Local authorities are governed by numerous rules and regulations, which can also further delay service delivery. The intention of the aforementioned legislation is to ensure that public resources are utilised effectively to avoid fruitless and wasteful expenditure.

### **5.4 Conclusions**

Sewer overflows negatively affect residents in various parts of the City of Cape Town. The deterioration of the services in lower income areas is primarily due to the misuse of critical infrastructure intended to service communities. Numerous sewer related challenges were reported during the period of study however complaints in excess of 7000 are still reported on a yearly basis and this number seems to be increasing. The study faced limitations, notably low resident participation restricting comprehensive insights into the challenges faced by the residents. A broader focus group could enhance understanding of issues arising from sewer overflows.

## **CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS**

### **6.1 Introduction**

Chapter 6 presents conclusions and recommendations derived from the research. The conclusions stem from the analysis and research findings discussed in Chapter 4. Recommendations are formulated in response to the interpretations and conclusions made in the Chapter 5. The conclusions and recommendations align with the research objectives outlined in the previous chapters.

### **6.2 Current state of sewerage infrastructure in the selected townships**

The current state of most sewers in township developments remains unknown due to various factors that affect decision making. Certain indicators can be used by authorities to determine the state of sewers within township developments. Within the City of Cape Town, C3 notifications are often a good example of an indicator that can be used to determine the state of the sewer network in the various areas. However, this method only quantifies the faults that were logged to the City due to overflows observed by the residents. The C3 notifications in excess of 4500 complaints were observed in the study area between 2019 and 2021. However, many of these overflows were caused by the disposal of foreign objects into critical sewer infrastructure. This has been found to be a common occurrence in township developments throughout the city, and acts such as theft and vandalism further worsen the dilapidation of sewer infrastructure.

Continued and prolonged load-shedding periods were also identified as contributing factors to overflows experienced in the study area, since many catchments in the study area were draining towards numerous pump stations. While most pump stations have backup generators, the city faces challenges as criminals frequently target these generators, resulting in significant replacement costs. Despite being designed with a lifespan of at least 50 years, all sewers in the area of study have seen a considerable reduction in their intended design lifespan due to ongoing misuse of the sewer infrastructure. All pipe replacement projects must include an educational awareness programme to educate residents on the correct use of sewer infrastructure. The best engineering practices should consider the human factor of the end user when designing the infrastructure.

### **6.3 Annual costs of repairing dilapidated sewerage infrastructure in the selected townships**

The annual cost of repairs to sewer infrastructure between 2019 – 2021 was found to be extremely high, constituting a large portion of the national budget from Treasury. In all cases, the initial planned costs of repairs to sewer infrastructure were exceeded by the actual cost of repairs. In



total, the City of Cape Town's Regional operations districts spent R165 328 540.12 to maintain sewers between 2019 and 2021, affirming the assertion that sewer repairs are relatively expensive. Such costs have been exacerbated by acts of vandalism and theft. For instance, criminals vandalised and stripped a pump station in Site B in Khayelitsha, and the City of Cape Town incurred approximately R6 million to refurbish the pump station. Community members are urged to report acts of crime and vandalism to local authorities to ensure appropriate measures are taken against the perpetrators. Redirecting funds used to refurbish vandalised sewer infrastructure could be more beneficial if allocated to other community-oriented initiatives. Researchers have implored authorities in various parts of the world to explore alternative and cost-effective asset management models to limit the expenditure on conventional rehabilitation methods for water and sanitation infrastructure.

#### **6.4 Causes of the dilapidation of the sewerage infrastructure in the selected townships**

The main causes of dilapidation of the sewerage infrastructure in the selected townships were largely due to the misuse of the sewer infrastructure by the residents of the affected areas. Rags and other foreign objects were found to be the leading cause of spillages and recurrent overflows in the study area. The foreign objects often entwine within critical sewer infrastructure and cause stubborn blockages and continuous overflows that threaten the health and well-being of the affected community members. The sewerage infrastructure cannot function optimally without addressing human behaviour. The consensus established among City officials generally agreed that the disposal of foreign objects into the sewer network has led to the extensive deterioration of sewer infrastructure in the study area. A significant recommendation emphasized the need for educational awareness programmes to remind residents of the proper usage of sewer infrastructure. Another recommendation emphasised was for local authorities to address inadequate housing to reduce the spread of informal settlements throughout the City. Informal settlements are often placed directly over critical sewer infrastructure, limiting access to such infrastructure. The relocation of informal settlements has proven to be quite challenging and has been politicised by various political organisations within the city.

#### **6.5 Socio-economic impact of the sewerage infrastructure dilapidation on the lives of people in the selected townships**

Sewer spillages and overflows have a socio-economic impact on the residents of the affected communities. Exposure to raw sewerage after sewer spillages has health impacts on the affected residents. Sewerage contains bacteria that are harmful to humans. The recurring spillages and overflows emit unfavourable smells within the affected communities, affecting the well-being of the residents. An undesirable odour can often be smelt when driving through the area of study.

Small businesses that operate on the roadside, particularly those selling fast foods, are often affected by sewer spillages. These vendors are often required to find alternative places of business when spillages occur.

The socio-economic challenges that characterize township developments are the leading causes of the dilapidation experienced on the sewer network in the area of study. Challenges such as crime, vandalism, theft, inadequate housing and the exponential increase in informal settlements have all contributed to the dilapidation. Local authorities and law enforcement agencies are urged to undertake meaningful engagements with communities to address the socio-economic challenges that define township development in South Africa.

### **6.6 Solutions to remedy the dilapidation of the sewerage infrastructure in Samora Machel, Nyanga and Lower Crossroads townships.**

The main objective of the research was to determine the causes of dilapidation experienced on the sewer network in the selected townships within the City of Cape Town. The leading cause of recurrent blockages and overflows is the disposal of foreign objects into the sewer network by the residents of the affected areas. Residents are encouraged to collaborate with the City of Cape Town by disposing of only appropriate items into the sewer network. This approach will enable the city to maintain the infrastructure, accommodate population growth and clear blockages and overflows as efficiently as possible. The residents of the affected areas are urged to report individuals involved in the vandalism of crucial sewer infrastructure and those responsible for attacks on City officials as City staff have become targets of opportunistic criminals. Engineering solutions need to be developed to consider human behaviour. Long-term engineering solutions rely on meaningful engagements between the intended end users of the infrastructure and the local authority responsible for the maintenance of the infrastructure in question. The City of Cape Town should consider the following recommendations to address sewer infrastructure dilapidation in various lower-income areas across the metro:

#### ***Education and awareness***

It is recommended that the City of Cape Town embark on an education and awareness program to educate residents on the correct use of sewers. The continued misuse of the sewer network results in critical resources being diverted to blockages caused by the intended end users of the infrastructure. These resources could be allocated to other proactive cleaning operations. All projects implemented to address sewer rehabilitation should prioritise education and awareness campaigns to remind residents of the appropriate items that can be disposed of in sewers. An example of common misuse of sewers is the disposal of sanitary pads into toilets or the dumping

of fats and waste into the kitchen sink after cooking. Sewers were not designed to accommodate such waste, and this often results in blockages and overflows in the system.

### ***Engineering best practises***

Designers and engineers are recommended to consider revising design standards to cater to lower-income areas. Bulk sewers, trunk sewers and distribution sewer lines can be redesigned to accommodate the possibility of illegal dumping into the sewer system. Sand traps can be installed on sewer networks in lower-income areas to trap foreign objects disposed into the network. However, sand traps require constant maintenance to remove trapped foreign objects. Sand traps can potentially reduce recurrent blockages, allowing local authorities to focus their efforts on proactive maintenance. Screens can be installed at pump stations to filter foreign objects and prevent them from getting into critical mechanical parts of the pump stations. Backup generators and inverters can be installed at pump stations to address the challenge of load shedding (power cuts) that South Africa faces.

Local authorities are urged to explore reducing the bureaucratic red tape involved in initiating sewer rehabilitation projects to allow quicker turnaround times in the implementation of rehabilitation projects. Security should also be prioritised when implementing rehabilitation projects to address any disruptions that often threaten the successful implementation of such projects.

### ***Anonymous reporting lines***

Residents of the affected communities often fear reporting the perpetrators of crime and vandalism for their own safety. The City of Cape Town has developed anonymous reporting lines, allowing residents to remain anonymous when reporting criminals to authorities. The residents should be encouraged to explore these options and take ownership of the sewer infrastructure intended to service their communities.

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## APPENDIX A: QUESTIONNAIRE

### Condition assessment of sewerage infrastructure in selected townships in the City of Cape Town, South Africa.

#### (Questionnaire)

I am a registered student at the Cape Peninsula University of Technology, studying for a Masters in Civil Engineering. I am conducting a study on the condition of sewerage infrastructure in selected townships in the City of Cape Town. May you kindly assist by completing the questionnaire below. The completion will take about ten minutes. All information will be kept confidential and it will be used for academic purposes only. You are free to withdraw from partaking in this survey at any time

#### **PART 1: Demographic profile (Please tick the appropriate box)**

---

##### 1. Gender

Male	
Female	

##### 2. Nationality

South African	
If other, please specify	

##### 3. Age

< 20	
21 to 30	

31 to 40	
41 to 50	
51 to 60	
> 60 (Please specify)	

4. Highest level of education completed

No schooling	
Primary Education	
Secondary Education	
Diploma	
Degree	
Postgraduate Degree	
Other, please specify	

5. Race

Black	
White	
Coloured	
Indian/Asian	
Other, please specify	

6. Township

Samora Machel	
Nyanga	
Lower Crossroads	

7. How long have you been living in this township?

< 1 Year	
1 year – 2 years	
> 2 years – 5 years	
5 – 10 years	
>10 years	

8. Marital status:

Single	
Married	
Divorced	
Widowed	

**PART 2: Sewerage overflow experiences (Please tick the appropriate box)**

How often do sewerage blockages and overflows occur in your area of residence?

Once a week	
-------------	--

More than once a week	
Never occur	

1. How long does it take for council to clear blockages and overflows?

< Hour	
Hour – Day	
> 2 Days	

2. Are you aware of the risk associated with exposure to raw sewerage?

Yes	No
-----	----

3. Are you aware of the water and sanitation call centre number to log complaints?

Yes	No
-----	----

4. Are you satisfied with the level of service received from the water and sanitation teams?

Yes	No
-----	----

5. Are you satisfied with the efforts of the ward councillor in resolving sewerage overflows?

Yes	No
-----	----

6. Has the community been informed and involved with sewer rehabilitation projects?

Yes	No
-----	----

7. Are you aware of objects that may contribute to blockages of sewer systems?

Yes	No
-----	----

8. What kind of objects do you dispose into the sewer line?

Tissues only	
Rags, fats, cloths, toilet papers	

9. Has the community been informed about the proper use of sewer systems?

Yes	No
-----	----

10. Do you report improper use of the sewer systems?

Yes	No
-----	----

**PART 3: Health problems caused by sewerage overflows (Please tick the appropriate box)**

1. Are you aware of the health risks associated with exposure to raw sewerage?

Yes	No
-----	----

2. Are you affected by the bad smell of sewer in your place of residence?

Yes	No
-----	----

1. Do you commonly see raw sewerage flowing through the streets in your place of residence?

Yes	No
-----	----

2. Have you or your family become sick from exposure to raw sewerage?

Yes	No
-----	----

3. Do children play in unclean water puddles?

Yes	No
-----	----

4. Do all manholes in your place of residence have proper covers?

Yes	No
-----	----

5. Has the community been informed about the dangers of exposure to raw sewerage?

Yes	No
-----	----

6. Are you negatively affected by sewerage overflows?

Yes	No
-----	----

**PART 4: Impact of sewerage overflows (Please tick the appropriate box)**

1. Do sewerage overflows affect your personal life?

Yes	No
-----	----

2. How do you deal with sewerage overflows?

Report the blockages	
Inform the ward councillor	
Nothing	

3. Do service protests occur on a regular basis?

Yes	No
-----	----

4. How do you react to service delivery protests?

Join the protest	
Avoid the protest	

5. Do councillors encourage people to report sewerage overflows?

Yes	No
-----	----

6. Do councillors take note of your issues and try to sort them out?

Yes	No
-----	----

7. Rank the challenges of sewerage overflows in order of importance, 1 being the most important and 4 the least important

Vulgar smell	1		2		3	4	
Raw sewer flowing through the streets	1		2		3	4	
Disease	1		2		3	4	
Unhygienic conditions	1		2		3	4	



Do you have any comments? Please add the comments in the space below

.....

.....

.....

.....

.....

## APPENDIX B: INTERVIEW GUIDE

### Condition assessment of sewerage infrastructure in selected townships in the City of Cape Town, South Africa (Interview guide)

My name is Simphiwe Dube, a registered student at the Cape Peninsula University of Technology, studying for a Masters in Civil Engineering. I am conducting a study on the condition of sewerage infrastructure in selected townships in the City of Cape Town. May you kindly assist by participating in this interview. It will take less than ten minutes. All information will be kept confidential and it will be used for academic purposes only. You are free to withdraw from partaking in this interview at any time.

#### Interviewee details:

Name:

Position:

#### **Question 1:**

How long have you been working in the operations department at the City?

#### **Question 2:**

How often are you required to conduct repairs in the area of study (Nyanga/ Samora Machel, Lower Crossroads)?

#### **Question 3:**

What are the common causes of blockages that you have identified when attending to the blockages onsite?

#### **Question 4:**

What challenges do you face when working in these areas? (Safety when working in the dark)

#### **Question 5:**

What is the general response from the public when the teams are busy with a repair/blockage on the sewer line?

#### **Question 6:**

What effect do informal settlements have on the sewer infrastructure in the selected townships?

**Question 7:**

What is your opinion on the use of midblocks in the selected townships?

**Question 8:**

Do backyard dwellers restrict access to the sanitation services in cases where midblocks are involved?

**Question 9:**

What is the role of councillors when you are doing repairs to sewer infrastructure in the selected townships?

**Question 10:**

Do you also work in affluent areas and experience similar challenges there?

**Question 11:**

What are some of the solutions you would recommend to solve the sanitation challenges?

**Question 12**

How much does it cost per year to maintain the sewer infrastructure in the selected townships?

**Thank you for your time and participation in the interview**

## APPENDIX C: RESEARCH APPROVAL FROM CITY OF CAPE TOWN



CITY OF CAPE TOWN  
ISIXEKO SASEKAPA  
STAD KAAPSTAD

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Date : 1 November 2022

To Reference : Director: Policy & Strategy  
: PSRR- 0518

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### Research Approval Request

In terms of the City of Cape Town System of Delegations (March 2022) - Part 35, No 3 Subsection 4, 5 and 6

*“Research:*

- (4) To consider any request for the commissioning of an organizational wide research report in the City and to approve or refuse such a request.*
- (5) To grant authority to external parties that wish to conduct research within the City of Cape Town and/or publish the results thereof.*
- (6) To after consultation with the relevant Executive Director: grant permission to employees of the City of Cape Town to conduct research, surveys etc. related to their studies, within the relevant directorate*

The Director: Policy & Strategy is hereby requested to consider, in terms of sub-section 6, the request received from

Name	: Simphiwe Dube
Designation	: Master's candidate
Affiliation	: Cape Peninsula University of Technology
Research Title	: “Conditions Assessment of Sewerage Infrastructure in Selected Township in Cape Town, South Africa”

Taking into account the recommendations below (see Annexure for detailed review):

## **Recommendations**

That the CCT via the Director: Policy & Strategy grants permission to Simphiwe Dube, in his capacity as a student at the Cape Peninsula University of Technology and as a City of Cape Town employee, to conduct research subject to the following conditions:

- Adherence to the scope and scale of the study as proposed;
- The staff member's City work not being negatively impacted by the research project;
- Approval is subject to staff capacity (time and resource availability) and the willingness of City officials to participate in the provision of data, on a voluntary basis.
- Relevant Water & Sanitation data to be accessed, via communications with Water and Sanitation official, Meagan Donnelly on [Meagan.Donnelly@capetown.gov.za](mailto:Meagan.Donnelly@capetown.gov.za);
- Permission granted by DWS to access data on the cost of maintenance to sewer infrastructure in the areas of study – Nyanga and Phillipi - for 2019 – 2021 ;

Permission is granted by DWS to interview staff at the relevant depots;

Submission of the completed research report to the Director: Technical Services, Water and Sanitation Directorate, the Manager: Research, Policy and Strategy and the Director: Policy and Strategy departments, within 3 months of completion of the research report.

**Delegated authority:**

**Acceptance by Applicant:**

Data requests to be directed to

Approved✓

Comment:

I, .....,

confirm that I agree to abide by the conditions as stipulated above.

\_\_\_\_\_  
Meagan Donnelly.

~~Not Approved~~

Comment:

**Applicant:** \_\_\_\_\_

**Date:** \_\_\_\_\_

\_\_\_\_\_  
**Hugh Cole:** Dir: Policy & Strategy: \_\_\_\_\_

**Date:** \_\_\_\_\_

***CCT departments: No interviews or data to be provided without proof of acceptance of the conditions under which the research permission is granted.***

***Kindly return signed copy to [sivuyilevuyo.rilityana@capetown.gov.za](mailto:sivuyilevuyo.rilityana@capetown.gov.za)***

**CIVIC CENTRE**

**IZIKO LEENKONZO ZOLUNTU**

**BURGERSENTRUM**

12 HERTZOG BOULEVARD CAPE TOWN 8001 PRIVATE BAG X9181 CAPE TOWN 8000 [www.capetown.gov.za](http://www.capetown.gov.za)

**Making progress possible. Together.**



# APPENDIX D: IMQS DATA OF SAMORA MACHEL



Sewer: Absolute Spare Capacity

2023-08-01 17:34

0 200m  
Scale 1:5342







# APPENDIX F: IMQS DATA OF LOWER CROSSROADS



Sewer: Absolute Spare Capacity

2023-08-01 17:45



## **APPENDIX G: CONSENT FORM**

### **Introduction**

My name is Simphiwe Dube, I am a Master's student at Cape Peninsula University of Technology under the supervision of Prof Bongani Ncube. The research forms part of my M Eng degree in Civil Engineering.

### **About the study**

This study investigates the causes of dilapidation on the sanitation services in Nyanga, Samora Machel and Lower Crossroads.

### **Invitation to participate**

This is an invitation for you to voluntarily participate in this study.

### **What is involved in the study?**

Your involvement in the study would require your participation as a participant in an interview or questionnaire. The process should take approximately 10 minutes. Be advised that all interviews will be recorded and used only for the purpose of this study.

### **Risks**

There are no risks involved in participating in this study. The researcher will not request the participants to divulge any personal information or information that may implicate others.

### **Your Participation**

Your participation in this study is voluntary. Refusal to participate will be accepted. Participants may withdraw from participating in this study at any stage without giving further explanation or liability to pay any costs incurred.

### **Confidentiality**

All personal information will be kept confidential and there will be no personal ramifications of any results found. Results will be captured in a manner that will ensure confidentiality and anonymity. All interviews will be recorded using a device and will be secured with a password.

### **Benefits**

Participants will not be compensated for their participation in this study. Your participation in this study is voluntary. The benefits of the study will not be immediate, nor direct benefit to the participants.

**Contact details of researchers**

Student: Mr Simphiwe Dube

Email: 214011941@cput.ac.za

Supervisor: Prof Bongani Ncube

By signing this document, I confirm that:

- The researcher informed me about the above study.
- I have read and understood my participation in the study as explained in this form.
- I understand that my personal details will be kept confidential.
- I understand that I may, at any time, withdraw consent and participation in the study should I wish to discontinue.
- The research gave me enough time to seek clarity and I am ready to continue and participate in the study.
- I have been informed and gave consent for the study interview to be recorded.

Signature:..... Date: .....