Cape Peninsula
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ASSESSMENT OF THE EFICACY OF THE LEGISLATIVE FRAMEWORK FOR GREYWATER MANAGEMENT IN THREE SELECTED MUNICIPALITIES IN SOUTH AFRICA.

by

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DECLARATION

I, Babalo Vala, declare that the contents of this dissertation/thesis represent my own unaided work, and that the dissertation/thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

07 March 2024

Signed **Date**

ABSTRACT

In 1994, the reality for many South Africans in urban informal settlements was displacement, marginalisation, inadequate shelter, accompanied by the lack of access to water supply services, adequate sanitation, greywater nuisances and exposure to waterborne disease outbreaks. The advent of democracy however, has seen the development of a national legislative framework, goals and strategies that will help to manage these spatial, water service inequalities and greywater nuisances in informal settlements. The Water Services Act of 1997 and the SANS 1732:201x are examples of national government interventions to manage greywater in South Africa. Correspondingly, water service institutions such as metropolitan and district municipalities are mandated to develop strategies and by-laws which resembles the national legislative interventions but suitable to local conditions. Despite the significant wastewater policy developments made by the South African government, municipalities still struggle to make corresponding greywater by-laws, implement the mandate of water service provision and to manage greywater nuisances in informal settlements. Greywater challenges are more pronounced in South Africa's Metropolitan municipalities because of their inherently high informal settlement population density. Against this backdrop, this project aimed to review the existing greywater legislative framework of South Africa. In particular, the research objectives were firstly to conduct an empirical review of the efficacy of the legislative framework (the Water Services Act of 1997 and the SANS 1732:201x of 2019 framework) in assisting officials to govern the management of greywater in South Africa's urban informal settlements and secondly to investigate if there is a policy basis in South Africa for non-treatment interventions of greywater by water service authorities in South Africa's informal settlements. The last objective was to assess the state of cooperative governance between municipalities and national government institutions responsible for the management of greywater.

This was a quantitative research design using a cross-sectional survey model. Questionnaires were administered electronically to a sample of 17 municipal leaders whose responsibilities were on water management. Descriptive statistics (including graphs, pie charts) were employed in analysis of the data. Outcomes were reviewed against the alignment or the lack thereof with the SANS 1732:201x standards. There were four findings in this study. Firstly, this study found that the challenges associated with greywater management in informal settlements are caused by water service delivery backlogs and thus institutional in nature. Secondly, the implementation of SANS 1732:201x standards is only possible if the sanitation service level of informal settlements is improved to waterborne sanitation. Thirdly, the Water Services Act of 1997 is ineffective to help manage greywater in informal settlements through reuse since the act does not clearly define and distinguish greywater from blackwater. Lastly, the study found that workers in metropolitan municipalities do not uphold the principle of access

to information enshrined in section 32 of the South African Constitution which states that everyone has the right of access to any information that is held by the state. Moreover, this study recommends the development of laundry houses and incentive-based regulation to implement SANS 1732:201x standards by collecting, treating, and reusing greywater for toilet flushing in informal settlements.

Keywords: greywater, informal settlements, legislation, statistics

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DEDICATION

I dedicate this research to the Maker of all things, the Almighty God.

For (whomever)

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GLOSSARY

Terms/Acronyms/Abbreviations	Definition/Explanation
Basic Sanitation	means the prescribed minimum standard of services necessary for the safe, hygienic and adequate collection. Removal, disposal or purification of human excreta. Domestic waste-water and sewage from households, including informal households.
Basic Water Supply	means the prescribed minimum standard of water supply services necessary for the reliable supply of a sufficient quantity and quality of water to households, including informal households, to support life and personal hygiene.
Bucket system	is a dry on-site sanitation system consisting of a top-structure with a seat positioned above a bucket or other container located in a small compartment beneath.
Communicable Disease Outbreak	means a disease resulting from an infection due to pathogenic agents or toxins generated by the infection, following the direct or indirect transmission of the agents from the source to the host;
Consumer	means any end user who receives water services from a water services institution, including an end user in an informal settlement
Domestic waste	means waste, excluding hazardous waste, that emanate s from premises that are used wholly or mainly for residential, educational, health care, sport or recreation purposes.
Environmental health	encompasses those aspects of human health, including quality of life that is determined by physical, chemical, biological, social and psychosocial factors in the environment. It also refers to the theory and practice of assessing, correcting, controlling and preventing those factors in the environment that can potentially affect adversely the health of present and future generations.
Environmental health services	means the assessment, monitoring, correction, control and prevention of environmental factors that can adversely affect human health. It includes but not limited to anticipation and identification of environmental health hazards and risks regarding: a) Water quality monitoring, b) Food control, c) Waste management, d) Surveillance of premises, e) Communicable diseases control, f) Vector control, g)

	Environmental pollution control, h) Disposal of the dead, i) Chemical safety and noise control, j) Port Health, and k) Malaria Control; l) Hazardous Substances control m) Air Quality Management
Environmentally sound management	means the taking of all practicable steps to ensure that waste is managed in a manner that will protect health and the environment; means waste that does not pose an immediate hazard or threat to health or to the environment, and includes— (a) domestic waste; (b) building and demolition waste; (c) business waste: and (d) inert waste;
General waste	
Greywater	refers to untreated household wastewater, which has not been contaminated by toilet waste. It includes the water from bathtubs, showers, hand basins, laundry tubs, floor wastes and washing machines. It does not include waste from kitchen sinks, garbage disposal units or dishwashers.
Health	means a state of complete physical, mental and social well-being, and not merely the absence of diseases or infirmity;
Health nuisance	means health nuisance as defined in the National Health Act 2003, act 61 of 2003. Means a situation, or state of affairs, that endangers life or health or adversely affects the well-being of a person or community;
Health service	means (a) health care services, including reproductive health care and emergency medical treatment, contemplated in section 27 of the Constitution; (b) basic nutrition and basic health care services contemplated in section 28(l)(c) 25 of the Constitution; (c) medical treatment contemplated in section 35(2)(e) of the Constitution; and (d) municipal health services;
Housing development	means the establishment and maintenance of habitable, stable and sustainable public and private residential environments to ensure viable households and communities in areas allowing convenient access to economic opportunities, and to health, educational and social amenities in which all citizens and permanent residents of the Republic will on a progressive basis have access to--(a) permanent residential structures with secure tenure, ensuring internal and external privacy and providing adequate protection against the elements; and (b) potable water, adequate sanitary facilities and domestic energy supply;
Metropolitan municipality	means a municipality that has exclusive executive and legislative authority in its area, and which is described in section l55 (1) of the Constitution as a category A municipality;
Municipality	

Municipal health services	(a) is an organ of state within the local sphere of government exercising legislative and executive authority within an area determined in terms of the Local Government: Municipal Demarcation Act, 1998;
Informal settlement	for the purposes of this National Health Act, includes- (a) water quality monitoring; (b) food control; (c) waste management; (d) health surveillance of premises; (e) surveillance and prevention of communicable diseases, excluding immunisations; ('j) vector control; (8) environmental pollution control; (h) disposal of the dead; and 10 (i) chemical safety, but excludes port health, malaria control and control of hazardous substances; means Municipal Health Services as defined by Section 1 of the National Health Act, 2003 (Act No. 61 of 2003), and the Constitution of South Africa, Act 108 of 1996;
Non-communicable disease	unplanned settlement on land which has not been surveyed or proclaimed as residential, consisting mainly of informal dwellings (shacks)" and also as "a makeshift structure not approved by a local authority and not intended as a permanent dwelling.
Organised local government.	means a disease or health condition that cannot be contracted from another person, an animal or directly from the environment;
Organisation representing municipalities	means a provincial organisation recognised in terms of section 2 (1) *(b)* of the Organised Local Government Act, 1997 (Act 52 of1997);
Pollution	means an organisation recognised under a law contemplated in section 163 of the Constitution as representing municipalities, or in the absence of such a law, any organisation or organisations considered by the Minister after consultation with the Minister for Provincial Affairs and Constitutional Development as representing municipalities and includes an organisation representing district or rural councils as defined in the Local Government Transition Act, 1993 (Act No. 209 of 1993):
SALGA	means any change in the environment caused by- (i) substances; (ii) radio-active or other waves; or (iii) noise, odours, dust or heat, emitted from any activity, including the storage or treatment of waste or substances, construction and the provision of services, whether engaged in by any person or an organ of state, where that change has an adverse effect on human health or well-being or on the composition, resilience and productivity of natural or managed ecosystems, or on materials useful to people, or will have such an effect in the future;
Slum	means the South African Local Government Association recognised in terms of section 2 (1) *(a)* of

	the Organised Local Government Act, 1997 (Act 52 of 1997);
Treatment	are the areas or pockets within or outside municipal limits where poverty stricken rural migrants find shelter and search for their work and livelihood make necessary adjustment with urban life and get minimum life supporting conditions at affordable rate.
Waste	means any method, technique or process that is designed to— 20 (a) change the physical, biological or chemical character or composition of a waste; or (/;) remove, separate, concentrate or recover a hazardous or toxic component of a waste; or (c) destroy or reduce the toxicity of a waste, 25 in order to minimise the impact of the waste on the environment prior to further use or disposal:
Water services	means any substance, whether or not that substance can be reduced, re-used, recycled and recovered— (a) that is surplus, unwanted, rejected, discarded, abandoned or disposed of; 30 (b) which the generator has no further use of for (he purposes of production; (c) that must be treated or disposed of; or (d) that is identified as a waste by the Minister by notice in the Gazette, and includes waste generated by the mining, medical or other sector, but— (i) a by-product is not considered waste; and 35 (ii) any portion of waste, once re-used, recycled and recovered, ceases to be waste;
Urban water service cycle	refer to water supply and sanitation services and include regional water schemes, local water schemes, on-site sanitation and the collection and treatment of
Water board	wastewater.
	is a concept that explains the storage, supply of freshwater and the management of wastewater.
Water services authority	means an organ of state established or regarded as having been established in terms of the Water Services Act, 1997 to perform. as its primary activity a public function.
Water services institution	means any municipality, including a district or rural council as defined in the Local Government Transition Act, 1993 (Act No. 209 of 1993) responsible for
Water services provider	ensuring access to water services.
Water services work	means a water services authority, a water services provider, a water board and a water services committee.
	means any person who provides water services to consumers or to another water services institution but does not include a water services intermediary.

Water supply services	means a reservoir, dam, well, pumphouse, borehole, pumping installation, purification work, sewage treatment plant, access road, electricity) transmission line, pipeline, meter, fitting or apparatus built, installed or used by a water services institution– (i) to provide water services: (ii) to provide water for industrial use; or (iii) to dispose of industrial effluent.
Wetland	means the abstraction, conveyance, treatment and distribution of potable water, water intended to be converted to potable water or water for commercial use but not water for industrial use.
BCMM	means land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.
BOD	
BLACKWATER	
COD –	
SAR –	Buffalo City Metropolitan Municipality
CSIR –	Biological Oxygen Demand
CoCT –	Wastewater from flush toilets
COGTA –	Chemical Oxygen Demand
DAFF	Sodium adsorption ratio
DEA	Centre of Science and Institutional Research
DM	City of Cape Town
DWA	Department of Cooperative Governance and Traditional Affairs
DWAF	Department of Environmental Affairs, Fisheries and Forestry
EH	Department of Environmental Affairs
GDD	District Municipalities
GDP	Department of Water Affairs
GTS	Department of Water Affairs and Forestry
MDG	Environmental Health
MHS	Greywater Diversion Device
MM	Gross Domestic Product
NDHS	Greywater Treatment System
	Millennium Development Goals

NMMM	Municipal Health Services
NGOs	Metropolitan Municipalities
NEMA	National Department of Human Settlements
NHA	Nelson Mandela Metropolitan Municipality
NWA	Non-government organisations
NIIF	National Environmental Management Act, Act 107 of 1998
NWRS	National Health Act
SAHRC	National Water Act
SALGA	Municipal Infrastructure Investment Framework
SAICE	National Water Resource Strategy
StatsSA	South African Human Rights Commission
WESP	South African Local Government Agency
W.H.O	South African Institution of Civil Engineers
WQ	Statistics South Africa
	World Economic Situation and Prospects
	World Health Organisation
	Water Quality

CHAPTER ONE
1. INTRODUCTION

1.1 Background

South Africa has made considerable progress relating to the delivery of water services and the development of legislations to manage greywater. The development of the Water Services Act (1997) and the subsequent SANS 1732:201 in 2019 for greywater reuse is one of the feats towards realising the sustainable development and management of South Africa's limited water resources. However, wastewater legislation in South Africa is not always clear regarding the management of greywater in informal settlements. The Water Services Act of 1997 is the first binding legal tenet which mandates municipalities to manage wastewater in South Africa. Section 1(ii) of the WSA of 1997 makes provision for the safe removal and hygienic management of greywater in informal settlements. The first limiting aspect of the WSA is that it does not distinguish between greywater and blackwater but treats greywater as one with sewerage (refer to Section 1(xvi). The WSA as a result does not mandate the development of a greywater system separate from the sewerage system but treats all domestic wastewater as the same. In addition, the WSA also does not make any provision for the on-site treatment and reuse of domestic wastewater but mandates the collection and removal thereof to offsite wastewater treatment works. The second aspect of the WSA is the limitation of rights. Section 3(1) of the WSA affords every person in South Africa the right of access to basic water supply and basic sanitation.

The provision of these water services, environmental and consumer health rights is conditional and hinges on the institutional capacity of the municipality to meet these requirements. If a municipality is unable to meet the requirements of all its consumers, section 5 of the WSA then mandates the institution to prioritise the provision of basic water supply and basic sanitation. Pit latrines, bucket system and chemical toilets are examples of what a basic sanitation service constitutes. Chemical toilets, bucket system and pit latrines as temporary interventions are however not fitted to collect and remove domestic wastewater. In the absence of a wastewater conveyance system residents dispose greywater through bucketing outside the shack dwellings which results in greywater nuisances of mosquito infestations, and bad smells due to ponding (Winter et al, 2007). The environmental and consumer health risks are further aggravated when these chemical toilets end up being a permanent solution in some metropolitan municipalities due to weak cooperative governance between municipalities and national government in the areas of financing (SALGA, 2014/2015).

The ongoing greywater challenges of mosquito infestations, bad smells, and risks to waterborne disease outbreaks in South Africa's informal settlements have necessitated the development of more regulations to help officials manage these challenges. Policy

development about the non-potable use of greywater in South Africa as an alternative water resource has been made possible by a series of greywater studies that spans over 20 years. Greywater investigations and the subsequent development of a legislative framework in South Africa is inspired by water shortages and the management of greywater nuisances in informal settlements.

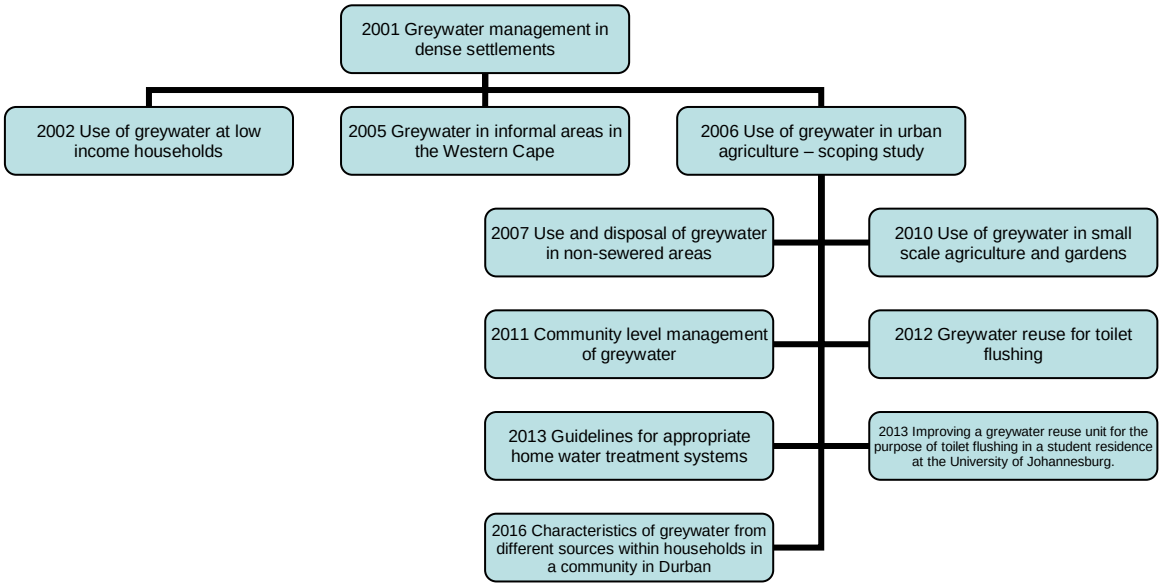


Figure 1.1 List of greywater studies in South Africa since 2001.

The greywater studies were targeted towards household level, onsite greywater reuse within formal and informal settlements in South Africa. The various greywater studies in figure 1.1 have helped to improve stakeholder understanding about the vast nature of the greywater issues in informal settlements. In addition, the greywater studies have assisted water service authorities to recognise greywater as a resource which can help to compensate for water shortages. The studies have led the government to formulate the SANS 1732:201x standard as a national guideline on the safe use and management of greywater at a household level.

South Africa has a climate that varies from desert and semi-desert in the dry north-western region to sub-humid and wet along the eastern coastal area (Benhin, 2006). The annual rainfall index of South Africa is 450mm compared to the global average of 870mm. This rainfall statistics according to DEA (2011), therefore makes South Africa a water scarce country and thus the world's 30th driest country with a high demand for freshwater resources. According to the Water Research Commission (2017) South Africa is expected to be vulnerable to food insecurity over the coming decades due to lower rainfalls caused by global warming. It is on the backdrop of these environmental conditions that South Africa needs alternative sources of water and to recycle wastewater as much as possible. To cut down on water usage many South Africans have resorted to the reuse of greywater. The reuse of greywater is a practice that is common amongst all classes of people in South Africa to supplement irrigation water, either in urban gardens in middle- to upper-income suburbs or in food gardens in lower-income

informal, peri-urban, and rural areas (Rodda, et. al., 2011). However, many informal settlement residents still perceive greywater as waste or unwanted water that is dirty and must be discarded (WRC, 2017). Apart from the water user perception of greywater, lack of infrastructure is one of the leading challenges that are associated with greywater management in informal settlements. According to Winter et al. (2007), the absence, mismanagement, and malfunctioning of treatment systems in informal settlements leads residents to dispose of this greywater onto the ground outside the shack dwelling resulting in health and environment concerns. To mitigate the situation Carden et. al (2007) describes how residents of some non-sewered areas have devised a variety of ways of dealing with health and environmental concerns with respect to nuisance factors like insect, odours and ponding caused by greywater casual tipping around settlements. For example, residents in some informal settlements have agreed to carry all greywater to nearby stormwater infrastructure to prevent ponding around shacks and restrict breeding areas for mosquitoes and flies. The management of greywater like any other resource requires an integrated, multi-layered approach which will see cooperation between households, the ward, followed by the municipality, and the national government (IWA, 2006). The integrated water resource management approach is a way forward for efficient, equitable, sustainable development and management of South Africa's limited resources (UN Water, 2008).

The Integrated Water Resource Management approach as depicted in figure 1.2 is a process that has the following 6 steps: national goals; water resource issues assessment; water resource policy/strategy; IWRM implementation plan; actions of implementation; Monitoring and evaluation of progress. Integrated Water Resource Management is divided into 2 parts. The first half of IWRM is planning which is followed by the second half of implementation. The first step of IWRM is the development of national goals by the highest sphere of government followed by an assessment of water resource issues. The development of a water resource policy is then the third step of IWRM planning. This study is a review of the existing legislative framework of greywater to determine its efficiency as a tool to manage the country's limited water resources. The government of South Africa has recognized the need to manage both blackwater and greywater as a national goal. Following the assessment of wastewater issues the government has consequently developed the Water Services Act of 1997 and the SANS 1732:201 of 2019 to manage blackwater and greywater.

The effectiveness of cooperative governance and other management responses such as regulation, measures, controls, instruments, and processes hinge on the competence of the legal framework in place. Moreover, policies make up the framework to set national development priorities and provide decision-making criteria to guide the development process

towards achieving them. In addition, policies are the cradle of a legislation which establishes the responsibilities and rights of different stakeholders.

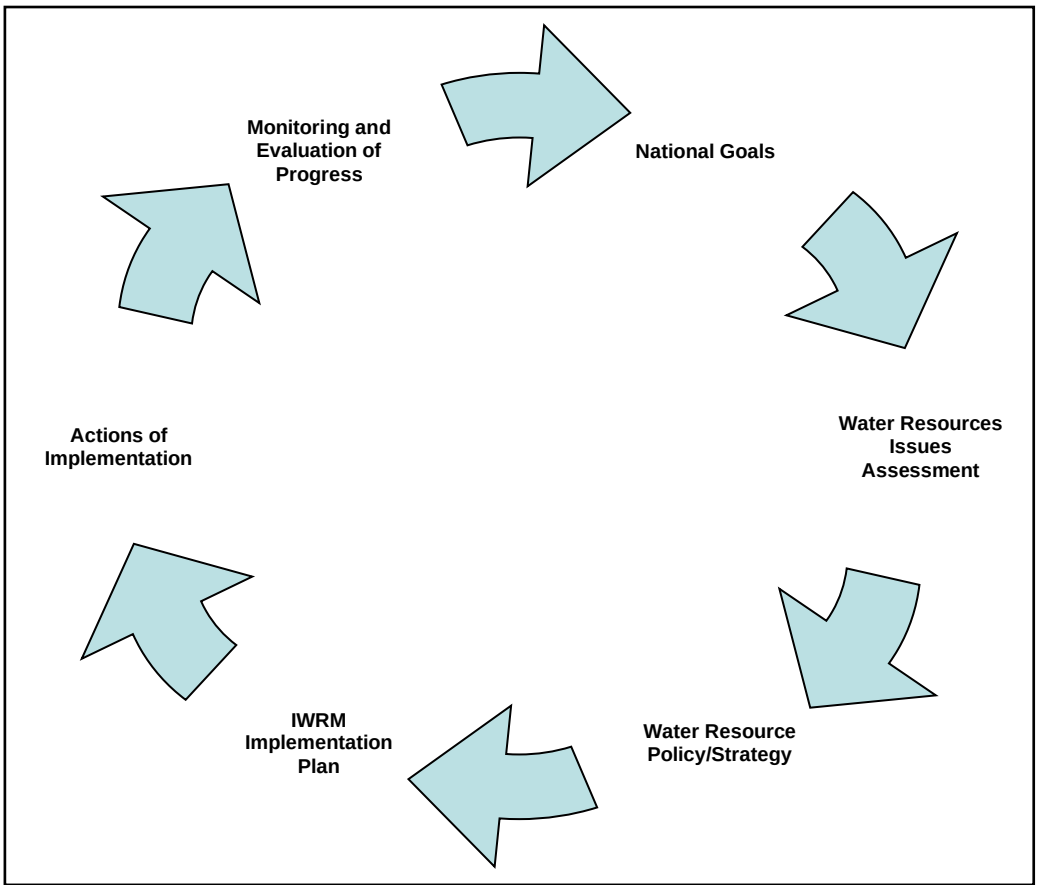


Figure 1.2 Stages of Integrated Water Resource Management (IWRM) planning and implementation (adopted from UN-Water, 2007 and 2008).

This thesis focuses its investigation on greywater management as a public health policy issue. The aim of this project is to formally assess the legislative framework that governs greywater management in South Africa with special emphasis on informal settlements in metropolitan areas to recommend legal reform for institutional proficiency in the provision of water services. In this project, challenges that are associated with greywater management in the informal settlements of 3 of South Africa's 8 metropolitan municipalities namely, City of Johannesburg, Buffalo City, and the City of Tshwane are investigated.

1.2 Location of the study area

Figure 1.3 South Africa with provincial, district borders and metropolitan municipalities. Metropolitan municipalities are highlighted in red and named (www.municipalities.co.za).

The project is located around South Africa's informal settlements of the metropolitan municipalities namely, the City of Tshwane, City of Johannesburg and the Buffalo City metropolitan municipality (refer to figure 1.2). The City of Tshwane and the City of Johannesburg are both found in the province of Gauteng. According to StatsSA (2011), Gauteng has a population of 13.4 million people of which 50% is distributed between the City of Johannesburg (4,4 million) and the City of Tshwane (2,9 million). Formal dwellings are at 82,6% in the City of Tshwane and 81,4% in the City of Johannesburg with informal dwellings (settlements) forming less than 20% of the total households in each of these metropolitan municipalities. The Eastern Cape is the second province where this project is found. Buffalo City is one of two metropolitan municipalities which are in the province of the Eastern Cape. The province has a total population of 7 million people of which 834997 are in the Buffalo City metropolitan municipality. Informal settlements make up 29.8% of the total households in the city (StatsSA, 2016).

1.3 Delineation of the study

The project is a review of the legislative framework that governs the management of greywater in South Africa's informal settlements. Particularly, the Water Services Act of 1997 and SANS 1732:201 of 2019 are greywater related policy guidelines the project reviews. The collection and analysis of data from metropolitan municipalities in the project is limited to the City of Tshwane, Buffalo City and the City of Johannesburg at a local government level. The City of Tshwane, Buffalo City and City of Johannesburg are samples of the 8 metropolitan municipalities in South Africa which are classified under Category A according to the Municipal Structures Act of 1998. At a national level, data was collected from the Department of Water and Sanitation and COGTA to assess the official's understanding of the greywater legislative framework, strength of cooperative governance and greywater issues which affect urban informal settlements.

1.4 Research problem

The Water Services Act of 1997 and the SANS 1732:201 of 2019 does not provide satisfactory legislative guidelines to help officials manage greywater nuisances and exposure to waterborne disease outbreaks in metropolitan informal settlements.

1.5 Research questions

The research questions of this project are as follows.

- Does the current legislative framework in South Africa provide enough guidance for municipal officials to deal with the full range of greywater management challenges in informal settlements?
- What is the state of cooperative governance between the various government institutions with regards to the management of greywater in metropolitan informal settlements?
- Is there a policy basis in South Africa for the non-treatment and diversion of greywater by water service institutions in urban informal settlements?

1.6 Research Aims

The aim of this research was to review the existing greywater legislative framework of South Africa's metropolitan informal settlements.

1.7 Research Objectives

The objectives of this research were.

- To assess if the Water Services Act of 1997 and the SANS 1732:201 of 2019 is a sufficient guide to help officials manage greywater challenges in metropolitan informal settlements.
- To investigate the vast nature of the greywater challenges in South Africa's informal settlements as experienced by municipal officials.
- To assess the state of cooperative governance between the various government institutions with regards to greywater management in metropolitan informal settlements.
- To investigate if there is a policy basis in South Africa for non-treatment interventions of greywater by water service authorities in urban informal settlements.

1.8 Thesis overview

The thesis has a total of 6 chapters. Chapter 1 provides a background to the study. An overview of the integrated water policy approach is given as a management context within which greywater policy must be developed and investigated. The chapter also defines and provides the general attributes that constitute an informal settlement. The City of Tshwane, Buffalo City and the City of Johannesburg are set out as the location of the project in chapter 1. Chapter 1 also brings about the aims, objectives, research problem and questions investigated in the project. Chapter 2 of the project reviews literature on the legal framework and background of relevant legislations about greywater management in South Africa and the international guidelines in place. Greywater is characterized in the chapter and its beneficiation for non-potable use in urban informal settlements is highlighted. Moreover, the history of South Africa's informal settlements with their contribution to the global urban population is investigated. Chapter 2 also provides an overview of the urban water services cycle employed in cities and the state of access to sanitation services per province in South Africa. The chapter also sets out the WHO International guidelines for greywater use, the management practices, and policies in developed and developing countries. Lastly, the chapter provides an overview of the legislative framework that governs the management of greywater in South Africa. In particular, the Water Services Act of 1997 and the SANS 1732:201 of 2019 standards are reviewed.

Chapter 3 of the project sets out the research design and methodology followed to collect data and the analysis thereof. Chapter 4 presents findings of the project. Chapter 5 discusses the limitations of the Water Services Act of 1997 and the SANS 1732:201 of 2019 as policy guidelines for the management of greywater nuisances in urban informal settlements. The chapter also discusses the non-potable uses of greywater for toilet flushing and irrigation in informal settlements and the public health risk factors thereof. The state of cooperative governance between municipalities and national departments is also discussed in the chapter.

Awareness and understanding among municipal officials about greywater issues and legal responsibilities is discussed in chapter 5. Chapter 6 is the conclusion that entails incentive-based regulation and subsidised public laundry houses as recommendations of the project.

CHAPTER TWO
2. LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature on the legal framework and background of relevant legislations about wastewater management in South Africa and international guidelines. In 1994, the reality for many South Africans was displacement, marginalisation, inadequate shelter (State of Cities report, 2016), accompanied by the lack of access to water supply services and adequate sanitation (Nnadozie, 2011). The democratic government of South Africa in 1994 set national goals to redress past spatial (housing) and water services inequalities that were imposed by the Apartheid government by developing a legislative framework. The Reconstruction and Development Programme (RDP) and its later RDP White Paper (1994) is the first policy document that became a cornerstone to address these factors that were incubated by the Apartheid regime. Furthermore, the White Paper on Water and Sanitation was also released in 1994 following the establishment of the central department of water management, DWAF. The 1994 White Paper was further succeeded by the Water Services Act of 1997 and the National Water Act of 1998 which expressed the need to manage freshwater reserves, recycle and reuse wastewater. The constitution of South Africa is the supreme law of the land and is central to developing and implementing water services and environmental health laws that advocate a better quality of life for all the citizens of the country. The right to an environment that is not harmful to health and well-being is given in section 24 (a) and (b) of the Constitution. In obtaining this healthy environment, the provision of water services is central.

The efficient provision of water services can also help to eradicate poverty and promote economic development (DWS, 2015). The Water Services Act, 1997 defines water services as water supply and sanitation services that include regional water schemes, local water schemes, on-site sanitation and the collection and treatment of wastewater (DWS, 2015). The global community has for several years been actively involved in investigating about establishing legislations and water management schemes. It is true that considerable progress has been made concerning the provision of water services and the drafting of a legislative framework for water management but informal settlements with its wastewater management challenges are still a reality of modern South Africa. This project looks to investigate whether these wastewater management challenges in informal settlements are in any way a result of poor policy development. The project also seeks to investigate the assertions that Mathee (2011) makes about the disconnection between national, local roles and responsibilities in the management of water. In addition, the aim of this project is to review the existing legislative framework that governs greywater management in South Africa with special emphasis on informal settlements. This study was a quantitative research design using a cross-sectional survey design. Questionnaires were administered electronically to a sample of 17 municipal

leaders whose role centres on water management. Descriptive statistics (including graphs, pie charts) were employed in analysis of the data. Outcomes were reviewed against the alignment or the lack thereof with the SANS 1732:201x standards.

2.2 Greywater, an alternative non potable resource

The main drivers of greywater investigation and reuse globally is environmental conditions, specifically about water availability, cost benefits of greywater reuse, availability of information for decision-making, risks involved with greywater reuse, interest in sustainability and greywater reuse (Cass et. al., 2012). The WHO lists water scarcity, expanding population with increasing environmental pollution from improper wastewater disposal and recognition of the resource value of wastewater, excreta and greywater as the principal forces that drives the increased use of greywater in aquaculture and agriculture. In a developed country like New-Zealand the main drivers of greywater reuse is water conservation/water shortage, environmental risks, health risks, ongoing management of established systems, direction of regulatory and advisory, greywater information and promotion (CIBR, 2012) and the benefit of reduced demand on wastewater reticulation and treatment systems, both municipal and household. Like New Zealand, the drivers of greywater use in Australia stems from the widespread drought, combined with the continued population growth, has resulted in increasing pressure on drinking water supplies in the largest cities and many regional areas of Australia (GWA, 2010).

In South Africa greywater reuse stems from environmental conditions, specifically about water availability. Furthermore, South Africa faces challenges with respect to water management, including demand for water, resource shortages, environmental degradation, fragmented institutional structures, and basic services backlogs (Kok and Collinson, 2006; Turton, 2008; DEA, 2010; UNEP, 2010; RSA, 2011a, 2011b; Fisher-Jeffes et al., 2012; DWA, 2013). The conditions of water shortages then make the reuse of greywater as an essential mechanism to reduce a household's requirement for potable water (LTC, 2011). The local environmental conditions of water shortages in South Africa are what has guided the government to investigate the potential use of greywater for both aquaculture and agricultural purposes. Due to the increasing demand of greywater use and safety concerns surrounding it, the South African legislators have formulated the SANS 1732:201x standards on greywater use and management with an emphasis on food security and environmental protection.

Policies are the basis of governance, and the WHO Guidelines recognizes public health, environmental protection, and food security (WHO, 2013) as the main policy issues that requires investigation. It has already been proven by Winter et al (2011) that greywater traverses through all these policy issues to ease its management and set up the responsibilities

and rights of different stakeholders. The development of a greywater policy helps to set national development priorities and provide decision-making criteria to guide the development process towards achieving them. This project focuses its investigation on greywater management as a public health policy issue with the aim of reviewing the legislative framework that governs the management thereof. The SANS 1732:201x standards on greywater use and management is South Africa's national government commitment in achieving the 1st and 7th MDG of the eradication of extreme poverty and hunger whilst ensuring environmental sustainability. Additionally, this study seeks to prove whether there is a policy basis in South Africa for non-treatment or diversion interventions and greywater infrastructural development in line with the concepts and procedures held in the SANS 1732:201x standards of 2019 and the Water Services Act of 1997.

2.3 The characterization of greywater

Of interest in this study is the wastewater that emanates from households in non-sewered informal settlements. There are two categories of wastewater that emanates from households namely, black water and greywater. The definition of greywater and its usage varies in various parts of the world. This is because in some parts of the world greywater is often combined with black water in a single domestic wastewater stream. Whereas in other utility services of the world greywater is separated from black water, channelled into the stormwater network, treated, and re-used. According to Nolde (1999) the term "greywater" refers to untreated household wastewater, which has not been contaminated by toilet waste. It includes the water from bathtubs, showers, hand basins, laundry tubs, floor wastes and washing machines (table 2.1). It does not include waste from garbage disposal units or dishwashers. The World Health Organization (2006) also defines greywater as untreated household wastewater that has not come into contact with sewage (or "black water"). The etymology of this "greywater" term stems from its physical characteristics. When this wastewater is stored for even short periods of time, the water will often cloud and turn grey in colour. (Emerson, 1998) According to the National Water Resource Strategy, conventional waterborne sanitation (that uses freshwater to wash away human faeces) is not an efficient system in a context where fresh water is scarce and precious and where fertiliser inputs for agriculture productivity are limiting (DWA, 2013b).

The physical characteristics of greywater are measured in terms of their temperature and suspended solids index. According to Morel and Diener (2006) the greywater temperature is often higher than that of the water supply and varies within a range of 18–30 ^{0}C. These high temperatures are attributed to the use of warm water for personal hygiene and discharge of cooking water. The chemical parameters used to figure out the chemical constituents of greywater is pH, alkalinity, electrical conductivity, sodium adsorption ratio (SAR), biological and chemical oxygen demand (BOD, COD), nutrient content (nitrogen, phosphorus), heavy

metals, disinfectants, bleach, surfactants, or organic pollutants in detergents. The principal sources of greywater are laundry, kitchen sink, dishwasher, shower & bath water and hand basin water. Water sourced from various domestic usages often has the following constituents.

Table 2.1 A representation of the sources and constituents of greywater (Carden, et. al., 2007).

Sources of greywater	Constituents
Laundry water	Soaps, detergents bleaches, water softeners, lint, dirt, small amounts of skin or faecal matter from clothes.
Kitchen sink or dishwashing	Soap, grease, oils, small traces of pesticides and food scrap.
Shower and bath water	Soaps, shampoo as well as hair, skin, oil, faecal matter and urine.
Hand basin water	Soap, toothpaste, mouthwash, hair, shaving cream, residues of cleaning products.[1]

The specification of these sources of greywater as listed in table 2.1 are important as they provide information about the potential levels of contamination of that greywater. The use of the "source" as a basis of classifying greywater is a precautionary measure which is calculated to determine the potential level of contaminants. It is worth noting that the sources of domestic wastewater are determined by the socio-economic rudiments of the various households. For example, indigent households are generally not in possession of any showers, kitchen sinks but utilize hand basins for multi-purposed household duties. In informal settlements the use and disposal of greywater is narrowed and generally the same and there is no in-house kitchen sink utility (facility) to wash dishes & drain the wastewater thereof into the stormwater network. Neither any shower facilities which drain water into the wastewater conveyance system.

2.4 Informal settlements definition

The definition of what constitutes an informal settlement varies from country to country but the United Nations (2002 and 2003) report assists by giving guidelines in table 2.2 of what must be contained in that meaning. The following elements is what characterizes the informal settlements; (a) lack of basic services (b) substandard housing or illegal inadequate building structures (c) overcrowding and high density (d) unhealthy living conditions and hazardous locations (e) insecure tenure; irregular and informal settlements (f) poverty and social exclusion (g) minimum settlement size (h) inadequate access to safe water (i) inadequate access to

[1] Kirsty Carden, 2016, "Resource guidelines for greywater use and management." Water Research Commission project K5/2592 Development of resource guidelines for greywater use and management.

sanitation and other infrastructure (j) poor structural quality of housing (k) overcrowding (l) insecure residential status. This characterization of informal settlements by the UN (2002 and 2003) helps local governments to develop an operational definition and give the required services to informal settlements.

Table 2.2 United Nations definition of informal settlements adopted from the UN-Habitat,2002a,2002b.

United Nations definition of informal settlements		
Characteristics	**Indicator**	**Definition**
Access to water	Inadequate drinking water supply (adjusted MDG indicator)	A settlement has an inadequate drinking water supply if less than 50% households have an improved water supply - Household connection - Access to public standpipe - Rainwater collection With atleast 20litres/person/day available within an acceptable collection distance
Access to sanitation	Inadequate sanitation (MDG indicator 31)	A settlement has inadequate sanitation if less than 50% of households have improved sanitation. - Public sewer - Septic tank - Pour flush latrines. - Ventilated improved pit latrines The excreta disposal system is considered adequate if it is private or shared by a minimum of 2 households.
Structural quality of housing	a. Location	Proportion of households residing on or near a hazardous site. The following locations should be considered. - Housing in geologically hazardous zones (landslide/earthquake or flood zones) - Housing on or under garbage mountains - Housing around highly industrial pollution areas - Housing around other unprotected areas (railroads, airports, energy transmission lines, etc.)
	b. Permanency of structure	Proportion of households living in temporary and/or dilapidated structures. The following factors should be considered when placing a housing unit in these categories: - Quality of construction (materials for wall, floor and roof)

		- Compliance with local building codes, standards, and bylaws
Overcrowding		Proportion of households with more than two persons per room. The alternative is to set a minimum standard for floor area per person (e.g. 5 square metres).
Security of tenure	Security of tenure (MDG indicator 32)	- Proportion of households with formal title deeds to both land and residence. - Proportion of households with formal title deeds to either one of land or residence. - Proportion of households with enforceable agreement or any document as a proof of a tenure of arrangement

Based on the above indicators in table 2.2, the UN Habitat (2002) defines informal settlements as "areas characterized by inadequate access to safe water, sanitation, poor quality of housing, overcrowding and insecure residential status." At present there is no legal definition of what an informal settlement is in South Africa. Instead, various institutions and municipalities provide variable definitions of informal settlements in their bylaws and policy documents. The definitions reflect varying local conditions and varying underlying purposes for which informal settlements data is gathered. Definitions may make specific reference to the lack of municipal services (HDA, 2013). The National Department of Housing Development (2009) as the custodian of the housing sector in South Africa has adopted the UN Habitat guidelines to provide rudimental characteristics that helps to identify an informal settlement which is (a) illegality and informality (b) inappropriate locations (c) restricted public (d) private sector investment (e) poverty and vulnerability and (f) social stress. StatsSA defines informal settlements as an "unplanned settlement on land which has not been surveyed or proclaimed as residential, consisting mainly of informal dwellings (shacks)" and also as "a makeshift structure not approved by a local authority and not intended as a permanent dwelling." However, many municipalities and metropolitans in South Africa (refer to table 2.3) use variable definitions in their policy documents to describe an informal settlement. A municipality is an organ of state within the local sphere of government exercising legislative and executive authority within an area determined in terms of the 25 Local Government: Municipal Demarcation Act, 1998 (Municipal Systems Act s(2)(a). The Municipal Systems Act identifies three types of municipalities in South Africa namely, Category A are metropolitan municipalities, Category B are local municipalities, and Category C are district municipalities.

Table 2.3 Informal settlements definitions by various Metropolitan municipalities in South Africa.

Municipalities	Informal Settlement Definitions

Nelson Mandela Bay Metropolitan	"An informal settlement refers to one or more shacks constructed on land with or without the consent of the owner of the land or the person in charge of the land. In some settlements no formal layouts have been approved whilst in others there are formal sites. Services are communal in nature."[2]
Buffalo City Metropolitan Municipality	"Areas where groups of housing units have been constructed on land that the occupants have no legal claim to, or occupy illegally; Unplanned settlements and areas where housing is not in compliance with current Planning and building regulations (unauthorized housing)."[3]
Mangaung Metropolitan Municipality	"Informal settlements refer to areas that are not formally planned but nevertheless are occupied illegally by the dwellers."[4]
City of Johannesburg Metropolitan Municipality	No formal definition, however the following working definition is used: An informal settlement comprises "An impoverished group of households who have illegally or without authority taken occupation of a parcel of land (with the land owned by the Council in the majority of cases) and who have created a shanty town of impoverished illegal residential structures built mostly from scrap material without provision made for essential services and which may or may not have a layout that is more or less formal in nature.[5]
City of Tshwane Metropolitan Municipality	"Informal settlement means one shack or more constructed on land, with or without the consent of the owner of the land or the person in charge of the land." "Shack means any temporary shelter, building, hut, tent, dwelling or similar structure which does not comply with the provisions of the National Building Regulations and Building Standards Act, 1977 (Act 103 of 1977), the regulations promulgated under that Act and the Municipality's Building Control By-laws and which is primarily used for residential purposes."[6]
Ekurhuleni Metropolitan Municipality	"As a basic characteristic, the occupation of the land is unauthorised. In addition, the use of the land may be unauthorised, and in most cases the construction standards do not comply with building regulations."[7]
City of Cape Town Metropolitan Municipality	"An unplanned settlement on land which has not been surveyed or proclaimed as residential, consisting mainly of informal dwellings (shacks)." Definition of an informal dwelling:"A makeshift structure not approved by a local authority and not intended as a permanent dwelling".[8]
eThekwini Metropolitan Municipality	"Structures which are made of rudimentary materials (wood, cardboard, metal sheets, mud, etc.) without any building plans approved, often on land that has been illegally occupied. Services are very basic or not available at all."[9]

[2]Simiselo Nogampula, Director Human Settlements at Nelson Mandela Metropolitan Municipality
[3]Buffalo City Metropolitan Municipality Draft Integrated Development Plan 2012/13
[4]Mangaung Metropolitan Integrated Development Plan, Review 2013/14
[5]John Maytham, Project Manager: Informal Settlement Formalization Unit, Development Planning and Urban Management
[6]City of Tshwane Metropolitan Municipality, By-laws Relating to the Management and Control of Informal Settlements, Definitions
[7]Study into supporting informal settlements, Main Report, 28 August 2004 Prepared for Department of Housing, Pretoria by the University of the Witwatersrand Research Team
[8] Statistics South Africa
[9]Faizal Seedat, Senior Manager: Housing Unit (Durban)

Variations in the definition of an “informal settlement” is not without any implications. Due to varying definitions of what constitutes an informal settlement in South Africa the approach to service delivery by local government will consequently be different. To date, water and sanitation service backlogs is largely experienced by informal settlements than formal households in South Africa. Pan et al (2014) focuses on providing equitable sanitation services in the informal settlements of Cape Town and shows that inequality will persist as long as differentiation between the services provided to formal areas from the services provided in informal areas in the City.

2.5 Greywater quality issues in informal settlements

The term water quality describes the physical, chemical, microbiological and aesthetic properties of water that determine its fitness for a variety of uses and for protecting the health and integrity of aquatic ecosystems (NWRS2, 2005). Water quality promotes health and well-being for as long as it is not polluted. It is therefore imperative to protect the water quality. Greywater poses a threat on human health especially if it is stored for extended periods of time. The quality of greywater varies depending on the quality of the water supply, its source (sink, washing machine, bath, etc.), as well as the scarcity and costs of freshwater. When greywater is stored it easily becomes a breeding space for pathogens. In addition, the quality of greywater is determined by the health of the people. However, as soon as greywater is polluted the health risks thereof to human beings is increased. Studies by Carden et al. (2007) have shown that greywater produced in densely populated informal settlements are highly polluted and is not safe for direct re-use. According to Winter et al. (2011) the per capita volume of greywater disposed on the ground in the vicinity of shack dwellings is low, greywater runoff often carries solid and liquid waste contaminants that accumulate in ponds in and around settlements and are then discharged via stormwater systems into surrounding surface water systems. The absence of water services infrastructure or the maintenance thereof is one of the leading causes of pollution in the informal settlements.

The health risks associated with greywater are (1) malaria (2) diarrhoea. When greywater is contaminated with faecal material it swarms with micro-organisms, and can bring diarrhoea, disease and death as easily, and as quickly, as safe water brings life (WRC, 2003). The World Health Organisation (WHO, 1996) study shows that diarrhoeal diseases are responsible for over a quarter of the deaths of children in the world. Esrey (1988) further states that 80% of the deaths of children are as a result of a lack of adequate water and sanitation (Esrey, 1998). According to Mara (2001), 43 000 people in South Africa, mainly children under the age of five years, die from diarrhoeal diseases each year. Outbreaks of infectious disease are usually quickly contained, and shortages are typically transient, with people in developed countries

being much less prone to suffer from water-borne diseases than inhabitants of less developed areas, for example in Africa and Southeast Asia. It is worth noting that health risks connected to greywater must be addressed together with poor housing, inadequate water and sanitation, and exposure to indoor air pollution from the use of solid and liquid fuels for cooking (Wright et al, 2014). The potentially negative impacts from greywater disposal are felt most strongly in those areas where water supply services and on-site sanitation have been implemented (Carden, et. al., 2007).

It is evident from the studies done by Winter et.al (2011) that greywater emanating from informal settlements is unsafe for non-potable reuse such as crop irrigation unless it is treated. Standards for Health-Related Water Quality Management on Premises defines safe water as "water that has not been tested and does not present any significant risk to health over a lifetime of consumption (microbiological, physical and chemical quality)." Basic services are the fundamental building blocks of improved quality of life, and adequate supplies of safe water and adequate sanitation are necessary for life, well-being, and human dignity. The accessibility of basic services is closely related to social inclusion and social capital, and the failure of municipalities to deliver services can have a detrimental impact on social and economic development (IDASA, 2010).

Table 2.4 Pollutants in greywater that are associated with risks to human life (Shahsavani et al, 2022).

Contaminants	Sources	Potential Impact
Microbial pathogens (bacteria, viruses, protozoa & helminiths)	Soiled clothes and nappies, decaying organic particles etc.	Human health
Insect vectors, odours etc.	Decaying greases, proteins and blockages from lint, hairs	Quality of life (odours, aesthetics); human health (insect vendors)
Greases and suspended solids	Dish washing, body ablutions, bath soaps, dirty clothes	Soils (clogging of soil pores)
Chemical contaminants	Refers to trace chemical elements that are suspended in greywater	
Sodium	Soaps, detergents and water Softeners	Soils and crops
Boron, dissolved salts, pH, enzymes,	Detergents, water softeners and fabric softeners	Crops

chemicals		
Nitrates, dissolved salts, pathogens	Decaying organic particles, detergents, soiled clothes, etc.	Groundwater
Phosphates, dissolved salts, pathogens	Detergents, decaying organic particles, soiled clothes etc.	Surface Water Resources
Endocrine disruptors (EDCs)	EDCs are compounds not formed inside the body and which can have an impact on the structure and function of an organism's endocrine system.	
Pharmaceuticals	These are pharmaceutical drugs used for a variety of therapeutic purposes for both humans and animals. Examples include analgesics, antiretrovirals, anti-tuberculosis drugs, caffeine, anti-epileptics, cholesterol reducing drugs, antibiotics, and antidepressants.	
Disinfection additives	Domestic greywater is notable for the high concentration of soaps, detergents, and soils it contains. In addition greywater contains pharmaceuticals and personal care products that include antimicrobial agents such as triclosan.	

Greywater generated in households contains a variety of pollutants which makes this wastewater unsafe for direct use. Table 2.4 classes the pollutants that are trapped in greywater into 11 categories. The pollutants are a public health risk and an environmental hazard.

2.6 Global urban informal settlements

In 2001, 924 million people, or 31.6% of the world's urban population, lived in informal settlements (UN, 2001). The majority of the global populace were in the developing regions, accounting for 43% of the urban population, in contrast to 6% in more developed regions. Within the developing regions, sub-Saharan Africa had the largest proportion of the urban population resident in informal settlements in 2001 (71.9%) and Oceania had the lowest (24.1%). South Africa is one of the sub-Saharan countries which contribute to this 199, 5 million informal settlement population in urban areas (refer to table 2.5). In between these were South-central Asia (58%), Eastern Asia (36.4%), Western Asia (33.1%), Latin America and the Caribbean (31.9%), Northern Africa (28.2%) and Southeast Asia (28%). The global population

has increased from 2.5 billion to 7.7 billion people between 1950 and 2010 (UN, 2019). The UN (2019) further estimates that this number could increase to 8.5 billion in 2030, 9.7 billion in 2050, and 10.9 billion in 2100.

Table 2.5 A representation of the informal settlement distribution population in the world (UN-Habitat Agenda).

Informal settlement population in urban areas			
Sub-Saharan Africa	**Southern Asia**	**Eastern Asia**	**Latin America & Caribbean**
199.5 million (61.7%)	190.7 million (35%)	189.6 million (28.2%)	110.7 million (23.5%)

The global community of informal settlement dwellers is dominated by Asia having a total of 554 million residents in 2001 (about 60% of the world's total informal settlement dwellers). Africa had a total of 187 million informal settlement residents (about 20% of the world's total), while Latin America and the Caribbean had 128 million informal settlement residents (about 14% of the world's total) and Europe, and other developed countries had 54 million informal settlement dwellers (about 6% of the world's total). It is almost certain that informal settlement dwellers increased substantially during the 1990s. It is further projected that in the next 30 years, the global number of informal settlement dwellers will increase to about 2 billion, if no firm and concrete action is taken. The urban population in less developed regions increased by 36% in the last decade. It can be assumed that the number of urban households increased by a similar ratio. It seems very unlikely that informal improvement or formal construction kept pace to any degree with this increase, as very few developing countries had formal residential building programmes of any size, so it is likely that the number of households in informal settlements increased by more than 36%. However, trends in various parts of the world varied from this overall pattern.

The City of Cape Town, Tshwane, Johannesburg, eThekwini, Buffalo City, Mangaung, Ekurhuleni and Nelson Mandela Metropolitan municipality are South Africa's highest contributors to these global statistics of urban informal settlements. Between 2001 and 2011, the population in metros grew by more than 25%, compared to 10% in the rest of the country (Turok and Borel-Saladin, 2014). Much of this urban population growth has been in the former black townships and in particular informal settlements, which have grown the fastest because they are "the first recipients of rural (and foreign) migrants in search of work" (Mahajan, 2014). In addition to the expansion of informal settlements, many households are renting in backyard shacks. Again this has been in townships and new low-income housing (RDP) settlements. The decrease in household from 4.5 people in 1996 to 3.6 per household (StatsSA, 2012) have

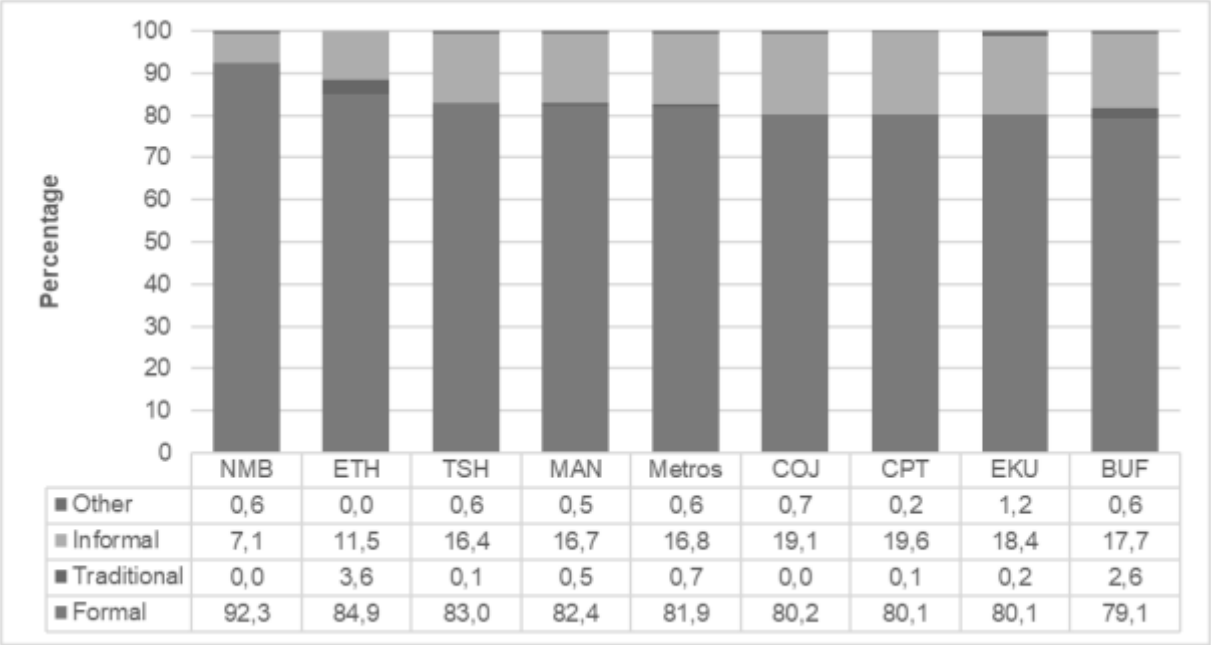
resulted in an escalating demand for housing within metropolitan areas, as well as an increased demand for employment opportunities, infrastructure, and services.

2.7 The history of informal settlements in South Africa

The existence of informal settlements in South Africa's Metropolitan Cities is the legacy of the Apartheid spatial forms and policies. The housing policy of the Apartheid government forced millions of South Africans to settle in urban townships and informal settlements (De Beer, 1993). Overcrowding of townships resulted in severe and inadequate infrastructure and service delivery backlogs which resulted in the collapse of local governance (SAHRC). When the Apartheid regime gave way to a racially inclusive Democratic government in 1994 the reality for many South Africans was inadequate shelter (State of Cities report, 2016), accompanied by the lack of access to water supply services and adequate sanitation (Nnadozie, 2011). Today (28 years later), access to improved water and sanitation services and quality houses for urban informal settlement is still a major problem which according to Forde et al (2021) is an Apartheid legacy of economic and structural violence.

The function of the South African democratic government according to the 1998 White Paper on Local Government has been to redress the past ills of the apartheid and colonial legacies of spatial distortion. In the first 10 years of South Africa's democracy the Constitutional mandate was translated into the housing policy that contained 7 strategic thrusts which primarily informed subsequent legislation and policies. In 2004 the South African housing policy adopted the UN-Habitat's ethos of Cities without Slums and the principle of Sustainable Human Settlement. By adopting this ethos, the South African government to all intents and purposes is working towards eradicating informal settlements from all urban spaces. About 60% of South Africa is urbanised and this is projected to be 70% by 2030 (refer to figure 1.3). Urbanization is the driving factor of migration. The analysis done by Kok and Aliber (2005) and Kok and Collinson (2006) on the motives for migrations used place-related expectations, weighted by the values attached to the underlying goals, as the primary determinations of migration intentions. People migrate from rural areas and small towns to large urban centres in a quest for jobs and a quality of life. Most job-seeking migrants moving to cities first live in informal settlements, which are an affordable entry to the city. Many migrants cannot break into the urban labour market and find it difficult to move out of shacks into more formal accommodation. The average residence period within urban informal settlements has increased from about two to four years in the early 1990s to 10 years currently. Informal settlements often have high population densities, and their residents have high social vulnerability to climate change.

Table 2.6 Percentage of households that lived in formal, informal, and traditional dwellings by metropolitan municipality in 2019 (Courtesy of GHS, 2019).



	NMB	ETH	TSH	MAN	Metros	COJ	CPT	EKU	BUF
Other	0,6	0,0	0,6	0,5	0,6	0,7	0,2	1,2	0,6
Informal	7,1	11,5	16,4	16,7	16,8	19,1	19,6	18,4	17,7
Traditional	0,0	3,6	0,1	0,5	0,7	0,0	0,1	0,2	2,6
Formal	92,3	84,9	83,0	82,4	81,9	80,2	80,1	80,1	79,1

An approximate figure of 81,9% of households in all the metropolitan municipalities are formal in nature. Informal settlements make up 16,8% of households in the metros whilst traditional dwellings are at 0,5% according to table 2.6. The City of Cape Town (19,6%) and the City of Johannesburg (19,1%) has the highest informal settlement clusters in the country which is followed by Ekurhuleni (18,4%) and Buffalo City Metro (17,7%). The Nelson Mandela Bay metro contrary to COJ and CPT has the lowest informal settlement clusters in South Africa.

2.8 Urban water services cycle

The urban water cycle is a concept that explains the source, storage, supply of freshwater and the management of wastewater as demonstrated in figure 2.1. Water Services is a nonstop delivery process “from source to tap” and “from tap to source”. The “source to sink” process explains what is supposed to happen with greywater generated in the households. For this process to be complete it requires the natural resource (water), processing (treatment works), distribution infrastructure and effective operation to deliver the actual output (potable water & safe sanitation) and its ultimate outcome (healthy people). It requires much more than infrastructure and is dependent on sequential delivery along a value chain. Municipalities are mandated by South Africa’s Water Services Act of 1997 to supply each household with the minimum of 6 kilolitres of water per month. This standard applies to the formal households as well as to the informal households. The management of wastewater must go with the supply of potable water.

Wastewater emanating from serviced households is disposed into the internal pipe network which eventually lands into the stormwater or sewer system. In informal (unserviced)

settlement settings however this biorhythm of water supply is disjointed since greywater is disposed of onto the ground outside the dwellings (Carden, et. al., 2007) through casual tipping. Due to the informal nature of these dwelling units proper planning and installation of the necessary greywater disposal infrastructure was not done and thus making the greywater challenges the inevitable. According to Morel and Diener (2006) the quality of greywater is intricately linked to the quantity of greywater generated, with the volumes of greywater generated per household varying, i.e. lowest in low-income households (20l/d to 30l/d) and highest in households with in-house taps and an affluent lifestyle. The average greywater return from informal settlements in South Africa is 75% of household water consumption; and the housing density in these settlements means that there are high overall volumes of greywater generated, even when the amount of water used per dwelling is relatively low (Carden et al., 2007).

Furthermore, studies by Carden, et. al. (2007) shows that greywater generated in informal settlements has a much greater pollution load compared to the formal settlements and this is due to the high housing densities. Consequently, greywater generated from these dense informal settlements are not fit for agricultural re-use but must be directed at disposal or off-site treatment facilities. In non-sewered informal settlements in South Africa, including those with limited waterborne services and drainage, the reality is that greywater often merges with toilet water and other effluent flows thus creating a toxic mix of contaminated water that poses a danger to human health and the environment. Although the per capita volume of greywater disposed on the ground in the vicinity of shack dwellings is low, greywater runoff often carries solid and liquid waste contaminants that accumulate in ponds in and around settlements and are then discharged via stormwater systems into surrounding surface water systems (Winter et al., 2011). Pollutants in greywater can include both chemical and biological contaminates that can significantly impact human, animal, and environmental health under certain conditions (Alexander and Godrej, 2015). Next to housing densities, the absence or insufficiency of basic services for water, sanitation, stormwater management and solid waste disposal is one of the leading causes of pollution in the informal settlements. In addition, all these factors directly impact the health of the people.

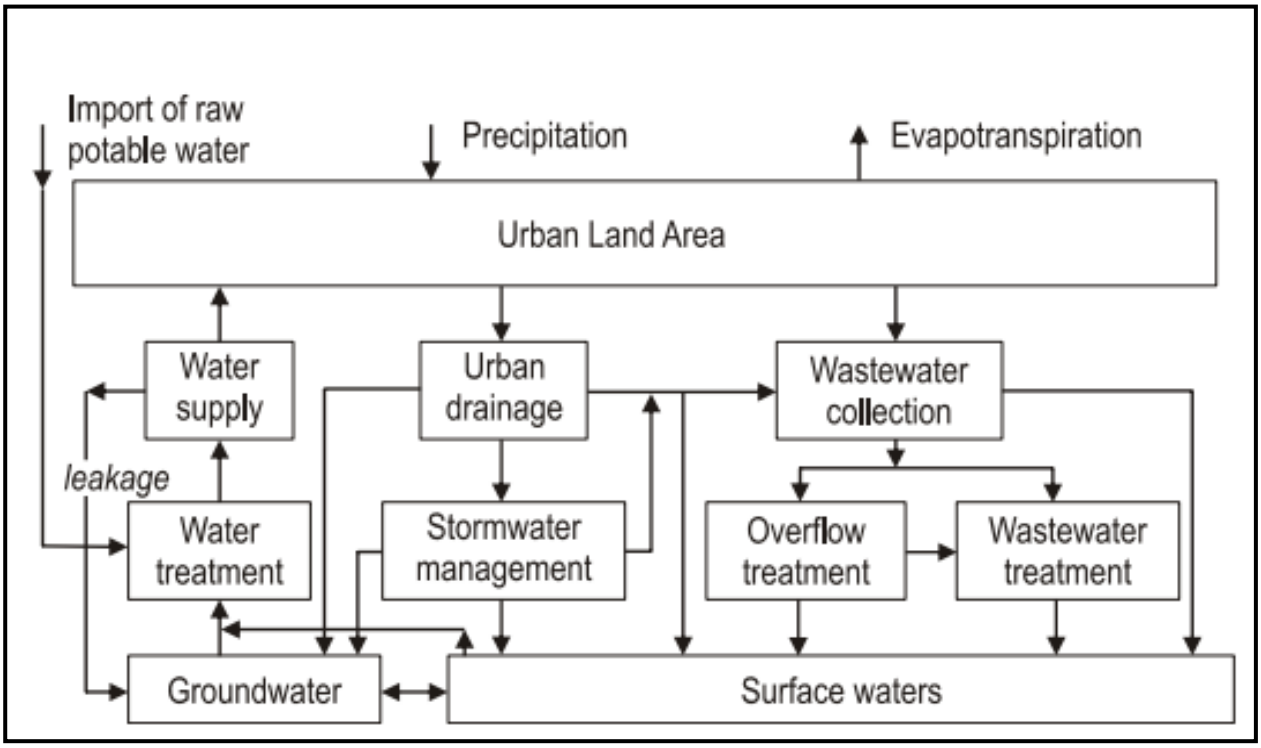


Figure 2.1 Components of urban water cycle and pathways (Marsalak et al, 2007).

In the absence of suitable conveyance systems, greywater is disposed onto the ground outside dwellings (Carden, et al. 2007). The NNS for Domestic Water and Sanitation Services (2017) refers to this kind of greywater disposal as casual tipping. The type of soil onto which greywater is disposed has a direct impact on the environmental health conditions. For instance, casual tipping in the yard can be tolerated, provided the soil has good permeability and is not continually moist. On the other hand, casual tipping becomes intolerable when it takes place on impermeable soils with poor drainage conditions (CSIR, 2000). Under these conditions (impermeable soils) casual tipping can result in ponding and/or muddy conditions, with adverse health effects as mentioned above. The environmental and health impacts can further be aggravated by high population densities. Waterborne sanitation in such areas (high population dense), is therefore the most proper technical solution and should be regarded as a basic level of service for the purposes of the free basic sanitation policy (DWAF, 2003). In addition, to population density, urban runoff from areas of human settlements with poor sanitation services is one of the main sources of pollution that have a negative impact on water quality (Edokpayi, 2017).

2.9 Access to sanitation services by municipality

This section of the project assesses the state of sanitation access in each municipality as per legislative framework. The scope of this study limits its assessment of sanitation access to the municipalities which fall under Category A. The Department of Water and Sanitation (2015) names 5 infrastructural levels of sanitation services provision in South Africa. The sanitation levels include bucket toilets, Ventilated Improved Pit Latrine (VIP), waterborne sanitation,

septic tanks, soak-aways and urine diversion toilets (DWS, 2015). In 2016 about 89,8% of households in South Africa used piped water as the main source of drinking water, 4,3% of households still relied on water from unsafe sources such as rivers, streams, wells or springs (StatsSA, 2016). Households using standpipes as the main source of drinking water has increased by 5.3% over a period of 15 years. The efficient management of greywater can play a significant role in improving the quality of life and health. The goal of sanitation services is to advocate and implement effective and sustainable greywater management practices to protect public health and prevent pollution of the environment (Core norms and standards for sanitation services). Households will produce wastewater (greywater) if water is supplied to its settlements. Greywater is generated in both formal and informal settlements. Table 2.7 shows the percentages of households which have access to basic sanitation according to the various levels per province. The overall percentage of households with access to flush toilet facility connected to a public sewerage system in South Africa is at 60,6%. The Western Cape is the leading province in terms service levels with 90,5% of its household having access to flush toilet connected to the sewerage system.

Table 2.7 Access to sanitation based on service level per province (StatsSA, 2011).

Service level	WC	EC	NC	FS	KZN	NW	GP	MP	LP	RSA
Flush toilet connected to public sewerage system	90,5	44,4	63,2	70,1	43,1	43,9	84,4	43,0	20,8	60,6
Flush toilet connected to a septic system	2,9	2,3	5,9	2,1	3,7	3,8	1,9	2,7	2,8	2,7
Chemical toilet	1,2	5,6	0,3	2,1	14,6	0,9	1,5	3,3	1,6	4,2
Pit latrine with ventilation pipe	0,1	27,7	9,4	6,8	18,3	16,9	2,1	14,7	28,0	12,2
Pit latrine without ventilation pipe	0,2	9,6	9,8	11,2	12,2	28,2	6,1	28,8	39,8	13,7
Ecological toilet	0,0	0,4	0,3	0,2	0,7	0,3	0,1	0,5	0,1	0,3

Bucket toilet (collected by municipality)	2,9	1,3	2,9	2,5	0,4	0,1	2,3	0,2	0,1	1,4
Bucket toilet (collected by household)	0,8	0,9	1,4	1,4	1,3	0,5	0,4	0,7	0,6	0,8
Other	0,5	1,9	1,1	2,0	3,1	1,5	0,6	3,0	2,0	1,6
None	0,9	5,9	5,5	1,7	2,5	3,9	0,5	3,1	4,3	2,4
Percentage	100,0	100,0	99,9	100,1	99,9	100,0	99,9	100,0	100,1	99,9
Numbers (thousands)	1 934	1 773	354	947	2 876	1 249	4 951	1 239	1 601	16 923

Households relying on chemical toilets are at 1,2%, and bucket toilets collected by the municipality is at 2,9%. The Gauteng province provides the second highest sanitation level access after the Western Cape with 84,4% of its households having access to flush toilet connected to the sewerage system. Households relying on pit latrines are 8,2%, chemical toilet facilities are at 1,5% and there is 2,3% households which make use of bucket toilets provided by the municipality. The Eastern Cape (44,4%), Kwa-Zulu Natal (43,1%), North West (43,9), Mpumalanga (43%) and Limpopo (20,8%) have the lowest percentage of households that have access to flush toilet connected to the sewerage system.

The lowest infrastructural levels of sanitation services that a municipality can provide in South Africa is the chemical toilet, pit latrines and a bucket system facility. Chemical toilets are for temporary use however due to increasing demands for sanitation services municipality end up leaving these facilities on a permanent basis. The overall percentage of households depending on chemical toilets is at 4,2%, pit latrine with and without ventilation pipe is 25,9%. The bucket system toilet which is provided and serviced by the municipality is at 1,4% nationally. The Limpopo province makes up the highest percentage of improved sanitation access backlog in South Africa with 67,8% of its population still relying on pit latrine facilities. Limpopo is then followed by the North West (45,1%), Mpumalanga (43,5%), KZN (30,5%), and Eastern Cape (37,3%) have the highest levels of unimproved pit latrine sanitation service levels in South Africa. The Western Cape (2,9%) and Northern Cape (2,9%) have the highest recorded percentage of households followed by the Free State (2,5%) that still rely on a bucket system facility provided and serviced by the municipality.

Table 2.8 Access to improved sanitation backlog based on municipal category (StatsSA, 2011).

Municipal Category	Access to improved sanitation	No Access to improved sanitation	Total	Backlog
Metro (A	6 585 721	960 574	**7 546 295**	**12,7**
Secondary city (B1)	1 960 433	620 923	**2 581 356**	**24,1**
Large town (B2)	1 024 083	348 523	**1 372 606**	**25,4**
Small town (B3)	1 613 470	563 990	**2 177 460**	**25,9**
Rural municipality (B4)	1 602 183	1 643 408	**3 245 591**	**50,6**
South Africa	**12 785 891**	**4 137 418**	**16 923 309**	**24,4**

According to table 2.8 metropolitan municipalities record the highest percentages in terms of sanitation service access as compared to other municipal categories. Backlog percentages on both improved and unimproved sanitation services in the 8 Metropolitan municipalities combined is at 12%. Rural municipalities have the highest backlog percentages in terms of access to basic sanitation. Despite the low backlog percentages in metropolitan municipalities, access to improved sanitation is still a major challenge as 960 574 people are recorded to have no access to improved sanitation. Improved sanitation service backlogs are particularly highest in eThekwini (22,7%), Mangaung (21,1%) and the City of Tshwane (18,7%) metropolitan municipality.

Table 2.9 Sanitation service infrastructure quality index of households based on the municipal category (StatsSA, 2011).

	Number of households by service level						
	None	**Minimal**	**Basic**	**Intermediate**	**Full**	**Total**	**Index score**
Municipal category							
Metropolitan (A)	114 631	228 386	388 136	412 079	6 403 064	7 546 296	4,7
Secondary city (B1)	86 482	35 470	418 911	267 072	1 773 421	2 581 356	4,4
Large town (B2)	60 962	29 671	192 714	234 484	854 775	1 372 606	4,3
Small town (B3)	131 795	52 102	294 497	337 728	1 383 981	2 200 103	4,3
Rural municipality (B4)	287 906	31 602	1 021 021	1 574 899	307 521	3 222 949	3,5

According to table 2.9 the index scores for the 8 metropolitan municipalities were all higher than 4,4 out of a possible 5, with the lowest index score estimated for Mangaung (4,4) and the highest score (4,8) shared by the Cities of Johannesburg and Cape Town, and Nelson Mandela

Bay. The StatsSA (2016) report on access to sanitation found that the percentage of households that use flush toilets increased from 60,1% in 2011 to 63,3% in 2016, while those that used ventilated pit toilets increased to 12,2% (refer to table 2.10).

Table 2.10 Household access to basic sanitation services on the basis of the category A metropolitan municipalities (StatsSA, 2016).

Sanitation			
Municipal category A	**Access to improved sanitation**	**Sharing toilet**	**Access to refuse removal**
Buffalo City	86,8	33,0	61,1
City of Cape Town	92,8	29,7	90,8
Nelson Mandela Metro	93,3	21,2	90,4
Mangaung	78,9	28,0	83,6
eThekwini	77,3	33,0	83,6
City of Johannesburg	93,6	49,3	89,0
City of Tshwane	81,3	32,1	82,8
City of Ekurhuleni	86,7	46,2	87,2

2.10 World Health Organisation international guidelines for greywater reuse

The World Health Organisation is a United Nations agency that connects nations, partners and people to promote health and serve the vulnerable communities (WHO, 2022). As the global custodian of public health, WHO has consequently developed guidelines on the use of greywater, excreta and wastewater in order to provide a consistent level of health protection in different settings. The first edition of the guidelines was published in 1973, followed by the 1989 second edition. The 1973 WHO edition, entitled "*The reuse of effluents: Methods of wastewater treatment and health standards*" are guidelines for the reuse of domestic wastewater for agricultural, recreational, industrial, economic and municipal purposes. The guideline further highlights the potential health effects associated with the direct or indirect use of wastewater. It is worth noting that the guideline does not distinguish blackwater from greywater but treats all domestic wastewater as the same. In addition, the guideline advocates the establishment of central government agencies with a legislative mandate for pollution control, water supply and health. The National Department of Water and Sanitation, Department of Health, Municipalities and the various Waterboards are examples of such agencies that the South African government has set up to manage its wastewater affairs. The second edition of 1989 are "*Health guidelines for the use of wastewater in agriculture and aquaculture*." The later third edition of the guidelines was published in 2006 which is split into three volumes focusing on the safe use of wastewater, excreta, and greywater in agriculture. The four volumes have the following focus areas;

- **Volume 1**: Policy and regulatory aspects
- **Volume 2**: Wastewater use in agriculture
- **Volume 3**: Wastewater and excreta use in aquaculture

The 3rd edition is the first guideline to clearly distinguish blackwater from greywater reuse. The present third edition of the Guidelines has been updated based on new health evidence, expanded to better reach key target audiences, and reoriented to reflect contemporary thinking on risk management. Moreover, the guidelines were updated to consider scientific evidence concerning pathogens, chemicals, and other factors, including changes in population characteristics, changes in sanitation practices, better methods for evaluating risk, social/equity issues, and sociocultural practices. Of interest in this project is to examine how these international standards for greywater reuse can be adopted and adapted to develop wastewater related policy suitable for South Africa's informal settlements network context.

2.11 Greywater management in developed vs developing countries

The World Economic Situation and Prospects (WESP) classifies all countries of the world into one of three broad categories namely (a) developed economies (b) economies in transition and (c) developing economies. South Africa is an example of a developing country. Van Bergeijk (2016) notes two advantages of classifying countries such as analytical and operational purposes. The operational advantage is that it helps to understand and straighten out problems in an increasingly complex and heterogeneous world. The challenges that face urban water management are different in developed countries compared to developing countries (World Bank, 2015). Additionally, according to Conteh and Ohemeng (2009), access to resources directly impacts the approach to environmental health politics. In other words, shortages in national budgets and requirements for water and sanitation financing in developing countries is likely to affect any implementation of wastewater management policies. The approach to the implementation of the WHO Guidelines will so vary from country to country based on set state priorities. In addition, the extent to which developed-world cities are affected by environmental change, sustainability, and the development of disease vectors from stagnant or unmanaged water courses is far less than in developing cities. This project compares the greywater use practices and policies of both South Africa (developing economy) and Australia (developed economy). This is because the two countries share almost similar low rainfall, semi-arid climatic conditions and have consequently been investigating the reuse of greywater as an alternative water resource. In addition, the two countries have developed greywater policy which makes provision for non sewered informal settlements.

2.11.1 Australia's greywater legislative framework

The Australia government has taken a lead from the World Health Organisation by being one of the first countries in the world to develop comprehensive policies for the management of greywater as a means to compensate for freshwater shortages. Approximately 55% of all the

households in Australia use greywater with the majority actively taking part in water saving activities (ABS, 2007). Greywater use in Australia is regulated by a variety of state and territory government environmental, health and water authorities (NWC, 2008). The Australian government has developed numerous national and state codes, standards and guidelines that relate to the installation of greywater diversion devices (GDD), greywater irrigation systems (GIS) and greywater treatment systems (GTS). This project is not focusing on the state codes and standards for greywater management in Australia but rather on the national guidelines in table 2.11. This is because the national codes, standards and guidelines are supreme above all the other state guidelines.

Table 2.11 National legislative framework for greywater management in Australia (Waterlines report systems No 10, November 2008)

National legislative framework for greywater management in Australia	
National Standards	**National Guidelines for water recycling (protection of human health and the environment)**
AS/NZS (2003b) AS/NZS 3500 Plumbing and drainage code	NRMMC and EPHC (2006)
SAI Global (2003) Product Certification. Product Compliance Program WATERMARK Level 1.	
AS/NZS (1998) AS/NZS 1546.1:1998 *On-site domestic wastewater treatment units—Septic tanks*	
AS/NZS (2001a) AS/NZS 1546.2:2001 *On-site domestic wastewater treatment units—waterless composting toilets*	
AS/NZS (2001b) AS/NZS 1546.3:2001 *On-site domestic wastewater treatment units—Aerated wastewater treatment systems*	
AS/NZS (2003a) (2008 draft released for public comment: AS/NZS 2008 Draft) – AS/NZS 1547:2000 or 2008 *On-site domestic-wastewater management*	
AS/NZS (1994) AS 1319—1994 *Safety signs for the occupational environment*	
AS/NZS (1996) AS 2700—1996 *Colour standards for general purposes*	
AS/NZS (1995) AS 1345—1995 *Identification of the contents of pipes, conduits and ducts*	

The Western Region of Australia has for long pioneered the work of the investigation and legalisation of greywater as an alternative water resource in Australia. In 2010, the Chief Health Officer of Western Australia in accordance with Section 344A (2) of the Health Act

(Miscellaneous Provisions) 1911 endorsed the “Code of Practice for the Use of Greywater in WA 2010.” The objective of this Code is to assist in the promotion of acceptable long-term greywater reuse and promote conservation of quality ground and surface water supplies. The Code of Practice for the Use of Greywater in WA 2010 has consequently replaced any earlier edition. Amongst other things the Code set the following minimum requirements for the reuse of greywater in sewered areas;

- Single residential domestic premises
- Multiple dwellings producing up to 5000 L/day of greywater
- Commercial premises reusing up to 5000 L/day.

Section 2.1.2 of the Code also takes into consideration the use and management of greywater in informal non-sewered settlements. The Code has vested all the authority to approve greywater treatment systems in informal non-sewered settlements on the local government.

2.11.2 Greywater legislative framework in New Zealand

New Zealand similarly to Australia has made greywater investigation a national issue. Greywater investigations and reuse in New Zealand is driven by water conservation and the benefit of reduced demand on wastewater reticulation and treatment systems, at both a municipal and household level. Nationally applicable policy, legislation or guidelines for greywater reuse are lacking in New Zealand (Zaayman 2014) instead regional legislations takes precedence similar to Australia. Although there is no national regulation for greywater reuse in New Zealand, the diversion and reuse of greywater remain popular amongst the residents. For example, the current legislation of the Kapiti Coast District Council proposes the use of diverted greywater for subsurface irrigation of land and restrict the use of greywater for irrigation to the property from which it originated (Kapiti Coast District Council 2017). The Kapiti Coast District, Central Otago, and Nelson are the drier regions of New Zealand and thus the search for alternative sources of water and reuse of greywater is indispensable in these regions.

2.11.3 United States of America greywater legislative framework

The United States of America (USA) does not have a federal legislative framework for greywater use instead there is state based legislations developed by various states. Non-government organisations (NGO) like the American National Standards Institute (ANSI) and the National Sanitation Foundation (NSF) have developed onsite greywater treatment and reuse standards that the various States can use as a benchmark for the management of greywater. Since 2011 ANSI and NSF developed a set of three standards namely, NSF/ANSI 40, NSF/ANSI 245 and NSF/ANSI 350 standards which provide guidelines on greywater treatment system installation for commercial and residential uses. NSF/ANSI 350 is the latest standard which deals with the non-potable uses of greywater for toilet flushing and irrigation.

Moreover, the State of California, Arizona, Texas, Alabama, Maine and Ohio are examples of states that have developed their own greywater guidelines. The greywater guidelines in California gives home owners license to reuse greywater and to install a diversion system. The code specifies that the diversion system must be designed and installed to prevent greywater from mixing with potable water and to direct it back to the sewer line. Moreover, the local building department is given authority to inspect the greywater system (California Plumbing Code 2016). In the state of Arizona, the use and installation of greywater systems is permissible but uses are restricted only for irrigation and toilet flushing (Arizona Administrative Code 2021). Texas also allows the reuse of greywater but residents are required to first obtain laundry-to-landscape system permits as well as permits for gravity-flow systems that use less than 250 gallons a day (Texas Health and Safety Code 341.039). In Alabama, the law requires greywater operators to install filters and disinfect the water before reuse (Alabama Administrative Code 420-3-1-64). The state of Maine also issues permits for the installation of greywater systems and guides residents to first treat greywater before disposal (Clean Water Act 33; Maine subsurface wastewater disposal rules; NSF/ANSI Standard 350). In Ohio, the non-potable use of greywater is also permitted for landscaping and irrigation purposes (Ohio Administrative Code 3701:29).

2.11.4 Kenya's greywater legislation

Kenya is an east African developing country with a dense informal settlement clusters. The local municipal authorities of Kenya struggle to supply urban communities with freshwater due to low water reserves and rainfall patterns. As a result, 89% of informal settlement dwellers make use of shallow wells as a source for domestic water and less than 10% of residents receive tap water from the local municipalities (Kimani-Murage and Ngindu 2007). The non-potable use of greywater is consequently a common practice in Kenya's informal settlements. In Nairobi specifically, 50% of the greywater generated in 2006-2007 was used for irrigation purposes. Despite the common reuse of greywater amongst residents, the national government of Kenya regards the reuse of it as illegal. Kenya has no national wastewater reuse policy in place, but instead the government has developed a 2030 vision which includes the conservation of water sources, rainwater harvesting and the use of groundwater (Nyika and Dinka 2022).

2.11.5 Brazil greywater legislation

Water demand is a global phenomenon that affects every country and Brazil has consequently faced successive water scarcities in the recent years (Targa et al, 2015). At the same time Brazil has a high informal settlement population where greywater management are a major problem. Greywater investigations and policy development in Brazil are as well influenced by freshwater scarcities and wastewater related disease risks in urban informal settlements

communities. The non-potable use of greywater for small scale agricultural purposes has been investigated in higher water deficit regions of Brazil (Santiago et al, 2015). The Brazil government has consequently developed the Association of Technical Standards - NBR 13.969 / 97 which is a national benchmark for the reuse and management of greywater. The standard makes provision for the recirculation of rinse water from washer (laundry use) with or without treatment for toilet flushing. The limitation of the national legislation is that it does not include concepts, classifications and quality standards which ensure the reuse water for different destinations, with safety necessary for humans, animals and the environment (Moura et al, 2019). Subservient to the national standard on greywater reuse, local states have developed legislative guidelines for the management of wastewater. The following are examples of states that have developed legislations for greywater use in Brazil;

- Rio de Janeiro (Law No. 7424/2016, Law No. 7599 24/2017),
- Espírito Santo (Law No. 10,487 / 2016),
- São Paulo (Law No. 16174/2015, Law No. 16,160 / 2015),
- Ceará (Law No. 16,033 / 2016),
- Bahia (Resolution No. 75/2010),
- Paraná (Law No. 11,552 / 2012) and
- Rio Grande do Sul (Law No. 6616/2006)

Brazil similar to South Africa is a developing country with a dense informal settlements network. Greywater policy in both countries requires revision to reduce greywater nuisances and the risks of waterborne disease outbreaks in informal settlements.

2.12 Overview of the existing greywater legislation in South Africa

Figure 2.2 provides an outline of the existing greywater-related legislative framework in South Africa and the timeline when these legislations were developed. The Constitution is the supreme law of South Africa and sets out how all the elements of government are organised. The Oxford English Dictionary defines a constitution as a body of fundamental principles or established precedents according to which a state or organisation is governed. The right to an environment that is not harmful to health or wellbeing through reasonable legislative measures is accorded in Section 24 (a) of the Constitution. Section 27 of the Constitution makes provision for access to health care and water services. Section 27 of the Constitution provided the basis for the development of other legislations that clearly define the conditions of water service provision, wastewater management and the relevant institutions (municipalities and waterboards) which are tasked to provide such services. The Water Services Act of 1997, the Strategic Framework for Water Services of 2003, the Draft National Sanitation Policy of 2016 and the SANS 1732:201x are policy examples which deal specifically with the management of wastewater (blackwater and greywater) in South Africa as illustrated in figure 2.2.

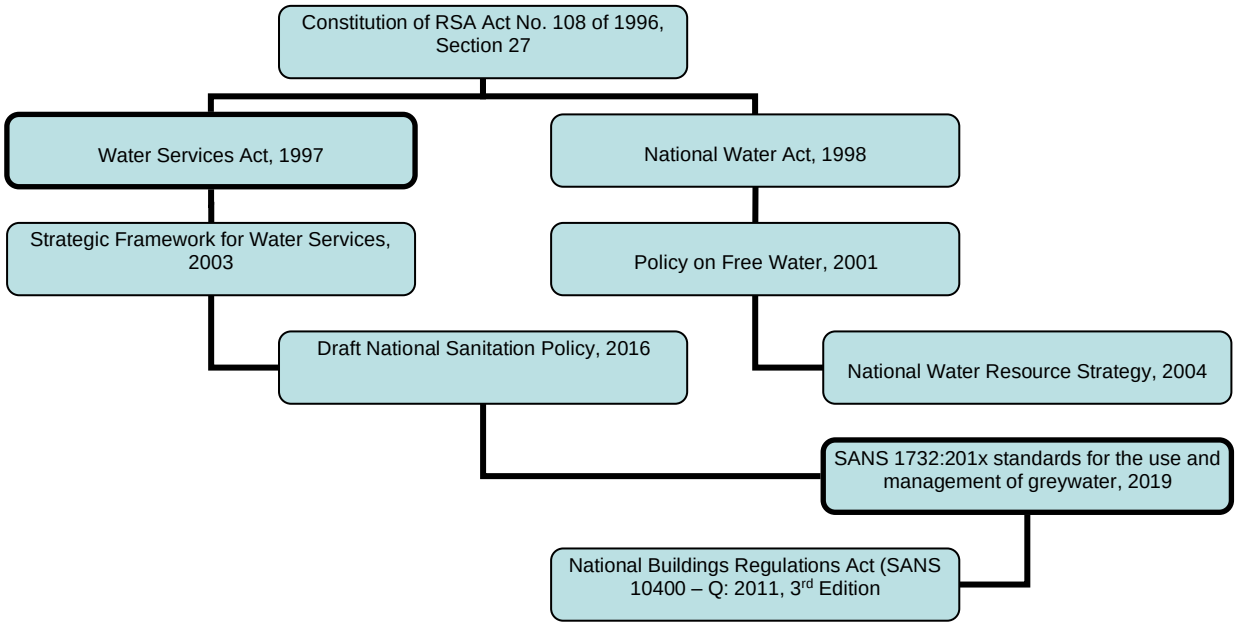


Figure 2.2 Overview of the legislative framework that governs the management of greywater in South Africa.

The National Buildings Regulations Act of 2011 is a policy document that provides engineering guidelines for the installation of water services infrastructure in households. Whereas, the National Water Act of 1998, Policy on Free Water of 2001 and the National Water Resource Strategy of 2004 are policies which deal with bulk and potable water supply geared to meet the human rights enshrined in section 24 and 27 of the Constitution.

2.13 Water Services Act, 1997 review

The objective of this project is to investigate if the WSA is a sufficient guide to help officials manage greywater challenges in urban informal settlements. The rights of access to basic water supply and basic sanitation for every inhabitant of South Africa is given by the Water Services Act, 1997. The WSA recognizes that in order to ensure sufficient water and an environment that is not harmful to health or well-being, rights to access water services is necessary. Section 1 (ii) defines basic sanitation as the prescribed minimum standard of services necessary for the safe, hygiene and adequate collection, removal, disposal or purification of human excreta, domestic wastewater, and sewage from households, including informal households. This section gives a mandate to water service institutions to manage greywater in both formal and informal settlements. The WSA is intended to provide for the rights of access to basic water supply and basic sanitation and a regulatory framework for water services institutions and water services intermediaries.

2.13.1 Institutional arrangements

The WSA is also intended to provide for the establishment and disestablishment of water-boards and water services committees and their powers and duties. The inception of the WSA in 1997 has seen the establishment of additional water service institutions such as waterboards to assist municipalities provide basic water supply and basic sanitation. All water service authorities such as municipalities are mandated under section 21 (1) of WSA to synthesize and implement by-laws which contain conditions for the provision of water services. Section 21 also sets minimum requirements of what the by-law must be comprised of namely s21 (1)(a) standard of services s(1)(b) technical conditions of supply s21 (1)(c) the installation, alteration, operation, protection and inspection of water services works and consumer installations. Furthermore, the WSA also makes a requirement for conditions for water services authorities under which they can provide water services to their consumers. According to s21 (2)(a) a Water Service Authority "may place limits on the areas to which water services will be provided according to the nature, topography, zoning, and situation of the land in question. The WSA defines water services as "water supply services and sanitation services", and sanitation services as "the collection, removal, disposal, or purification of human excreta, domestic wastewater, sewage and effluent resulting from the use of water"– i.e. this implies that greywater management is included as part of the Water Services Act. The institutional arrangements post 1944 is an act of commitment by the South African government to meet the informal settlement dwellers rights of an environment that is not harmful to health or well-being.

2.13.2 Waterboards

The inception of the WSA has seen the development of waterboards whose primary activity is to provide water services to other water services institutions within its service area in terms of Section 29 of the Water Services Act No 108 of 1997. Each province in South Africa has a waterboard in place. Examples of waterboards in place are Amatole Water, Lepelle Water, Bloem Water, Magalies Water, Umhlathuzi Water, Overberg Water, Rand Water, Sedibeng Water, and Umngeni Water. The outcome of the establishment of these waterboards has been the provision of bulk potable water services to the municipalities and industries. The waterboards primarily focus on freshwater supply and do not hinge on the supply of sanitation services which includes the management of greywater. In addition, the Water Act of 1988 has resulted in the development of Catchment Management Agencies (CMA) whose function is to investigate and advise interested persons on water resource management. The other functions of CMAs are to co-ordinate related activities of water users and WMIs, promote co-ordination of implementation of any applicable development plan, promote community participation in water resource management. Examples of such agencies which has been set up is the Inkomati-Usuthu and Breede-Gouritz CMAs.

The Water Research Commission (WRC) is another entity which is supported by the Water Services Act of 1997. The WRC was founded in 1971 and was mandated by the Apartheid government to generate new knowledge and to promote the country's water research. The Commission has been able to outlive the Apartheid era and has carried over its existence into the democratic dispensation. The WRC aims to empower communities, inform policy and decision making, develop innovative products and services for economic growth, enhance human capital development and the water and science sectors, promote transformation and redress and to drive sustainable development solutions. Another entity which has outlived the Apartheid era is the TCTA. Established in 1986 as a state-owned entity, TCTA specialised in project financing, implementation, and liability management. Today the TCTA handles the development of bulk raw water infrastructure for the expanded supply of water to stimulate South Africa's economic growth, and to simultaneously deal with the historical imbalances relating to access to water.

2.13.3 Municipalities

A municipality is an organ of state within the local sphere of government exercising legislative and executive authority within an area determined in terms of the 25 Local Government: Municipal Demarcation Act, 1998 (Municipal Systems Act s(2)(a). A municipality will then consist of section (2)(b)(i) the political structures and administration of the municipality; and (ii) the community of the municipality. The Municipal Structures Act of 1998 classifies municipalities into 3 categories namely, metropolitan, local and district. Municipalities are defined by the Water Services Act of 1997 as a water service authority. As a water service authority, municipalities carry the responsibility to build water services infrastructure, manage and foresee the delivery of services. A constitutional duty is placed on national and provincial government to support and strengthen capacity of municipalities to manage their affairs, exercise their powers and perform their functions. Municipalities that do not execute their functions lose their autonomy and placed under the administration of the provincial government. National and provincial government thus perform an oversight role over municipalities to ensure compliance with the national norms and standards and legislative requirements of the Water Services Act of 1997.

2.13.4 WSA provision for greywater management in informal settlements

The management of greywater in informal settlements is included in section 1 (ii) (iii) and (iv) of the WSA under basic sanitation, and basic water supply whilst its residents are identified as consumers. Basic sanitation according to section 1(ii) has to do with the prescribed minimum standard of services necessary for the safe, hygienic, and adequate collection, removal, disposal, or purification of human excreta. domestic wastewater and sewage from households, including informal households. The definition makes provision for the safe and hygienic

management of greywater in informal settlements. Section 1 (iv) of the WSA defines a consumer as any end user who receives water services from a water services institution, including an end user in an informal settlement. The WSA mandates municipalities to set water services development plans in order to meet the rights of access to basic water supply and the right to basic sanitation necessary to secure sufficient water and an environment not harmful to human health or well-being. The inclusion of greywater management systems in informal settlements serves as an adoption of the prescribed water services development plans by municipalities as stipulated in section 2(c) of the act. The inclusion of sections 1 (ii) (iii) and (iv) makes it therefore conclusive that the WSA does indeed provide a policy basis for local government intervention by either treating or diverting greywater in informal settlements to meet the environmental and health needs of the residents. The National Water and Sanitation Master Plan (NWSMP) indicates that by 2040 the water re-use could guarantee availability of water supply particularly for non-potable water uses. Treated greywater is as a resource will thus play an invaluable role in meeting the water needs of the consumers.

2.14 Review of the SANS 1732:201x, 2019 standards on greywater use and management

2.14.1 Standard scope

The SANS 1732:201x was developed to provide guidance on the harvesting, storage and the safe reuse of greywater at a household level. The standard according to s (1) (1.1) is primarily for single re-use of greywater for subsurface irrigation of gardens and the treatment of greywater for flushing toilets. Section (1) (1.2) of the standard provides the minimum requirements for the development of a greywater system that includes design, installation, operation, maintenance, repair and monitoring thereof. Furthermore, s (3) (3.1) (a) (1) of the standard takes into consideration structures that are both of a permanent and temporary nature irrespective of the materials used in the erection thereof in connection with the accommodation of human beings. Informal settlements are included in this definition because they meet the requirement of tenure and open-ended building material. Table 2.12 furthermore alludes to informal settlements and places these under Class H3 according to the standards. Class H3 is defined as a domestic residence that consists of two or more dwelling units on a single site.

Table 2.12 Occupancy of building classification according to SANS 1732:201x.

Building classification	
Class of occupancy of building	**Occupancy**
H2	**Dormitory** – where groups of people are accommodated in one room

H3	**Domestic residence** – consisting of two or more dwelling units on a single site
H4	**Dwelling house** – consisting of a dwelling unit on its own site, including a garage and other domestic outbuildings if any.
H5	**Hospitality** – where unrelated persons rent furnished rooms on transient basis within a dwelling house or residence with sleeping accommodation for not more than sixteen (16) persons within a dwelling unit.

2.14.2 Standard Objectives

The purpose of the standard is to promote the sustainable reuse of greywater, and the conservation of quality groundwater and surface water supplies without compromising public health. The disposal practice of casual tipping and ponding of greywater around the shacks usually creates health and environmental nuisances such as insect infestation, odours, and waterborne disease outbreaks. The objective then of this standard according to section 4 (4.1) (4.1.3) is to provide guidance for the development of a greywater system which will not harm humans or the environment and cause a nuisance.

2.14.3 Greywater systems

The standards have provided a guideline for the development, and installation of two greywater systems. Sections 5 (5.1) and (5.2) refers to direct capture and reuse system plus the diversion, storage, treatment and reuse system. The direct capture and reuse system is a harvesting method which directly captures greywater without entering a wastewater piping system to use for irrigation or flushing. This is a harvesting method that most informal settlement dwellers partially employ but not for the purpose of reuse. Greywater is rarely reused in informal settlements instead residents casually tip this greywater outside the shack dwelling or in nearby stormwater canals and stormwater access chambers (Carden et. al (2007). The diversion, storage, treatment, and reuse system are what is missing in informal settlements. This system requires a development of an infrastructure that is integrated with the sewerage and water supply drainage system.

2.14.4 Compliance, Monitoring and Enforcement (CME) of Greywater discharge standards

The standards may provide the necessary guidelines for the management of greywater however the implementation thereof requires a will from the municipal council as a water service authority. Additionally, consumer education must be conducted to ensure cooperation. A monitoring program is required to assess if the users act by the guidelines provided and to avoid the excessive use of greywater which will harm the environment and increase public health risks. Compliance, monitoring, and enforcement (CME) is one of the priority focus areas

found in the second edition of the national Water Resources Strategy. CME is essential to ensure that water is used according to authorisation conditions, and by legally authorised water users. Excessive use of greywater for plant irrigation according to section 4 (4.2) (a, b, c, d) can potentially reduce yields because of salinity, nitrogen overload, specific ionic effects, and soil clogging. In addition, the soil can be degraded due to high sodicity and salinity and contaminate groundwater. Moreover, uncontrolled use of greywater can cause reduced flows and higher solid contents causing blockages in the sewer system.

2.14.5 Service provider and greywater system installation authorisation process

The other limitation of the standard is that it does not clearly state who is mandated to provide this service of greywater system installation. The Municipality will presumably take this role of supplying informal settlements with a greywater management system as a part of its water service mandate to households. SANS 1732:201x further clearly states the authorisation process to be followed in order to install a greywater system in any settlement. Approval must be obtained according to section 6 (6.1) from the local authority for the use of specific materials or workmanship. The standard also places powers on the local authority bylaws which requires that all the components for use in their area of jurisdiction be listed on a schedule of approved plans. This project further proposes that the installation of greywater systems in informal settlements be added on the list of the municipal water service development strategic plans. The inclusion of greywater systems is in line with the Integrated Human Settlements Framework (IHSF) and will help to achieve the goals of regularising and progressively upgrade all informal settlements in South Africa. This will also improve the delivery of services, public space and the tenure to settlements.

2.15 Greywater policy of South Africa compared to policy in Queensland, Australia

This section of the project reviews the greywater legislation of Australia in comparison to South Africa. Australia was selected since its government was one of few first world countries to adopt WHO guidelines on greywater management and implement this as national policy. Australia is also reasonable example because it has also developed greywater management guidelines specifically for non sewered settlements which are the equivalents of South Africa's informal settlements. This project then compares Australia's greywater legislation for non sewered areas (informal settlements) with the SANS 1732:201x standards. The adapted guidelines from Queensland Australia in table 2.13 for non sewered areas provides a baseline that the local government in South African can use to develop greywater standards suitable for its urban informal settlements network. The state of Queensland water conservation strategy as far back as 1993 identified greywater as an alternative water source. The strategy allows for greywater to be used in garden watering, wetland maintenance, irrigation of

recreational areas and toilet flushing provided there is minimal contact with people. There are several significant pieces of legislation which control the provision of wastewater infrastructure and the management of these services within the state. Section 9 of the Health Act 1937 enables the delegation of health issues to local authorities. Further, Section 93 of the Health Act 1937 requires local government to construct and maintain all sewers, storm water drains and sanitary conveniences within its area so that they do not become a nuisance or are dangerous to health. Other legislation also applies to the use of greywater in Queensland. Section 87(1) of the Health Act 1937 requires that greywater disposed in an non sewered area must not be allowed to remain in any one place for more than 24 hours after a local government has given notice to remove it. Greywater is also not allowed to run-off from any premises or cause offensive odours. Section 87(2) requires the local government to control any problem which may arise under Section 87(1) [11].

Table 2.13 Guidelines on greywater use and management for non sewered settlements in Queensland State, Australia.

Queensland greywater guidelines for non sewered areas	
Discharge guidelines	When discharging greywater above ground by surface irrigation, it must be treated to remove or destroy pathogenic microorganisms.
Handling of greywater guidelines	Human contact with greywater that has not been treated to remove pathogenic microorganisms must be avoided.
	The proposed reuse of the greywater must be appropriate for the site.
Greywater use guidelines for toilet flushing	For urinal and toilet flushing, the microbial quality of the treated greywater must comply with the following; ■ Thermo tolerant coliforms less than 1/100 ml. ■ Total coliforms less than 10/100 ml.
Treatment system installation	The greywater treatment system and land application area must be sited within the property boundaries of the premises producing the greywater.

	A reliable treatment process that will achieve the effluent quality criteria must be provided.
	The greywater treatment system must treat and disinfect the greywater before toilet flushing reuse.
Maintenance guidelines	Operation and maintenance guidelines are available to all owners and users.
	Operation and maintenance procedures are undertaken to a regular schedule appropriate to the nature, type of treatment and land application facility.
Monitoring and evaluation	To be done by local government for the purposes of; ■ protect the health of residents ■ to protect bores and other local drinking-water sources from contamination; and ■ to ensure necessary maintenance, repair or component replacement is undertaken.

The guidelines from Queensland in table 2.13 deals with discharge procedures, handling and reuse of greywater, installation of greywater treatment, maintenance, monitoring, and evaluation. The legislation of the Queensland state makes provision for the treatment of greywater through a greywater treatment plant built in the vicinity of the residents. The reuse of greywater and the management thereof through a treatment system relies on the following elements;

- Availability of infrastructure,
- Suitable land,
- distance from dwelling to treatment system
- Cost implications and practicality
- Public perception or acceptability of the system

The reuse of greywater in informal settlements requires strong institutional support and monitoring if it were to be considered for agricultural purposes in South Africa's informal settlements. In addition, the beneficiation of greywater for agricultural purposes hinges on the availability of space for the planting of household or communal gardens (Carden et al, 2007). However, due to poor spatial planning which characterizes urban informal settlements in South

Africa, the beneficiation of greywater proves to be a great challenge. Lastly, effective comparison of greywater guidelines and policies between the various countries is affected by the lack of constructive collaboration of water quality parameters each country uses, and the categorisation of reuse options specified in the guidelines (Van de Walle et al 2023; Capodaglio 2021).

2.16 Greywater related legislation per municipality in South Africa

Figures of 4.2, 4.3, and 4.5 represents the different provinces that have all classes of district, metro and local municipalities with and without greywater related legislation in their jurisdiction. The provinces of Northern Cape, Free State and Kwa Zulu have 19 district, 134 local and 2 metropolitan municipalities amongst each other and none of these have greywater related references either in their municipal by-laws. The Municipal Systems Act of 200 defines By-Laws as regulations that are passed by the Council of a municipality to regulate the affairs and the services it provides within its area of jurisdiction. Section 21 of the Water Services Act of 1997 sets minimum requirements of what the municipal by-law must be comprised of namely s21 (1)(a) standard of services s(1)(b) technical conditions of supply s21 (1)(c) the installation, alteration, operation, protection, and inspection of water services works and consumer installations. It is worth noting that these legislative requirements apply in the context of potable water supply and sanitation services. The legislative requirements for greywater reuse will therefore vary. Furthermore, Carden et al (2007) in table 2.14 identified 5 guideline categories on the management of greywater per municipality which have greywater related by-laws in their jurisdiction. The guideline categories are based on how greywater is used in each by-law and is comprised of the (a) authorisation for the reuse of greywater, (b) installation of greywater systems guidelines, (c) health risk control on greywater reuse guideline, (d) guidelines of greywater reuse for gardening, and (e) reused greywater discharge guidelines. The occurrence of greywater related legislation amongst the various municipal categories of provinces is reviewed based on these requirements. The Western Cape and Eastern Cape are the only provinces in the country that have greywater related legislation in each of its municipal categories. The Western Cape though is the leading province in the country in terms of the development of greywater related legislation. The province has approximately 35 local municipalities and 20 of these have legislation in place whilst the remaining 15 have no legislation at all.

Table 2.14 Greywater related legislation based municipal category per province (sourced and adapted from Carden et. al, 2007).

Greywater related legislation
Western Cape

	Municipality	Legislation
Authorisation for the reuse of greywater	City of Cape Town Metro	Provincial Gazette No. 6847: Local Authority Notice of 2011
	West Coast District	Provincial Gazette No. 6777: Local Authority Notice of 2010
	Drakenstein local	Provincial Gazette No. 6426, 7291 & 51385 : Local Authority Notice of 2007 & 2014
	Bitou	Provincial Gazette No. 6668: Local Authority Notice of 2009
	George	Provincial Gazette No. 6887: Local Authority Notice of 2010
	Hessequa	Provincial Gazette No. 6588: Local Authority Notice of 2008
	Knysna	Provincial Gazette No. 7487: Local Authority Notice of 2015
	Mossel Bay	Provincial Gazette No. 6788 & 6678: Local Authority Notice of 2010 & 2009
	Swellendam	Provincial Gazette No. 7400: Local Authority Notice of 2015
	Theewaterskloof	Provincial Gazette No. 7488: Local Authority Notice of 2015
	Bergriver	Provincial Gazette No. 6777: Local Authority Notice of 2010
	Saldahna Bay	Provincial Gazette No. 7077: Local Authority Notice of 2012
	Swartland	Provincial Gazette No. 7285: Local Authority Notice of 2014
	Colesberg	Provincial Gazette No. 6181: Local Authority Notice of 2004
	Breede Valley	Provincial Gazette No. 6650: Local Authority Notice of 2008
	Drakenstein local	Provincial Gazette No. 7291: Local Authority Notice of 2014
Installation of greywater systems guidelines	City of Cape Town Metro	Provincial Gazette No. 6847: Local Authority Notice of 2011
	Overstrand	Provincial Gazette No. 6683: Local Authority Notice of 2009
	Drakenstein local	Provincial Gazette No. 51385 : Local Authority Notice of 2014
	Overstrand	Provincial Gazette No. 6683: Local Authority Notice of 2009
Health risk controls on greywater reuse	Mossel Bay	Provincial Gazette No. 6788: Local Authority Notice of 2010
Permission of greywater reuse for gardening	Mossel Bay	Provincial Gazette No. 6788: Local Authority Notice of 2010
North-West		
Guideline category	**Municipality**	**Legislation**

Installation of greywater systems guidelines	Madibeng local	Provincial Gazette No. 7602: Local Authority Notice of 2016
	Moses Kotane local	Provincial Gazette No. 6503: Local Authority Notice of 2008
	Moretele local	Provincial Gazette No. 6839: Local Authority Notice of 2010
	Ramotshere Moiloa local	Provincial Gazette No. 551: Local Authority Notice of 2015
Health risk controls on greywater reuse		
Mpumalanga		
Guideline category	**Municipality**	**Legislation**
Installation of greywater systems guidelines	Thaba Chweu local	Provincial Gazette No. 551: Local Authority Notice of 2007
	Thaba Chweu local	Provincial Gazette No. 551: Local Authority Notice of 2007
Limpopo		
Guideline category	**Municipality**	**Legislation**
Installation of greywater systems guidelines	Greater Sekhukhune District	Provincial Gazette No. 1844: Local Authority Notice of 2010
	Greater Sekhukhune District	Provincial Gazette No. 1844: Local Authority Notice of 2010
Kwa-Zulu Natal		
Guideline category	**Municipality**	**Legislation**
Authorisation for the reuse of greywater	Umhlathuze local	Provincial Gazette No. 6430: Local Authority Notice of 2005
	UThungulu District	Provincial Gazette No. 1261: Local Authority Notice of 2014
Installation of greywater systems guidelines	Umzimkhulu local	Provincial Gazette No. 1134: Local Authority Notice of 2004
	Umhlathuze local	Provincial Gazette No. 1929: Local Authority Notice of 2015
Reused greywater discharge guidelines	Umhlathuze local	Provincial Gazette No. 1929: Local Authority Notice of 2015
Health risk controls on greywater reuse	Umhlathuze local	Provincial Gazette No. 1929: Local Authority Notice of 2015

Gauteng		
Guideline category	**Municipality**	**Legislation**
	Mogale City local	Provincial Gazette No. 62: Local Authority Notice of 2007
Guidelines of greywater reuse for gardening	Mogale City local	Provincial Gazette No. 62: Local Authority Notice of 2007
Eastern Cape		
Guideline category	**Municipality**	**Legislation**
Authorisation for the reuse of greywater	Buffalo City Metro	Provincial Gazette No. 2532: Local Authority Notice of 2011
	Joe Gqabi District	Provincial Gazette No. 102: Local Authority Notice of 2015
	Nelson Mandela Metro	Provincial Gazette No. 2361: Local Authority Notice of 2010
Installation of greywater systems guidelines	Buffalo City Metro	Provincial Gazette No. 2532: Local Authority Notice of 2011
	Ntabankulu local	Provincial Gazette No. 1596: Local Authority Notice of 2006

In the Western Cape 72% of the municipalities have in their by-laws the guideline on the authorisation for the reuse of greywater. Municipalities that have a guideline on the installation of greywater systems are at 18%. The local municipality of Mossel Bay has guidelines on the reuse of greywater for gardening and health risk control. The City of Cape Town as the sole Metro of the province have 2 of the 5 guideline categories which is the authorisation for the reuse of greywater and also the installation of a greywater system. The authorisation powers for domestic usages are squarely placed on the Director of Water and Sanitation.

The North West province has guidelines on the installation of greywater systems and health risk control on greywater reuse. The Limpopo and Mpumalanga province have only one guideline which is the installation of greywater system. Kwa-Zulu Natal has 4 of the 5 guideline categories except for the guideline of greywater reuse for gardening. The Ethekwini City of the province has no greywater related legislation in place. The Mogale City of Gauteng is the only municipality in the province that has greywater related legislation which are guidelines of greywater reuse for gardening. The province even though it has 3 of the biggest metros in the country neither Ekurhuleni, City of Tshwane or Joburg City has greywater related legislation in place. On the other hand, the Metropolitan municipalities of Buffalo City and Nelson Mandela metro of the Eastern Cape do each have greywater related by-laws in place. The reuse of

greywater and the installation of greywater system guidelines are the only 2 categories which is included in the greywater related by-laws of the various municipalities of the province. The Buffalo City Metro has both categories in its by-laws whereas the Nelson Mandela City has only the installation of greywater system guideline in place.

2.17 Summary

The World Health Organisation as the global custodian of public health has developed guidelines on the use of greywater, excreta, and wastewater to provide a consistent level of health protection in different settings. The standards were split into 3 editions and published over a period of over 50 years since 1973. Australia alongside New Zealand, Israel, USA, and Germany have taken a leading role in adopting these WHO guidelines as national policy for greywater management. The greywater policies of Australia are significant in this study since they mandate the management of greywater in non sewered settlements as well. Non sewered areas are informal settlements which are unplanned residential spaces that have developed outside of the formal urban planning rules of a city often in physically marginalised or peri-urban areas. Wastewater emanating from serviced households is disposed into the internal pipe network which eventually lands into the stormwater or sewer system. In informal (unserviced) settings however this biorhythm of water supply is disjointed since greywater is disposed of onto the ground outside the dwellings (Carden, et. al., 2007). Due to the informal nature of these dwelling units proper planning and installation of the necessary greywater disposal infrastructure was not done and thus making the greywater challenges the inevitable. Since this study reviews the legislative framework that manages greywater in South Africa's informal settlements, Australia's greywater policies are thus a suitable benchmark for policy development. Greywater investigations and policy formulations in South Africa is driven by environmental conditions of water scarcity and public health concerns. This study then reviews the existing legislative framework and investigates these greywater challenges as experienced by municipal officials in metropolitan municipalities.

The constitution of South Africa is the supreme law of the land and is central to developing and implementing water services and environmental health laws that advocate a better quality of life for all the citizens of the country. The right to an environment that is not harmful to health and well-being is given in section 24 (a) and (b) of the Constitution. In obtaining this healthy environment, the provision of water services and the development of a national greywater policy is central. The development of a greywater policy such as the Water Services Act of 1997 and the SANS 1732:201x helps to set national development priorities and provide decision-making criteria to guide the development process towards achieving them. Furthermore, the WHO guidelines on greywater management informs governments to reform institutions through the development of a central government that will manage wastewater

affairs. The establishment of the Department of Water and Sanitation and the Waterboards are the institutional arrangements which the South African government has effected to help centralize the management of wastewater through the aid of the Water Services Act of 1997. Section 1 of the Water Services Act in addition mandates municipalities to manage greywater emanating from formal and informal settlements by collecting, removing, disposing domestic water and sewage from households. The WSA however does not clearly distinguish greywater from blackwater but views these as the same wastewater that must be diverted from the households to treatment plants. The SANS 1732:201x standard on the other hand is formulated to specifically guide the harvesting, storage, and the safe reuse of greywater at a household level.

CHAPTER THREE
3. RESEARCH METHODOLOGY

3.1 Research Design

This section of the project deals with the research design used and the data collection processes followed to gather information and analyse it. Borwankar (1995) describes research design as a plan, structure, and investigation which according to Coldwel and Herbst (2004) is developed to specify the methods and procedure for collecting and analysing the required information. A quantitative research design was used to assemble, summarize and review the relevant legislations and published research on greywater management specifically focusing on urban informal settlements. A quantitative method utilising a cross-sectional survey design was employed in this study. Quantitative research adopts an objective, systematic and scientifically rigorous stance to knowledge production with an aim to empirically confirm and generalise outcomes (Black, 2005). A cross-sectional design obtains measures of variable at a cross section of, or single point or snapshot in time (Cramer and Howitt, 2004; Royai, Baker and Ponton, 2013). Surveys are suitable for gathering information about attitudes/perceptions and can be easily administered (Coleman, 2009). This design was appropriate as the study aimed to access a large number of participants, at one-time point. This study used statistical techniques to develop a quantitative summary of the evidence. In other words, this was a quantitative research design utilizing a cross-sectional survey design. Questionnaires were administered electronically to a sample of 17 municipal leaders whose role centres on water management. Descriptive statistics (including graphs, pie charts) were employed in analysis of the data. Outcomes were reviewed against the alignment or the lack thereof with the SANS 1732:201x standards of 2019 and the Water Services Act of 1997.

3.2 Participants and Sampling by Institution

The study identified 3 sample groups namely, the metropolitan municipalities, waterboards and national departments. The first sample group which took part in the research is the Metropolitan municipalities of the City of Tshwane, City of Joburg, as well as the Buffalo City (refer to figure 3.1) which is at local government level. Inputs was requested via questionnaires from managerial and non-managerial staff working in the Human Settlements, Engineering and Infrastructure Development, Public Health and Safety, Water and Sanitation Departments. The Engineering and Infrastructure Development and the Water and Sanitation departments were selected on the basis that they are mandated to provide oversight and deliver water services, maintain and install municipal water supply and sanitation infrastructure in informal settlements. The Human Settlements Department was requested for input since they are responsible for formal housing developments, quantification, and upgrade of the informal settlements network in the metropolitan municipality. Input was also requested from the Public

Health and Safety Department (managerial and non-managerial staff) since the department is responsible for managing waterborne disease outbreaks in the municipality.

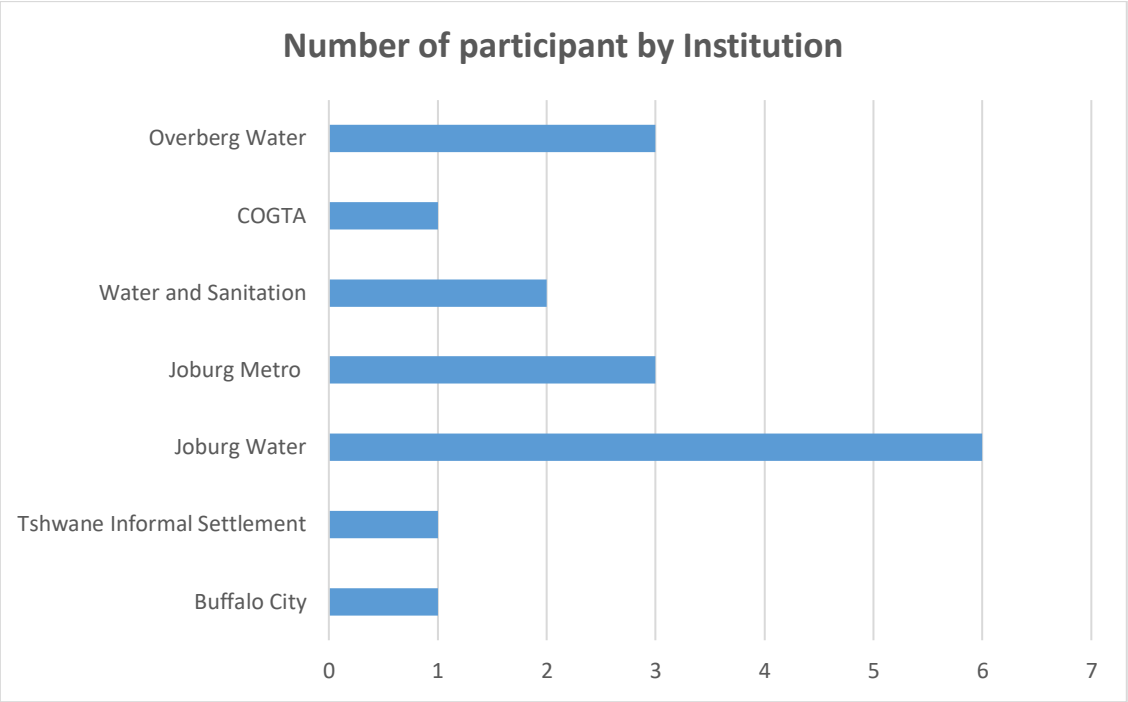


Figure 3.1 Number of respondents that took part in the research from the Metropolitan municipalities, Waterboards and National departments.

The second sample group at a local government level are waterboards. The Waterboards were selected on the basis that they are classified as water service institutions and mandated by the Water Services Act of 1997 to supply bulk water and sanitation services to the municipality. Waterboards that responded to the research includes participants from Joburg Water in Gauteng and Overberg Water in the Western Cape. The third sample group is at national government level and is made up of COGTA and the National Department of Water and Sanitation (DWS). Input was requested from the national department of COGTA due to the department's mandate of ensuring that there is constructive collaboration and cooperative governance between municipalities, waterboards and national departments. The National Department of Water and Sanitation was selected since it's the custodian of all bulk freshwater, wastewater systems and infrastructure in South Africa. The National Water Act of 1998 additional bestows upon DWS the oversight prerogative over all the lower structure water service institutions such as metropolitan municipalities and waterboards. A total of 17 participants from across the institutions could be reached to take part in the study.

3.3 Data Collection

3.4.1 Questionnaires

A questionnaire consisting of a list of questions is a tool which was developed and used in this study to collect information from the metropolitan municipal councils, waterboards and relevant

national departments of South Africa. The questionnaires were developed to investigate the efficiency of the legislative framework as a tool to help officials in managing greywater challenges in informal settlements. In addition, a generic questionnaire was developed to help understand the vast nature of the greywater challenges in South Africa's informal settlements as experienced by officials and to assess the state of cooperative governance between the various government institutions. The generic questionnaire had a total of 29 questions which are classed into 4 categories (refer to Appendix 1 for full questionnaire). The categories include personal information, knowledge about existing legislation, greywater management challenges, and cooperative governance (refer to table 2.15). At a municipal level inputs were needed from the departments of Infrastructure Services, Environment & Engineering Departments, Department of Environment and Agriculture Management, Economic Development & Spatial Planning, Public Health & Safety, Water and Sanitation, City Manager, Housing and Human Settlements of these Metros. Participation was solicited from both managerial and non-managerial staff and were given the same outline of questions.

Table 2.15 Summary of the contents of the questionnaire submitted to officials.

Section	Number of questions
Personal information (demographics)	5
Work experience	1
Department	1
Institutional experience	1
SANS 1732:201x guideline	2
Greywater management challenges	3
Waterborne disease outbreaks	3
Cooperative governance	4
City's greywater management response	8

3.4.2 Coding of questionnaires

Coding categories for open-ended questions were compiled from a review of the greywater literature and content analysis of responses to the 17 interviews. Open ended questions in this research included.

- Question 4: What is your highest educational qualification obtained?
- Question 14: What are the major waterborne disease outbreaks that the Municipality had to deal with over the last 27 years?
- Question 16: Are there any documented Municipal operational procedures that officials must follow when responding to waterborne disease outbreaks?

- Question 17: What are the challenges associated with greywater are you aware of informal settlements?
- Question 20: Has the City ever required the intervention of COGTA to help with greywater related management challenges in informal settlements?
- Question 24: Does the City have any greywater treatment system programs in place?
- Question 29: Does the Municipality have a legal process in place that requires industries to follow to treat & re-use greywater?

The project could not secure interviews with the municipal officials due the factors outlined on chapter 6 of the thesis. The use of interviews would have allowed for probes and clarification of ambiguous or incomplete responses. The use of actual incidents provided by the respondents addresses an ongoing problem in the management of greywater issues in informal settlements by local government officials.

3.5 Procedure

3.5.1 Guidelines on completing the questionnaires

The study has endeavoured to simplify the questionnaires for the interviewees by providing a set of 24 multiple choice questions and only 5 discussion questions. In addition, the study favoured Municipal Council visits to conduct interviews as well however due the COVID-19 Pandemic this method could not be realised since access to many government premises was limited. Attempts were however made to contact the officials via emails and telephone calls which proved to be another great complication since many relevant officials were either reported sick, deceased, or working from home with different email address and cell phone numbers. Notwithstanding all these challenges a number of officials were reached and given the questionnaires to complete following the easing of COVID-19 restrictions. The following guidelines were provided to the interviewees alongside the questionnaires.

- Respondents were required to either print out the questionnaire, complete it with black pen, scan it and send it back to the researcher.
- Upon answering questions, the respondent was requested to make an X in that particular box where the respondent's answer is.
- The respondent was given another option of completing the softcopy version of the questionnaire which is in a Microsoft Word format. Should the interviewee opt for this second option the respondent was requested to use a yellow highlighter to tick in the box when answering multiple choice questions.

3.6 Data Analysis

Data collection in this study was done through a questionnaire method. In doing so, wastewater legislations, standards and local government documentation related to water management in South Africa is listed and examined to see if they ease the adequate management of greywater in informal settlements. A systematic review was used to search relevant legislations, policies,

regulations, and published research on greywater management specifically focusing on urban informal settlements in South Africa and abroad. This comprehensive review searched a total of seven open-access databases (PubMed, ScienceDirect, ScieLo, Mendeley, Google Scholar, Springer, and Elsevier) for literature published between (2001) and (2022). The search word used was/were greywater legislative framework, informal settlements, slums, non sewered settlements, aimed at the title or abstract of the research.

Quantitative research is the numerical representation and manipulation of observations for the purpose of describing and explaining the phenomena that those observations reflect. Creswell (1994) has given a very concise definition of quantitative research as a type of research that is `explaining phenomena by collecting numerical data that are analysed using mathematically based methods (statistics). Quantitative research is made up of diverse types namely, correlational research, experimental research, and casual experimental research. This study employed the former method which has to do with scientific sampling and questionnaire design to measure characteristics of the population with statistical determination. Since this project is a review of the legislative framework of greywater management, a descriptive statistics technique was used. Moreover, the official statistics about water service provision in South Africa is analysed in the study. The purpose of the statistics data according to section 3 (b) and (c) of the Statistics Act is to assist organs of state in decision-making, monitoring, or assessment of policies. The information is presented in the form of interpretive and case studies illustrative of the work conducted by different investigators, government departments and water service authorities. Supportive information in this study is collected through literature review. Each case study is reported using a systems approach and a combined discussion of case studies if presented in a tabular format. Causes leading to the identified problems are given units to uncover the frequency of their occurrence.

3.7 Ethics Considerations

The project was granted ethical clearance (see figure 3.2 and Appendix C for full statement) by the University's Research Ethics Committee based on the research permits obtained from the various municipalities. Prior to receiving ethical clearance, the project was first given permit letters (as per prerequisite) by the Water Service Institutions of the Buffalo City Metropolitan, City of Johannesburg Metropolitan and Tshwane Metropolitan City (refer to Appendix B) which was later submitted to the Ethics Committee for clearance. The Ethics policy has the following principles enshrined.

- The research process should do no harm to any of the research participants.
- The researcher should attempt to maximise the potential benefits to the research participants.

- Informed consent – The research participants must give their informed consent to their involvement in the research project.
- Respect for persons – The researcher should uphold research participants' rights with regards to respect for human dignity, the safeguarding of confidentiality or anonymity and the right to information.
- Attention must be given to the specific ethical issues related to research involving vulnerable participants.

The project was guided by these principles to collect information from the local and national government officials. Participants were as a result requested to not sign their names, surnames, cell phone details and identification numbers to conceal their identities.

Statement of Permission

Data/Sample collection permission is required for this study.

Reference no.	/10/2019
Surname & name	Vala, B
Student Number	219291497
Degree	Master of Environmental Health
Title	A review of the legal framework governing greywater management in South Africa's informal settlements
Supervisor(s)	DR NTOKOZO MFANUFIKILE MALAZA
FRC Signature	
Date	

Figure 3.2 Ethics statement from the Cape Peninsula University of Technology Research Committee authorising the collection of data.

CHAPTER FOUR
4 RESULTS

4.4 Introduction

The results section of the thesis is a composite of information from field questionnaires and desktop studies. The questionnaires were developed and sent to the various metropolitan municipal councils, waterboards and relevant national departments of South Africa. The research required inputs from the following Municipal Departments such as Infrastructure Services, Environment & Engineering Departments, Department of Environment and Agriculture Management, Economic Development & Spatial Planning, Public Health & Safety, Water and Sanitation, City Manager, Housing and Human Settlements of these Metros. Input was requested from both managerial and non-managerial staff. The results are thus presented in two parts; the first part comprises of the analysis of the existing legislative framework and a review of existing literature on greywater management. The second part of the results is an analysis of answered questionnaires from the various water service authorities which include, metropolitan municipalities, waterboards, and key national departments. Questionnaires sent to all the officials have the same outline of questions.

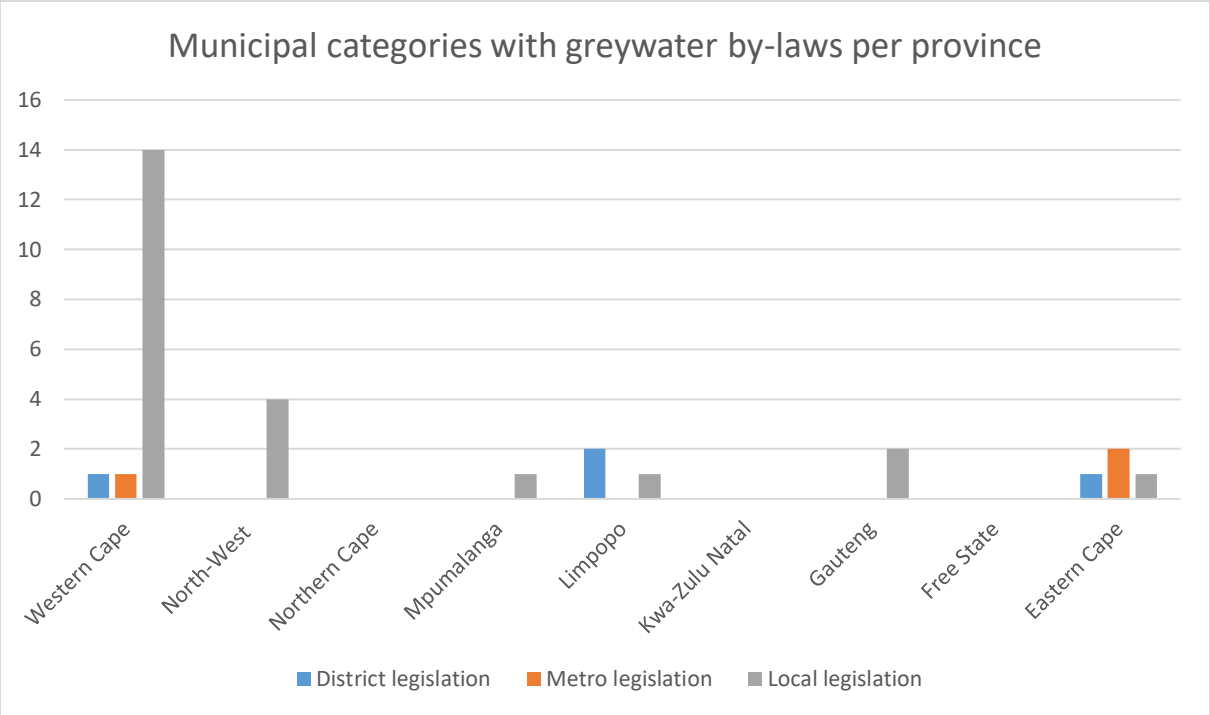


Figure 4.1 An overview of municipal categories with greywater by-laws per province in South Africa.

The abovementioned figure 4.1 is a distribution pattern of municipalities which have greywater legislation in place per province. Provinces such as the Western Cape, North West, Mpumalanga, Limpopo, Gauteng and Eastern Cape all have municipalities which have legislated greywater use. The other provinces however such as the Northern Cape, Kwa-Zulu Natal, and Free State have no municipal greywater legislation in place.

Overview of the legislative context for Class I and Class III municipalities in the Northern Cape and Limpopo Provinces

Figure 4.2 shows the various municipalities that fall under Class I (Districts) and Class III (Local) categories in the Northern Cape and Limpopo provinces according to the Municipal Structures Act. Northern Cape and Limpopo are 2 of 4 provinces in South Africa that have no Class II Metropolitan municipalities in their jurisdictions.

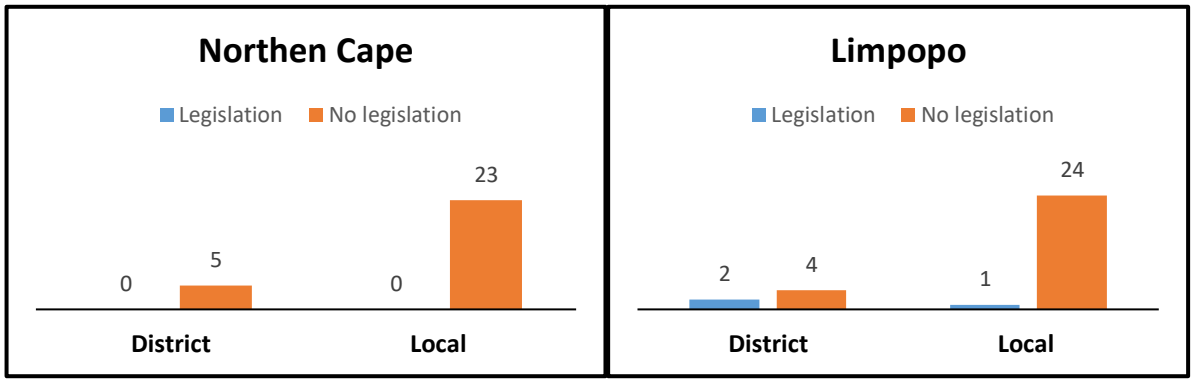


Figure 4.2 Municipalities that have greywater By-laws in the provinces of the Northern Cape and Limpopo.

The Northern Cape has a total of 23 local and 5 district municipalities and none of these have any greywater related by-laws in the legislative framework of their wastewater management program. The Limpopo province on the other hand have a total of 6 district and 25 local municipalities. Approximately, 2 District municipalities have greywater related by-laws whilst the remaining 4 have no legislation at all. Local municipalities in Limpopo that have no greywater-related legislation are 24 and only 1 municipality has a by-law that mentions greywater management.

Overview of the legislative context for Class I and Class III municipalities in the North West and Mpumalanga Provinces

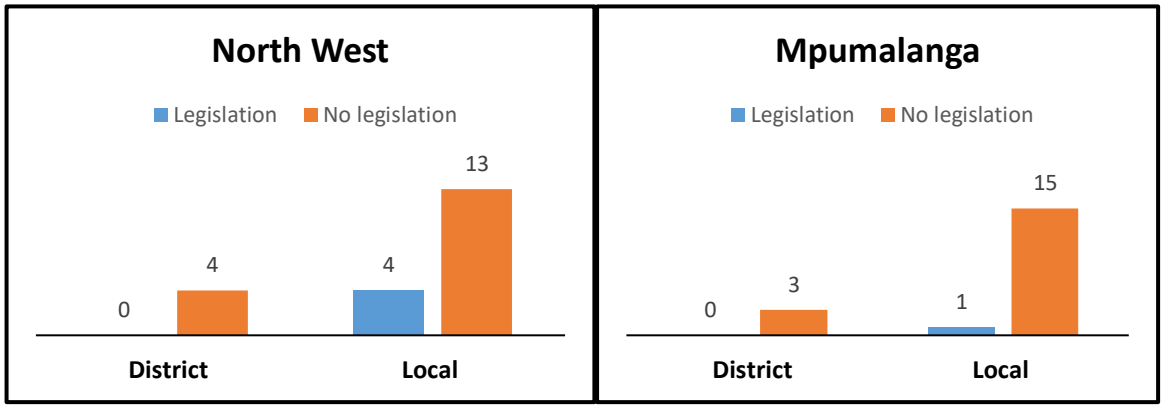


Figure 4.3 District and local municipalities that have greywater by-laws in the North West and Mpumalanga provinces.

Figure 4.3 represents the other 2 provinces, the North West and Mpumalanga that have zero municipalities which fall under Class II (Metropolitan) category according to the Municipal Structures Act. North West and Mpumalanga Province have only Class I and Class III

municipalities in their jurisdictions. The Province of the North West has a total of 4 District and 17 Local municipalities. No District in the province has legislation in place whilst 4 local municipalities have legislation which provides context for the management of greywater. The Mpumalanga Province has no District municipality out of the existing 3 that have greywater related by-laws in place. Whereas only 1 local municipality in the entire province has in place a greywater related by-law.

Overview of the legislative context for Class I, Class II and Class III municipalities in the Free State and Eastern Cape Provinces

Figure 4.4 shows the Free State and Eastern Cape provinces respectively that have all three municipal categories of Class I, Class II and Class III in their jurisdictions according to the Municipal Structures Act. The Free State Province has 5 District and 19 Local Municipalities and none of these have any greywater related legislation in place. The City of Mangaung is the province's metropolitan and has no legislation in place which provides context for the management of greywater.

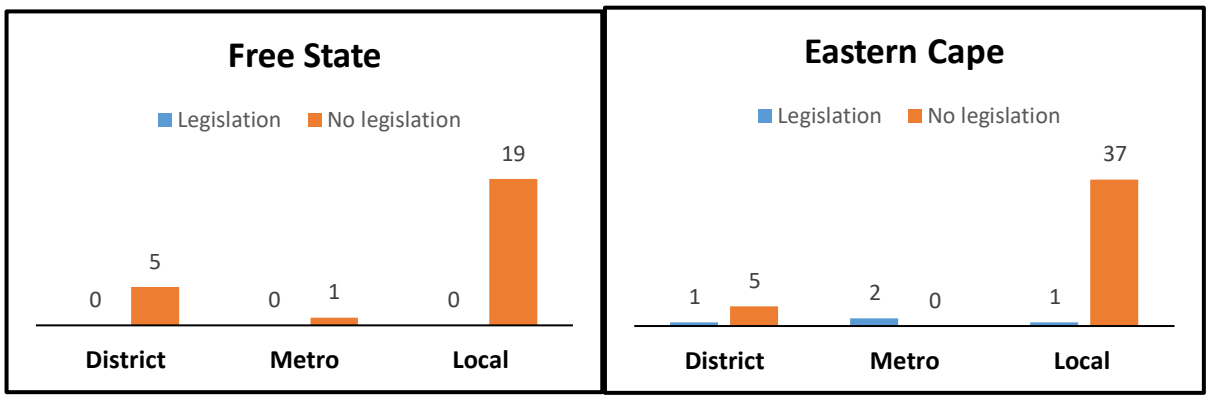


Figure 4.4 District, metro and local municipalities that that have greywater by-laws in the provinces of Free State and Eastern Cape.

The Eastern Cape on the other hand has approximately 6 district and 38 local municipalities and only 1 municipality per category has greywater related legislation in place. In addition, the province has two Metropolitan municipalities which is Buffalo City and Nelson Mandela Metro. Both metropolitans have legislation in place which provides context for the management of greywater in the 2 cities.

Overview of the legislative context for Class I - III municipalities in Gauteng, Kwa-Zulu Natal and Western Cape Provinces

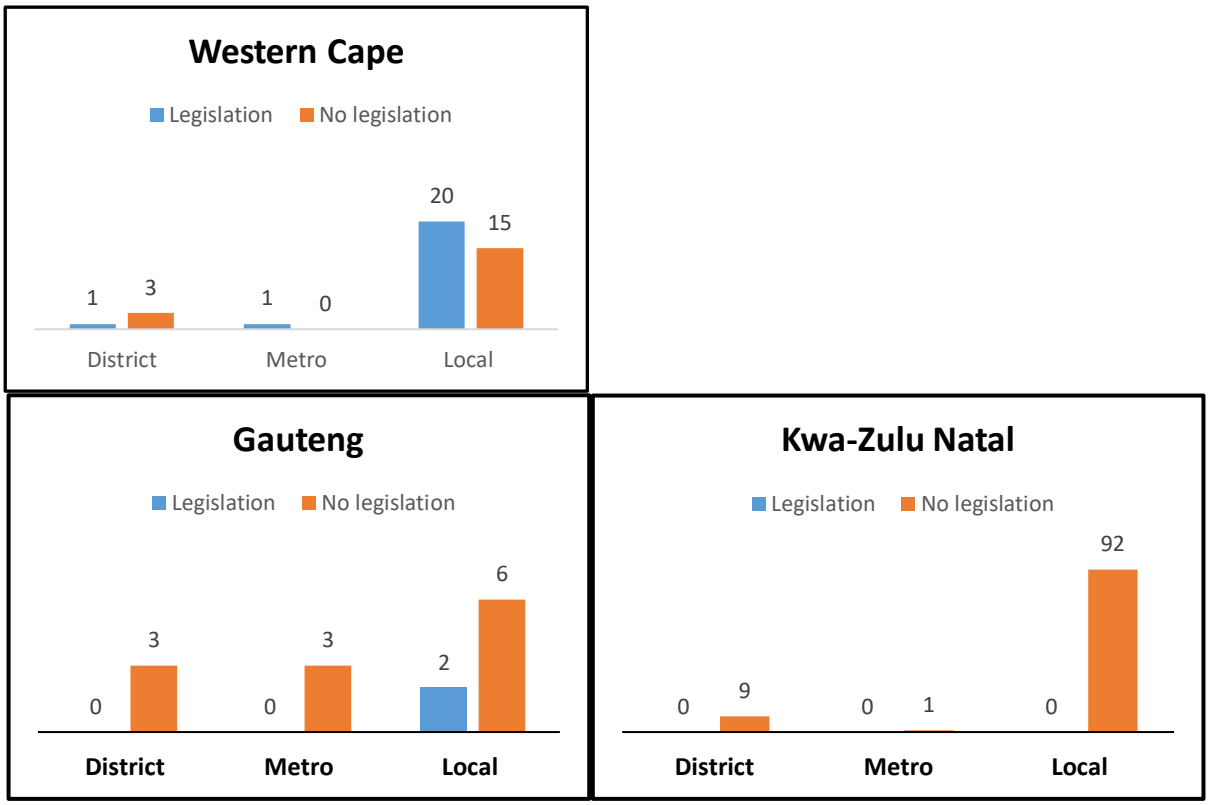


Figure 4.5 District, metro and local municipalities that have greywater by-laws in the provinces of Gauteng, Kwa-Zulu Natal and the Western Cape.

Figure 4.5 represents the remaining 3 provinces, Gauteng, Western Cape and Kwa-Zulu Natal that have all classes of district, metropolitan and local municipalities in their jurisdictions. The Gauteng Province has a total of 3 District municipalities and none of these have greywater related legislation in place. The City of Ekurhuleni, Tshwane and the City of Johannesburg are classified Class II municipalities in the province and none of these have any legislation in place which provides context for the management of greywater in the metropolitans. On the other hand, the local municipality of Mogale City and Kungwini provide a definition of greywater in their Provincial Gazette Extraordinary of 2008, 2007 and 2013 respectively. The province of Kwa Zulu Natal on the other hand has in its jurisdiction approximately 9 District and 92 Local municipalities and the EThekwini City as its sole metro. The Districts, Local and the Metro do not have any greywater related legislation in place. Lastly, the Western Cape completes the list of provinces in South Africa. The Province has all 3 municipal categories in its jurisdiction and each of these have greywater related legislation in place. The province has 4 District municipalities and only 1 of these have greywater related regulations in place which is the West Coast District. Furthermore, the City of Cape Town Metro has regulations in place which outlines the authorisation process for the installation of a greywater system. On the other hand,

there is approximately 35 local municipalities in the province and 20 of these have legislation in place whilst the remaining 15 have no legislation at all.

Language of participants & Gender splits

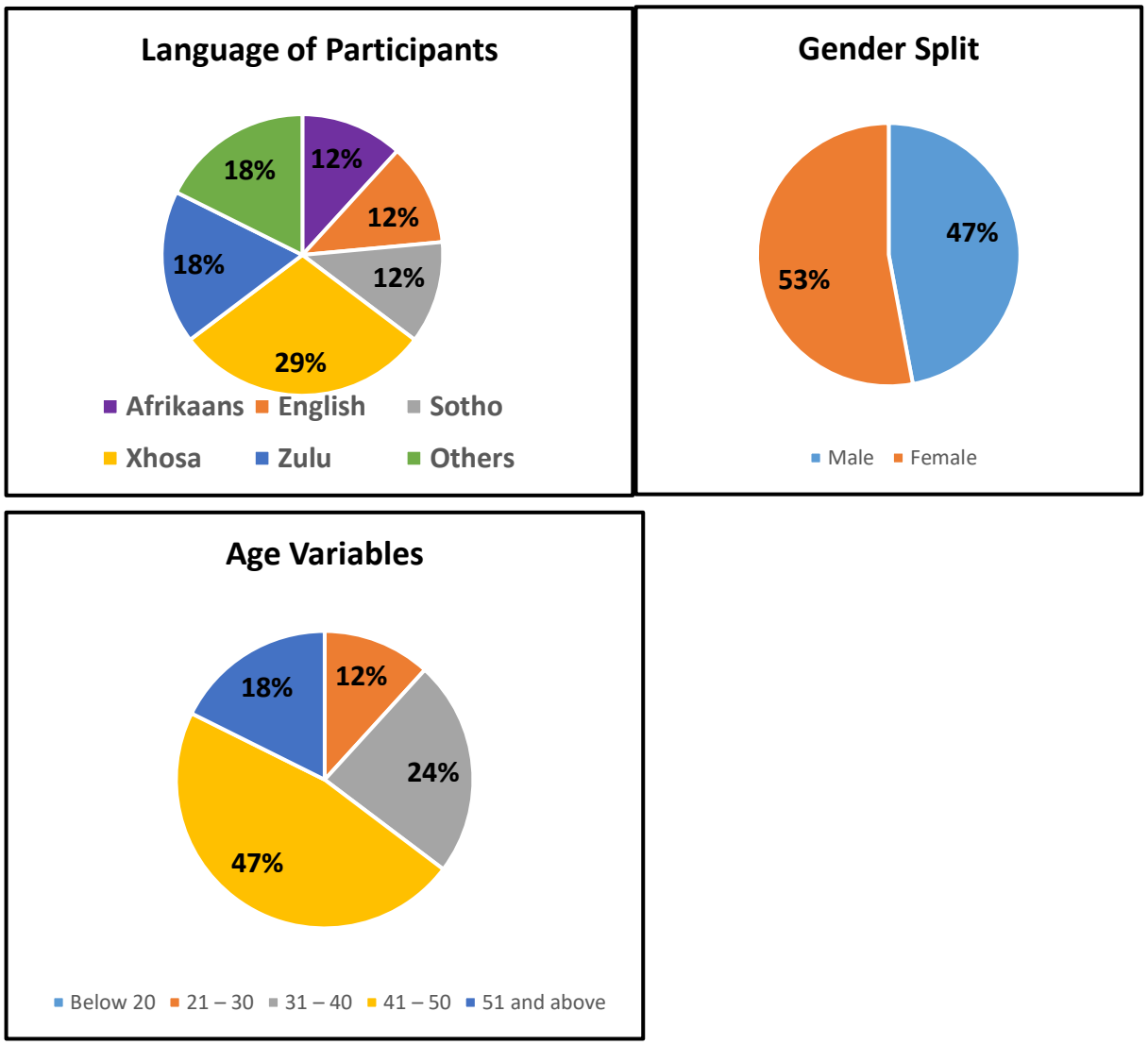


Figure 4.6 Various languages spoken by the respondents, the gender representation and also the age variables.

Approximately 29% of the interviewees are Xhosa speaking according to figure 4.6. The Sotho, English and Afrikaans speaking interviewees all share a 12% representation. The remaining 36% is divided in half between the Zulu (18%) speaking interviewees and Others (18%). Moreover, the males make up 53% whilst the females 47% of the interviewees. The age variables of the interviewees are divided into 4 classes which vary from youngest to oldest. The oldest class of interviewees which is 51 years and above comprises of 18% of the total. Subsequently, the class range of between 41 – 50 years makes up 47% of the interviewees which is the dominant class. The following class range of 31 – 40 comprises 24% of the total interviewees. The class range of 21 – 30 totals to 12% of the sum of interviewees.

Knowledge of SANS 1732:201x

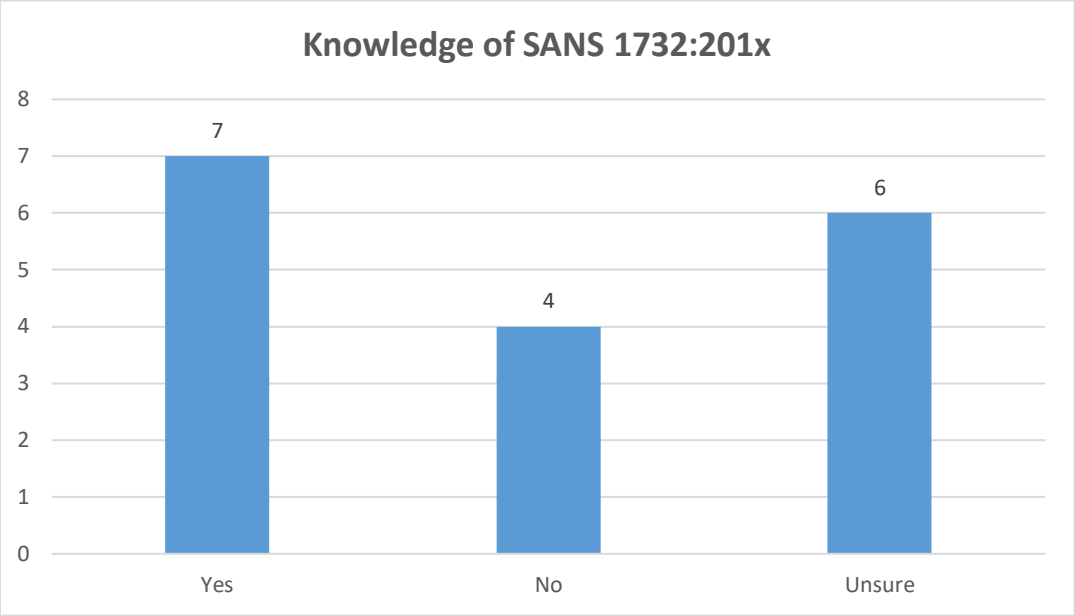


Figure 4.7 Knowledge of the officials about the SANS 1732:201x standard for greywater reuse.

Figure 4.7 of the study shows the knowledge of the officials about the SANS 1732:201x standard for greywater reuse and mangement. The officials that showed knowledge of the standard are at 7 contrary to 4 officials which indicated no knowledge of the standards. Approximately, 6 officials are unsure if the standards exist at all.

Is SANS 1732:201x clear enough?

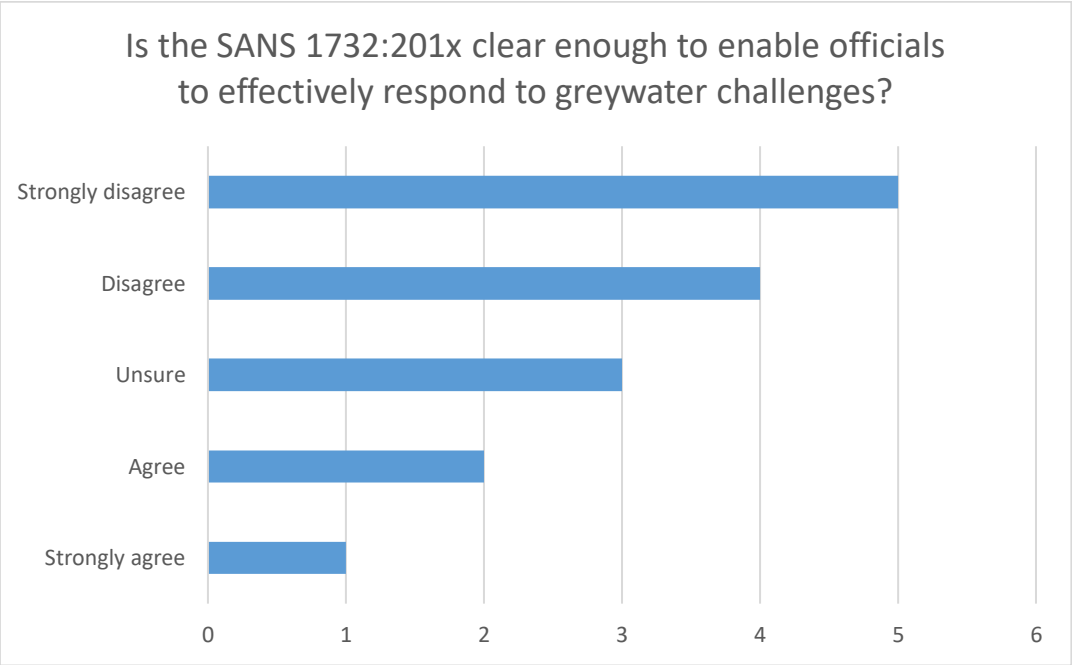


Figure 4.8 A survey of the official's satisfaction with the SANS 1732:201x standards for greywater reuse and management.

Figure 4.8 is a follow-up question of the official's understanding of the SANS 1732:201x standards and rates the interviewee's satisfaction with the standards. Officials that disagree and strongly disagree with the effectiveness of the standards are at 5 and 4 respectively. Atleast, 1 official (strongly agree) and 2 officials agree that the standards are clear enough to enable the officials to do deal with the wide range of greywater challenges in informal settlements. Officials which showed unsure are at 3.

Waterborne disease outbreak

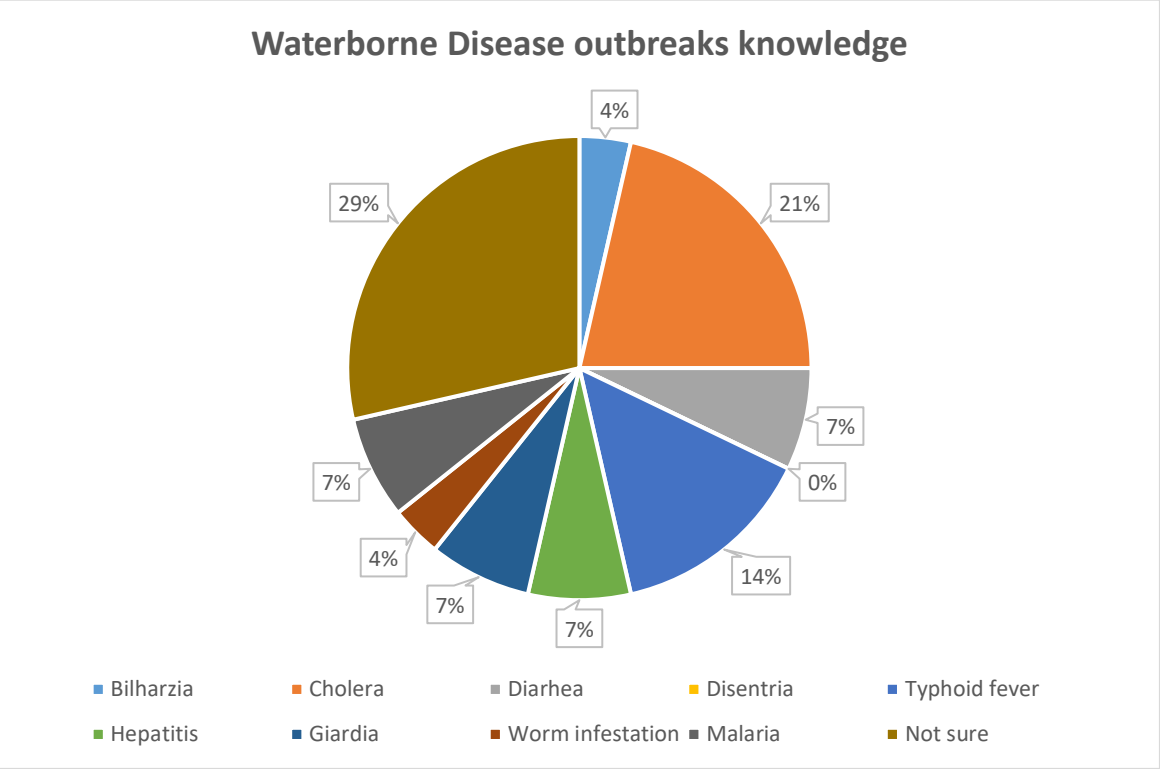


Figure 4.9 Waterborne disease outbreaks which officials are aware of took place in the City.

Figure 4.9 shows a section of the study which relates to waterborne disease outbreaks that municipal officials are aware of which took place in the Metro over the past 27 years. The waterborne disease outbreaks include Bilharzia, Cholera, Diarrhoea, Giardia, Hepatitis, Typhoid fever, Malaria and Worm infestation. A 8% figure of the interviewees indicated knowledge of Bilharzia (4%) and Worm infections (4%) disease outbreaks in the City. Subsequently, Diarrhoea (7%), Hepatitis (7%), Giardia (7%) and Malaria (7%) got listed 28% times by the interviewees. Typhoid fever got listed 14% times by the interviewees. The highest figure in the waterborne disease outbreak statistics that officials are aware of is Cholera (21%). Lastly, 29% of the interviewees do not have knowledge of any waterborne disease outbreaks in the City which might have taken place over the last 27 years. The results show a 71% knowledge of water related diseases in the City.

Greywater management challenges in informal settlements

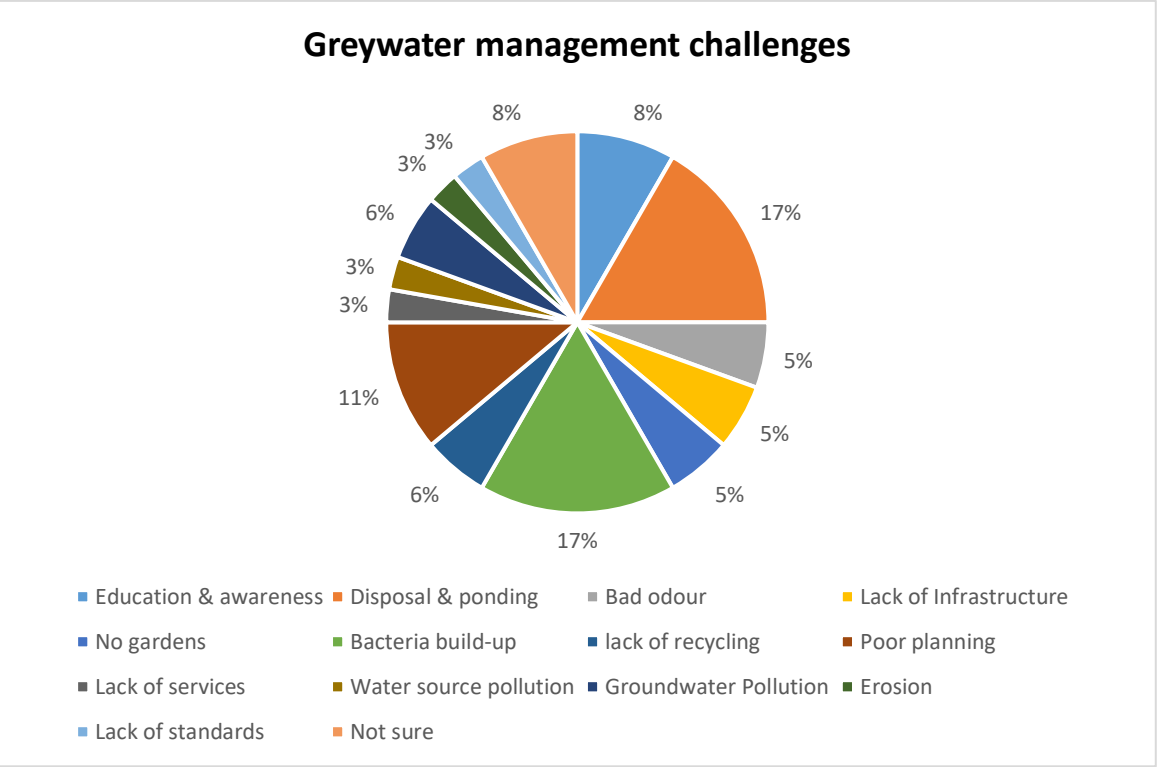


Figure 4.10 Distribution pattern of the greywater management challenges that officials are aware of.

Figure 4.10 shows a section of the study which relates to management challenges that municipal, waterboard and national government officials are aware of which characterise urban informal settlements. The greywater management challenges which the officials have listed in figure 4.10 can be grouped into 3 categories namely, Municipal service delivery functions, Community habits and Effects of poor management. Under the Municipal service delivery functions category is lack of education (8%), lack of infrastructure (5%), lack of standards (3%), lack of services (3%) and poor spatial planning (11%). This category makes up 30% of the total greywater issues the officials have highlighted. The Communal Habits category includes practices such as lack of recycling (6%), no gardens (5%) and disposal practices of casual tipping which results in ponding around shacks (17%). This second category is the lowest and makes up 23% of the statistics. The last category deals with the effects of poor management by the community and municipality and includes factors such as water source pollution (3%), groundwater pollution (6%), bad odour (5%), bacteria build-up (17%) and erosion of the soil (3%) due to greywater runoff. This last category is the leading greywater management challenges and makes up 34% of the total.

Cooperative governance

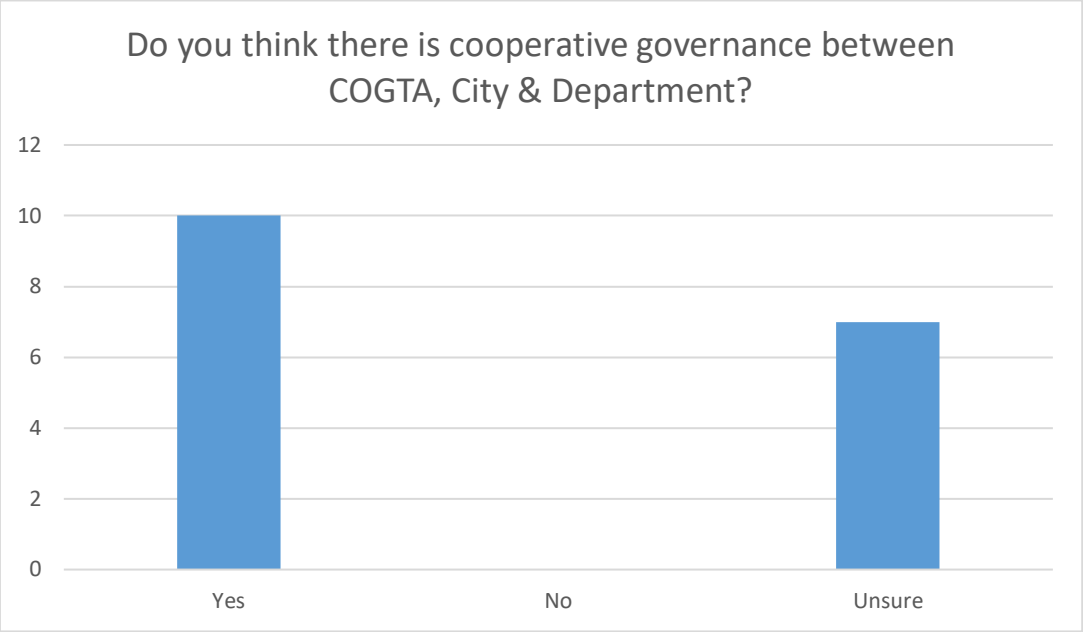


Figure 4.11 A survey of the official's satisfaction with cooperative governance between COGTA, City and the Department.

Figure 4.11 is a survey which seeks to investigate if there is cooperative governance between the Metropolitan Municipality, the National Departments, Waterboards and the department of COGTA. The purpose of the question is to review the enactment of the IWRM strategy as a means to address wastewater related challenges in informal settlements. The majority of the interviewees (10) think that there is cooperative governance between COGTA, the City and National Departments whilst 7 are unsure.

Strength of cooperative governance

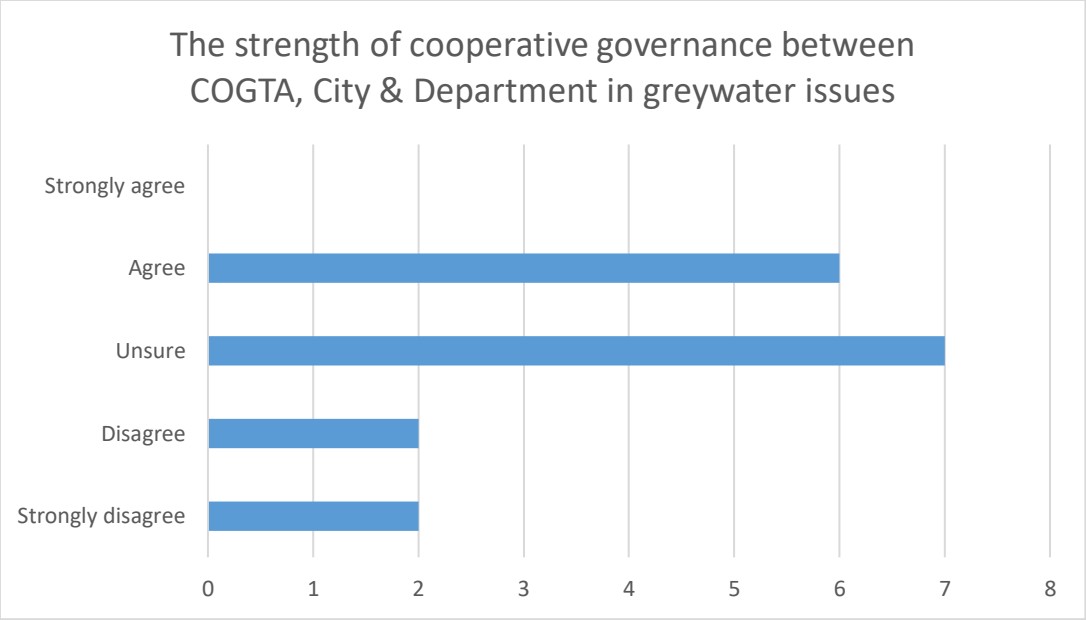


Figure 4.12 Survey of the strength of cooperative governance in helping officials deal with greywater related issues in informal settlements.

Figure 4.12 is a follow-up question which seeks to determine the strength of cooperative governance between COGTA, the City and the Department based on the official's experience. Moreover, the question looks to examine the role of cooperative in helping officials deal with a wide range of greywater related issues in informal settlements. Officials which agree that the cooperative governance between the City, COGTA and Department is adequate in helping address greywater challenges are 6. The majority (7) of the officials are unsure whilst 2 agree and another 2 strongly disagree about the effectiveness of cooperative governance.

COGTA Regulation, evaluation, and monitoring schedule

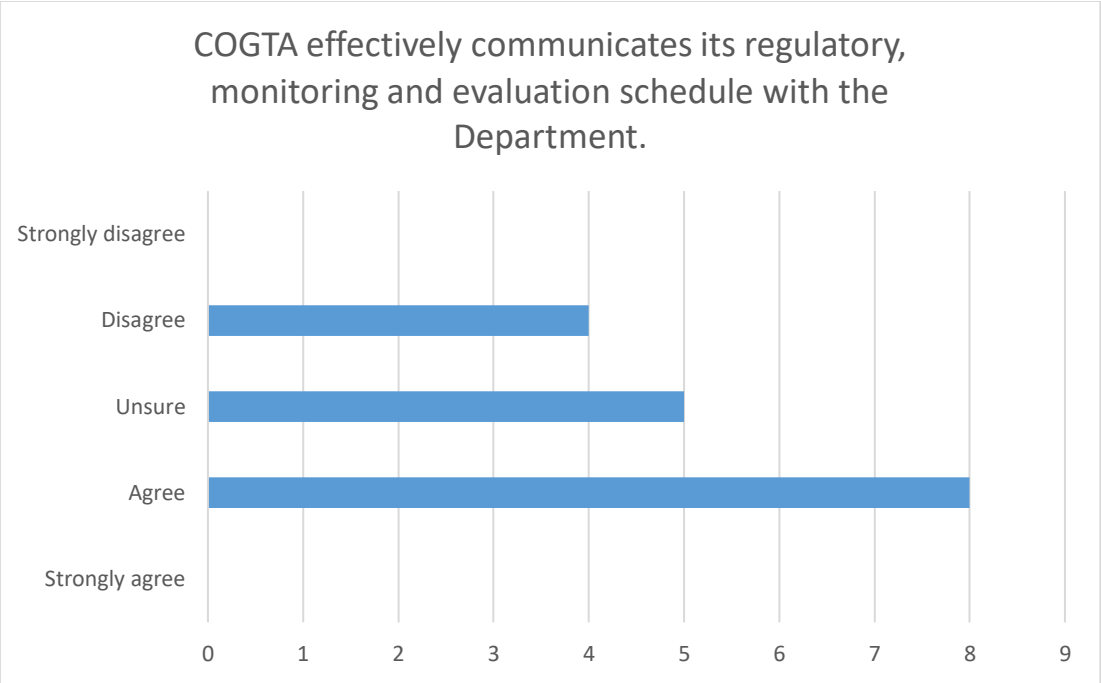


Figure 4.13 Survey of the communication of COGTA with other stakeholders concerning its regulation, monitoring and evaluation schedule.

Figure 4.13 examines the strength of COGTA's engagements in communicating its regulatory, monitoring and evaluation schedule with other stakeholders. The majority (8) of the officials agree that the department of COGTA does indeed effectively communicate its regulatory, monitoring and evaluation schedule with other stakeholders whilst 4 of the officials disagree. A total of 5 officials are unsure.

Greywater treatment system programs

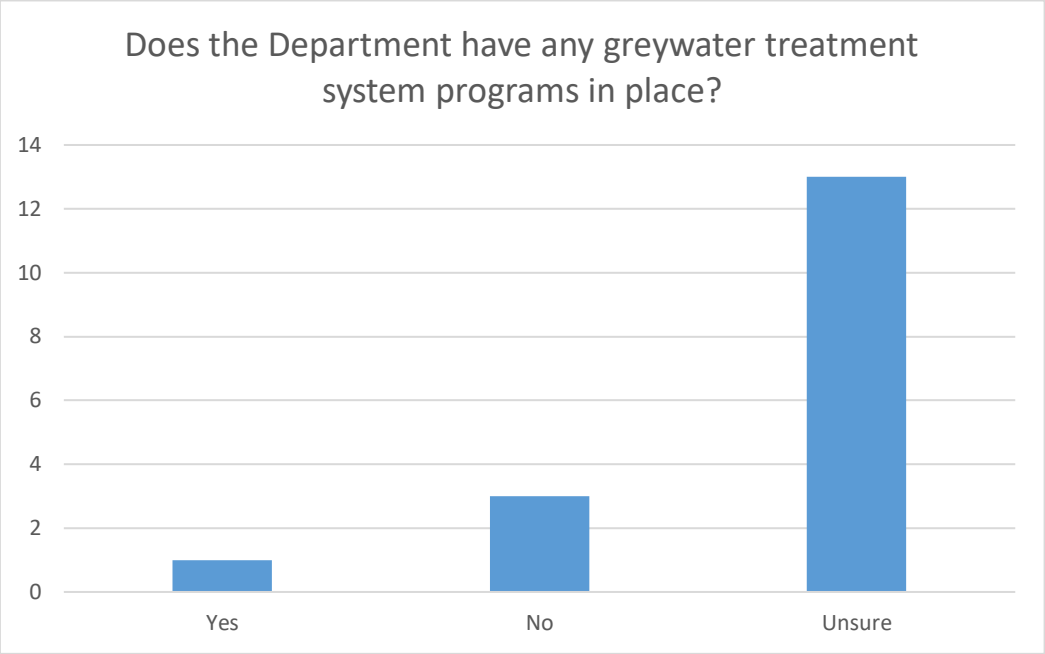


Figure 4.14 Survey of the greywater treatment system programs that the officials are aware of

Figure 4.14 is an investigation of the greywater treatment system programs of each City or Department that the officials are aware of. In response to this question 1 official indicated yes, 3 stated no whilst 13 of the officials are unsure about such greywater treatment system programs in the City or Department.

Greywater standards and level of education

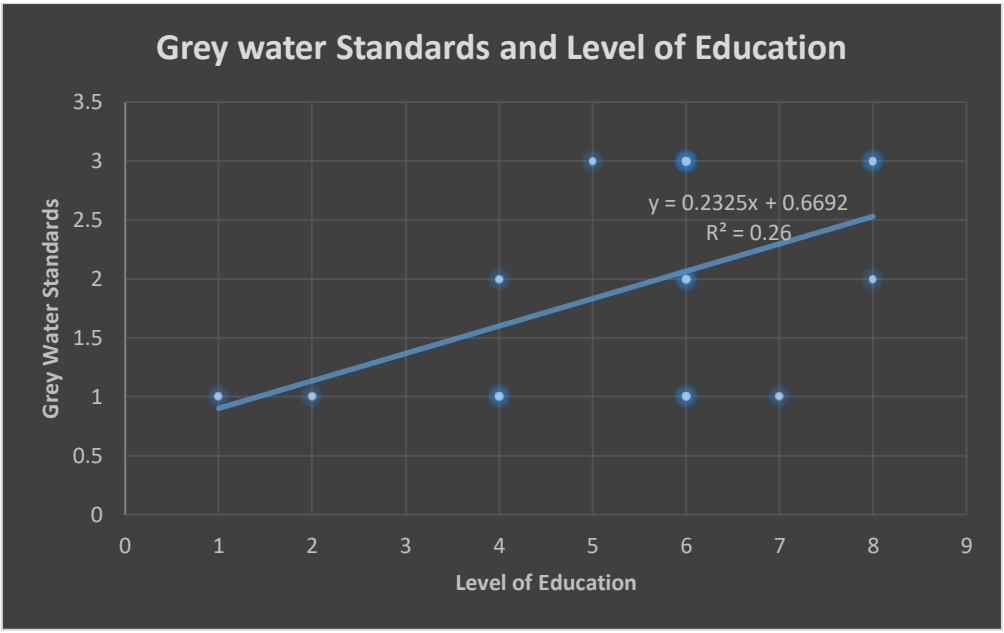


Figure 4.15 Scatter plot showing the correlation between the official's level of education and their knowledge of the greywater standards.

Figure 4.15 is based on the correlation between the official's years in service and their knowledge of the existing SANS 1732:201x standards for the reuse of greywater. The dots on the scatter plot are spaced out showing a very weak correlation between the level of education and the number of years in service. The R-Squared value of 0,2927 indicates that there is a correlation of 29,27% between the Level of Education and the number of years of experience.

Years in service and disease outbreaks

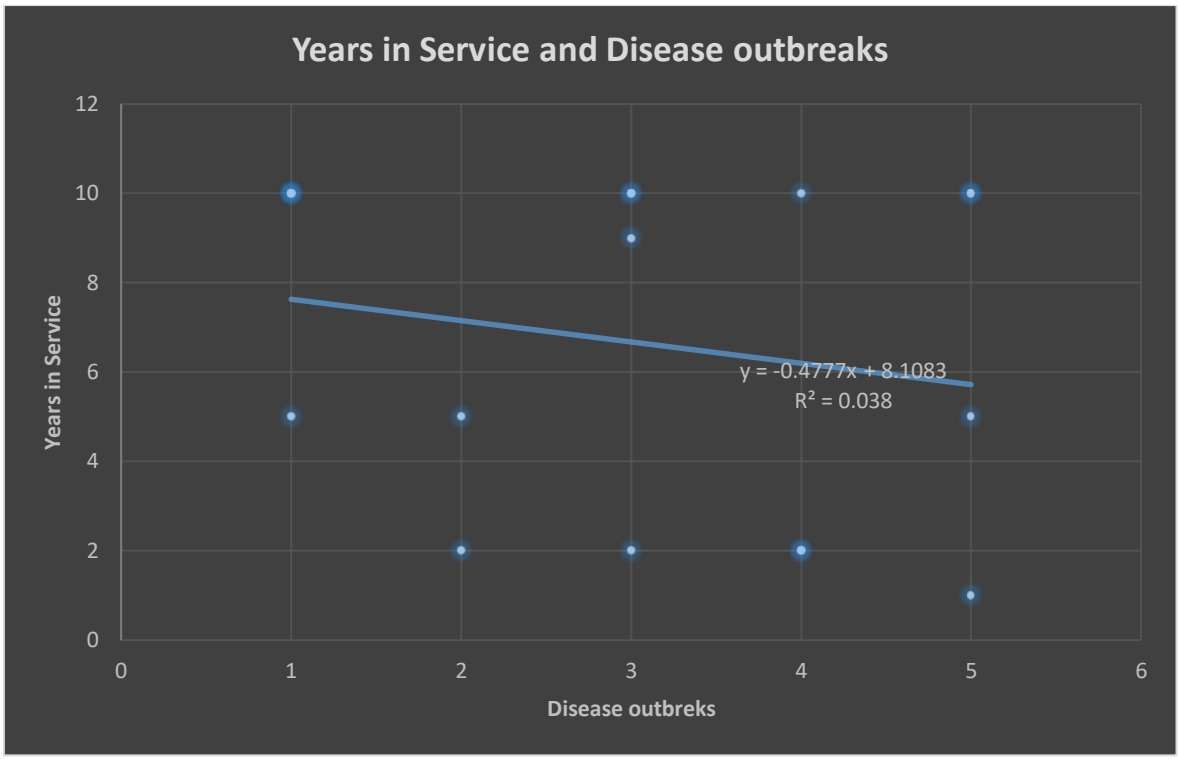


Figure 4.16 Scatter plots showing the correlation between the official's years in service and their knowledge of disease outbreaks.

The abovementioned figure 4.16 seeks to find a correlation between the official's years in service and their knowledge of disease outbreaks. The R-Squared value of 0,038 indicates a 3,8% correlation between the two variables. Therefore, there is a very slight correlation between the years in service and disease outbreaks.

Years in service and the level of education

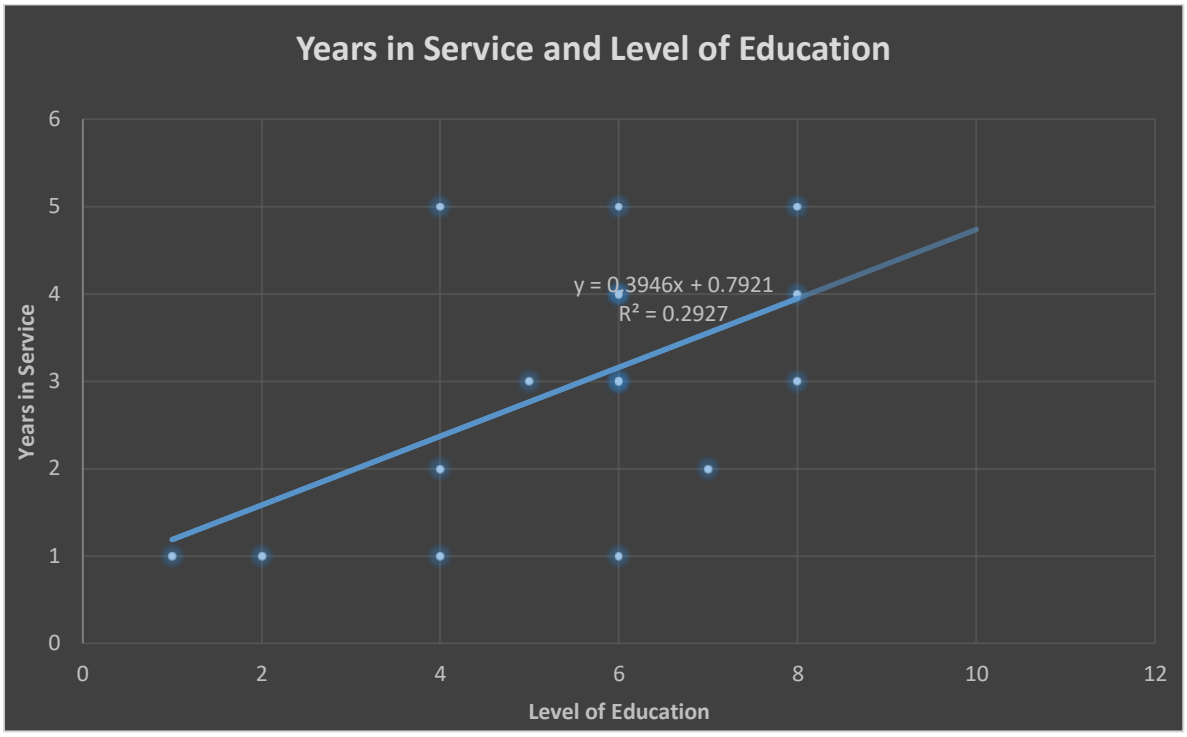


Figure 4.17 Scatter plot showing the official's years in service and their level of education.

Figure 4.17 seeks to find a correlation between the official's years in service with their level of education. The dots on the scatter plot are spaced out showing a very weak correlation between the level of education and the number of years in service. The R-Squared value of 0,2927 shows that there is a correlation of 29,27% between the level of education and the number of years of experience.

CHAPTER FIVE
5 DISCUSSIONS

The aim of this project was to review the existing greywater legislative framework of South Africa's metropolitan informal settlements to recommend legal reform for institutional ability in the provision of water services. The objectives of the study were (a) to assess if the Water Services Act of 1997 and the SANS 1732:201 of 2019 is a sufficient guide to help officials manage greywater challenges in metropolitan informal settlements. (b) To investigate the vast nature of the greywater challenges in South Africa's informal settlements as experienced by municipal officials. (c) To assess the state of cooperative governance between the various government institutions with regards to greywater management in metropolitan informal settlements. (d) To investigate if there is a policy basis in South Africa for non-treatment interventions of greywater by water service authorities in urban informal settlements. This section of the study discusses the abovementioned aims and objectives by making use of results from the desktop studies and data from the questionairres obtained from the City of Joburg, Buffalo City, and the City of Tshwane, COGTA, Waterboards and the National Department of Water and Sanitation. The results are discussed with reference to the greywater related literature in South Africa and WHO affiliated countries that have implemented the international guidelines on greywater management. Awareness

5.1 Knowledge of greywater issues in informal settlements

5.1.1 Classification of greywater challenges

This section of project deals with greywater challenges as understood by the government officials. The questionnaire sent to municipalities, waterboards and national government officials had three questions which relates to management challenges that officials are aware of which characterise urban informal settlements. The greywater management challenges in informal settlements listed in figure 4.10 are further grouped into 3 categories namely, poor municipal service delivery functions, community habits and effects of poor management. The officials that mentioned greywater reuse as a management challenge is at 4% whilst the other 4% of officials listed lack of education. The pollution of the stormwater system (9%) and the lack of infrastructure (9%) equals a total sum of 18%. In addition, 13% of the officials identify the poor management by water service authorities as one of the leading causes of greywater management challenges. Practices of disposing greywater and ponding around shacks makes up 26% of the challenges that officials are aware of. Disposal and ponding are the greatest greywater challenge that officials are aware of in informal settlements. The remaining 35% of the interviewees had no idea about any greywater challenges in informal settlements. The results confirm the findings by Carden et al (2007) that greywater ponding around shacks is the leading cause of greywater challenges in informal settlements. In addition, the 35% margin of the interviewees that showed no knowledge of greywater challenges point toward lack of

education and cross-sectional flow of information within government institutions. Carden (2008) further proposes that greywater management solutions are likely to be effective in the informal settlement if dwellers are informed and consulted in the development of these greywater management solutions. From the greywater challenges listed by the officials there is no indication of the current legislation as a possible challenge. In other words, the officials do not regard the presence or clarity of legislation as a challenge.

5.1.2 Knowledge of water related diseases

The published literature on the waterborne disease outbreaks in South Africa over the past few decades gave impetus to this study to investigate how much knowledge the officials have concerning these outbreaks. In addition, this study identified the factors which affects knowledge of disease awareness. An awareness of these water related diseases by the decision makers significantly impacts resource allocation to manage these challenges in informal settlements. In this study the questionnaire submitted to the various water service institutions contained 3 questions which are related to waterborne disease outbreaks in the respective metros (refer to appendix 1). Of the 3 questions the first question seeks to examine the interviewee's knowledge of water related disease outbreaks in the City during the democratic dispensation (past 27 years). The second question is on the documented procedural management responses to water related pandemics. The officials listed waterborne disease outbreaks such as Bilharzia (6%), Malaria (6%), Typhoid fever (18%), and Malaria (24%) disease outbreak in the City according to figure 4.9. The remaining 47% of the interviewees do not have knowledge of any waterborne disease outbreaks in the City which might have taken place over the last 27 years. The results show that 53% of the interviewees have a knowledge of disease outbreaks in the metro whilst 47% of the officials lack awareness. The difference between awareness and ignorance amongst the officials is scaled at 6% which is a very small percentage. Approximately 76% of the interviewees have an institutional experience of over 6 years and only 24% of the participants interviewed have a work experience of less than 5 years. Therefore, institutional experience is a variable that has little bearing on the interviewee's knowledge of waterborne disease outbreaks in South Africa for the past 27 years. Lack of awareness of these outbreaks is an indication of poor integrated water resource management practices amongst the departments of the City.

Waterborne disease outbreaks in informal settlements are linked to poor access to sanitation services and the poor drainage of soils. According to Griffiths (2017) waterborne diseases are the leading causes of human morbidity and mortality worldwide. Waterborne disease related mortalities are much higher in developing countries than in developed countries (Manetu and Karanja, 2021). Waterborne diseases are responsible for 1.8 deaths and 4 billion illnesses in the world yearly (UN, 2014). Manetu and Karanja (2021), Nyagwencha et al (2017), Njiru

(2016), Abdulkadir and Anandapandian (2013) found that access to piped water and poor hygienic practices resulting from the lack of sanitation facilities is the leading cause of waterborne disease outbreaks in the world. Gastroenteritis, cholera, viral hepatitis, typhoid fever, bilharziasis and dysentery are amongst the leading water related diseases in South Africa that pose a high risk. Malaria is endemic in small areas within the provinces of Kwazulu-Natal, Limpopo, and Mpumalanga.

In the province of KZN for example, Sekwadi et. al. (2018) reports of an unexpected increase in gastroenteritis cases in 2017. According to the study a sewage contamination event was the source of the outbreak which was perpetuated by person-to-person interaction. Previously, Kwa Zulu Natal was the epicentre (accounting for 98% cholera cases) of the cholera pandemic between 2000 and 2001 where most of the patients were African, mostly living in places with poor sanitation and other living conditions (Mugero and Moque, 2001). Between 2001 and 2002 the Eastern Cape province was also affected by the cholera pandemic which was caused by the disposal of untreated wastewater into the Umtata River (NDoH, 2003). The provision of safe water by the Department Water Affairs and Forestry (DWAF) saw a steady decline in cholera cases in all affected provinces of KZN, Free State, and Limpopo by 2003. In 2008 and 2009 there was another cholera outbreak according to the NICD (2008) which affected the province of Mpumalanga (54.0%) and Limpopo (43.0%). The SANS 1732:201x standard proposes the development of greywater treatment systems onsite for the purposes of reusing greywater in toilet functions. The treatment of water has its own challenges, and this includes the emergence of pathogens which are resistant to conventional water treatment (Griffiths, 2008). There is therefore a need to amend greywater policy in South Africa followed by the development of sound management practices of greywater systems by the household and municipality to prevent the emergence of water treatment resistant pathogens.

5.1.3 Knowledge of greywater legislation by officials

The project also assessed the knowledge of the officials about the SANS 1732:201x greywater reuse and mangement standards in place. Figure 4.7 shows the results of this assessment. The officials that indicated knowledge of the standard are at 41.2% contrary to 23.5% officials which showed no knowledge of the standards. Approximately, 35.3% officials are unsure if the standards exist at all. The awareness level difference is at 17,6%. The challenges with not knowing the laws in place results in poor compliance. Legislations and municipal by-laws usually undergo a lengthy process of public participation and amendments before being adopted and legalised. Section 13(a) of the Municipal Systems Act of 2000 mandates municipalities to publish a By-law passed by the municipal council in the Provincial Gazette, and, when feasible, also in a local newspaper or in any other practical way to bring the contents of the by-law to the attention of the local community. The SANS 1732:201 standards for

greywater use and management underwent the same process of public engagement before being passed as a legal imperative. The Municipal Systems Act prescribes the incorporation of existing policies into the municipality's integrated development plan. The integrated development plan of the municipality according to section 25(1)(a) links, integrates and coordinate plans and considers the proposals for the development of the municipality. The plan also forms the policy framework and general basis on which annual budgets must be based (section 25(1)(c). The integrated development plan also reflects the assessment and identification of communities which do not have access to basic municipal services (section 26(b). The municipal IDP is a document that is readily available for the community to access either through the municipality's website or handouts. A Water Research Commission funded study by Carden et al (2018) collated earlier greywater investigations to develop guidelines for the use of greywater. The findings of the study were published, circulated to municipal officials in the human settlements, engineering, water, and sanitation divisions for input. The study gave impetus to the development of SANS 1732:201 a year later. Before the standard was published, it also underwent a period of public scrutiny where the comments of the public were taken into consideration including the opinions of officials working in the water and sanitation field. Lack of awareness of greywater policy by officials is unjustified since the development thereof followed standard practice of stakeholder engagement. Various municipalities can learn lessons from the City of Johannesburg's "10 plus plan" which seeks to ensure coordination, cross sectional flow of plans and legislations between the various departments.

5.2 Greywater reuse limitations

5.2.1 Greywater reuse for crop irrigation in informal settlements

This study has investigated the efficiency of the policy guidelines which authorises the non-potable reuse of greywater to compensate for water scarcity in South Africa. The possible non-potable uses of greywater are irrigation and toilet flushing in urban informal settlements. The human, soil and plant risks connected with the non-potable reuse of greywater in informal settlements have also been highlighted. Rodda, et. al. (2011) investigated the development of guidelines for diverting greywater to be used in sustainable irrigation in gardens and small-scale agriculture in South Africa. The study identified 3 risk factors which are associated with greywater use in irrigation. The first risk is illness in human handlers of greywater and human consumers of greywater irrigated produce. The second risk is the reduction in plant growth irrigated with greywater. The final risk factor is the degradation of the environment. Mzini and Winter (2015) analysed grey water that is used for irrigating vegetables and its effects on soils in the vicinity of Umtata Dam, Eastern Cape. The study found that the greywater generated by informal settlements residents was 'fit for purpose' for irrigating edible vegetable plants. In addition, nutrients and heavy metal concentrations in the grey-water samples were significantly lower compared to the World Health Organization guidelines for the safe use of greywater and

within the target water quality range (TWQR) prescribed by South African guidelines for irrigation water. Mzini and Winter (2015) further proposes the dilution of greywater with freshwater to lower the sodium concentrations prior irrigation. Jackson (2010) confirms that the health risks connected with the reuse of greywater for irrigation purposes is less than one case of disease per 10,000 people per year by the implementation of simple barrier interventions. The Natural Resource Management Ministerial Council (2006) proposes the development of an integrated risk management framework which will comprise of hazard control measures, monitoring programs and the verification of the management system as it consistently provides quality recycled water that is fit for the intended non-potable reuse of greywater.

5.2.2 Greywater reuse for toilet flushing in informal settlements

Greywater poses risks not only on plants and soils but also on the health of humans. Moreover, Ilemobade, et. al. (2012) examined the use of greywater for toilet flushing in high density buildings. When used for toilet flushing, greywater can cause the transmission of infectious diseases from greywater ingress accidentally or deliberately into potable networks. Moreover, accidental ingestion of contaminated greywater can cause gastrointestinal illness. The National Resource Ministerial Council of Australia (2003) found that micro-organisms such as adenoviruses and enteroviruses cause respiratory illnesses because of the inhalation of recycled water. There are many routes of exposures to virus loaded greywater in the households. For example, aerosols and droplets may also be deposited on toilet seats which may in turn be touched by users who may later ingest through hand-to-mouth contact (Olanrewaju and Ilemobade, 2015). Pan et al (2014) focuses on providing equitable sanitation services in the informal settlements of Cape Town and shows that inequality will persist as long as differentiation between the services provided to formal areas from the services provided formal areas in the City. Given the present-day spatial inequalities, it is imperative that informal settlements be incorporated into the infrastructure development plans. The reuse of greywater is limited for non-potable purposes and cannot be beneficiated for potable uses such as cooking and drinking.

5.3 Limitations of the Water Services Act, 1997

The objective of this project was to investigate if there is a policy basis in South Africa for non-treatment interventions of greywater by water service authorities in urban informal settlements. The legislative mandate to manage greywater in the WSA of 1997 is placed under the provision of sanitation services. Sanitation services as defined in section 1(ii) of the WSA of 1997 makes provision for the safe and hygienic management of greywater in informal settlements. The first limiting aspect of the WSA is that it does not distinguish between greywater and blackwater but treats greywater as one with sewerage (refer to Section 1(xvi). The WSA as a result does

not mandate the development of a greywater system separate from the sewerage system but treats all domestic wastewater as the same. In addition, the WSA also does not make any provision for the on-site treatment and reuse of domestic wastewater but mandates the collection and removal thereof to offsite wastewater treatment works. It is evident that the WSA mandates the development and installation of a sewerage system to convey domestic wastewater from the household to the offsite treatment works.

The second aspect of the WSA is the limitation of rights. Section 3(1) of the WSA affords every person in South Africa the right of access to basic water supply and basic sanitation. The provision of these water service, environmental and consumer health rights is however conditional and hinges on the institutional capacity of the municipality to meet these requirements. If a municipality is unable to meet the requirements of all its consumers, section 5 of the WSA then mandates the institution to prioritise the provision of basic water supply and basic sanitation to them. Basic sanitation consists of the removal of domestic wastewater and sewerage from both formal and informal households according to the WSA. In other words, pit latrines, bucket system and chemical toilets are examples of what a basic sanitation service constitutes. It has already been proven that the reality of some municipalities relies on chemical toilets which end up being a permanent sanitation solution. Another important aspect to consider is whether greywater removal systems make up a part of basic sanitation in informal settlements. In instances where the growing population density of the informal settlement dwellers exceeds the water service allocation threshold, the municipality is still expected to prioritise the management of domestic wastewater. The act thus makes the provision of water services by the municipality a compulsory function.

5.4 Limitations of the SANS 1732:201x standards

5.4.1 Governance

The SANS 1732:201 standards may provide the necessary guidelines for the management of greywater however the implementation thereof relies heavily on the political will and priorities of the municipal council in place. The city of Johannesburg for example has identified 10 priorities in its 2040 Strategy to accelerate service delivery. Good governance and integrated sustainable human settlement are listed 2nd and 3rd on the City's 2040 Strategy. The delivery of integrated water, sanitation, waste and energy for informal settlements is covered by these priorities. A large part of the strategy focuses on maintenance work on the existing water and sanitation infrastructure. The tenure of local government municipal councils in South Africa according to policy is limited to a 5-year term and is subject to periodic changes. The seasonal changes in municipal council political leadership translates to varying water service delivery priorities. The role of municipal councils is to allocate and approve budgets for water service infrastructural development and maintenance. According to SALGA (2014/2015) the

implementation of water and sanitation development services is hampered by poor financing of municipalities by national government. The implementation of greywater programs in informal settlements is affected by these structural complications. In other words, the development of greywater infrastructure in informal settlements might not take precedence in metropolitan municipalities since there is an existing sanitation, housing and water supply backlog with a limited budget as proven in tables 2.3, 2.4, 2.5 and 2.6. This is the first obstacle that faces the implementation of the greywater standard. The implementation of the SANS 1732:201 standards in informal settlements will also requires a rigorous monitoring program by the municipality to ensure if there is compliance. This exercise will necessitate the allocation and channelling of resources towards a greywater program in informal settlements from the already debilitated water and sanitation budgets.

5.4.2 Service provider and greywater system installation authorisation process

The other limitation of SANS 1732:201x is that it does not clearly state who is mandated to provide this service of greywater system installation. The Municipality will presumably take this role of supplying informal settlements with a greywater management system as a part of its water service mandate to households. SANS 1732:201x further clearly states the authorisation process to be followed to install a greywater system in any settlement. Approval must be obtained according to section 6 (6.1) from the local authority for the use of specific materials or workmanship. The standard also places powers on the local authority bylaws which requires that all the components for use in their area of jurisdiction be listed on a schedule of approved plans. This study further proposes that the installation of greywater systems in informal settlements be added on the list of the municipal water service development strategic plans. The inclusion of greywater systems is in line with the Integrated Human Settlements Framework (IHSF) and will help to achieve the goals of regularising and progressively upgrade all informal settlements in South Africa. This will also improve the delivery of services, public space and the tenure to settlements.

5.4.3 SANS 1732:201x Greywater treatment and disposal system

5.4.3.1 Direct capture and reuse system

SANS 1732:201x mandates the development of two systems to deal with the collection, disposal, and treatment of greywater. Sections 5 (5.1) and (5.2) refers to direct capture and reuse system plus the diversion, storage, treatment, and reuse system. The direct capture and reuse system is a harvesting method (requires no treatment) that is already in use in informal settlements through casual tipping (bucketing) of greywater outside of shack dwellings. Winter et al (2007) has proven that this system poses significant environmental and public health risks in informal settlements. Casual tipping outside of shack dwellings causes ponding which leads to greywater nuisance factors like insect infestations (vector disease carriers), pathogen

breeding, and odours. This direct capture and reuse system that the SANS 1732:201x is mandating has proven to be less effective in minimising greywater nuisances in informal settlements over the years. For this method to be efficiently implemented it will require the development of an education and awareness program for the residents by the municipality. In addition, the method will require intervention by the municipality on spatial control by limiting the number of shacks to be erected per dwelling unit to make space for community agricultural land and recreational spaces which can provide site for the disposal of greywater.

5.4.3.2 Diversion, storage, treatment, and reuse system

The other harvesting method that the standard list is the diversion, storage, treatment, and reuse system. Under this method greywater enters a greywater drainpipe and is diverted before entering the soil pipe towards a collection tank for further processing. Treated greywater is then reused for the watering of plants and flushing of toilets. This method also requires special intervention by the municipality in terms of characterising the installation of this system in informal settlements as a basic legal requirement of waterservice provision. In other words, every urban informal settlement where water supply and sanitation services are provided must have a greywater diversion, storage, treatment, and reuse system in place. One of the ways that this can be effectively done is by the development of communal laundry houses in each informal settlement. The existing policy framework and strategies on the provision of waterservices through the installation of communal standpipes and toilets sets a good precedence and already gives the necessary latitude for the inclusion of communal laundry system. The laundry houses can exclusively be used for washing dishes and doing laundry. This greywater diversion system can then be connected to the laundry houses and used to divert, store, treat greywater effluent and reuse it for the toilet facilities.

Toilet flushing is the more workable option of non potable reuses of greywater in informal settlements compared to crop and landscape irrigation, cooling, groundwater recharge and vehicle washing. For treated greywater to qualify for unrestricted toilet flushing use it requires four processes namely pre-treatment, chemical/biological treatment, filtration, and disinfection (Li et al, 2009). On the other hand, disinfection may be excluded if the reuse of greywater is restricted. The need for treatment is also determined by the type of treatment technology to be employed including the scale of use and reuse application (Wiltshire, 2005).

Jefferson et al. (2001) and Holt and James (2003) identify 5 greywater technologies which include physical, biological, chemical, natural and hybrid treatments which was further re-classified by Pidou et al (2007) in table 2.16.

Table 2.16 Classification of the greywater treatment technologies by Pidou, et. al. (2007).

Greywater treatment technologies	Description
Simple treatment system	coarse filtration and disinfection) which can be referred to as (Hybrid system)
Chemical	photo catalysis, electrocoagulation and coagulation
Physical	sand filter, adsorption and membrane
Biological	biological aerated filter, rotating biological contactor and membrane bioreactor
Extensive	constructed wetlands) which can also be referred to as natural system.

SANS 1732:201x needs to specify the type of treatment system that is suitable to the conditions of the informal settlements in South Africa as proven by Pidou et al (2007) in table 2.16. The SANS 1732:201x must also take into consideration the quantities of greywater generated based on the dwelling typologies of single households, multi-dwelling, or community dwelling. In other words, the denser the settlements that produce greywater the more advanced the treatment thereof is needed and the SANS 1732:201x standard needs to specify this change. In addition, the non-potable reuse of greywater hinges on the health status of the people that have generated the greywater. The risks of waterborne disease outbreaks therefore increase if greywater coming from diverse households could be beneficiated for communal toilet flushing or irrigation of community gardens. The removal of waterborne pathogens is the most important public health concern for water treatment and the technology that the standard is mandating to be employed by the municipality should be able to perform this task in informal settlements.

5.4.4 Greywater discharge quality

The SANS 1732:201x also has no clause which outlines the greywater discharge standards. The establishment of standards will safeguard the aquatic ecosystem and ensure that the discharged water follow the requirements for basic human needs. The management responses such as regulation, measures, controls, instruments, and processes are thus the only way that municipalities can verify compliance. Should the greywater systems be installed in informal settlements it is thus imperative for water service authorities to regularly monitor the chemical, physical, and biological characteristics of the treated greywater bodies. The SANS 1732:201x standard contrary to the Queensland State greywater legislation requires no treatment of greywater when it is discharged above ground by surface irrigation. The pre-treatment of greywater for surface irrigation is a widespread practice in Australia.

5.4.5 SANS 1732:201x and unimproved sanitation

The status of access to improved sanitation is another limitation of the SANS 1732:201x standard for greywater reuse in informal settlements. The Department of Water and Sanitation (2015) identifies six infrastructural levels of sanitation services such as bucket toilets, Ventilated Improved Pit Latrine (VIP), waterborne sanitation, septic tanks, soak-aways and urine diversion toilets. General Household Survey (2018) data show that households' access to drinking water is at 89,0% whilst access to sanitation sits at 83,0%. Moreover, access to improved sanitation such as flush toilets or pit toilets with ventilation pipes according to figure 5.1 and 5.2 has increased by 21,3 percentage points over the 17-year period. Despite these advances there is still a sanitation service backlog in informal settlements. A large share of the informal settlement dwellers relies on unimproved sanitation facilities which are public toilets that is used by more than one household. This can either be a waterborne onsite facility, pit latrine without slab, chemical toilet or bucket latrines. 68% of the informal settlement dwellers share toilet facilities with 6.8% of households make use of bucket toilet system. The demand for sanitation services is therefore high which has led many municipalities to provide informal dwellers with chemical toilets as a short-term solution. In the province of Gauteng for example an estimated 25% of people living in informal settlements rely on chemical toilets for sanitation services.

The existence of chemical toilets is a feature which is characteristic of all other urban informal settlements in the country. The City of Cape erected 371 chemical toilets in 2016 to meet the sanitation needs of 60 000 dwellers of the Philippi informal settlement of Marikana. In other words, a single toilet is provided for a staggering amount of 32 households. A chemical toilet is a potable, standalone unit which uses chemicals below the toilet to neutralise human waste. Chemical toilets are only suitable for short-term temporary use, such as special functions. They are expensive, require regular emptying and are not recommended for large-scale use. The City of Cape Town and Johannesburg Metropolitan is one of the 3 most populous cities in South Africa with a considerable proportion of informal households, ~1 in 5 (Stats SA, 2012). According to van der Berg (2010) and the UN-HABITAT (2012) South Africa remains one of the world's most unequal country in the terms of income distribution and access to services. The studies by Pan et. al. (2018) shows that the focus of water service authorities on reducing service backlogs ignores equity and there is a need to incorporate equity assessment into the planning and monitoring of sanitation service delivery to South African informal settlements.

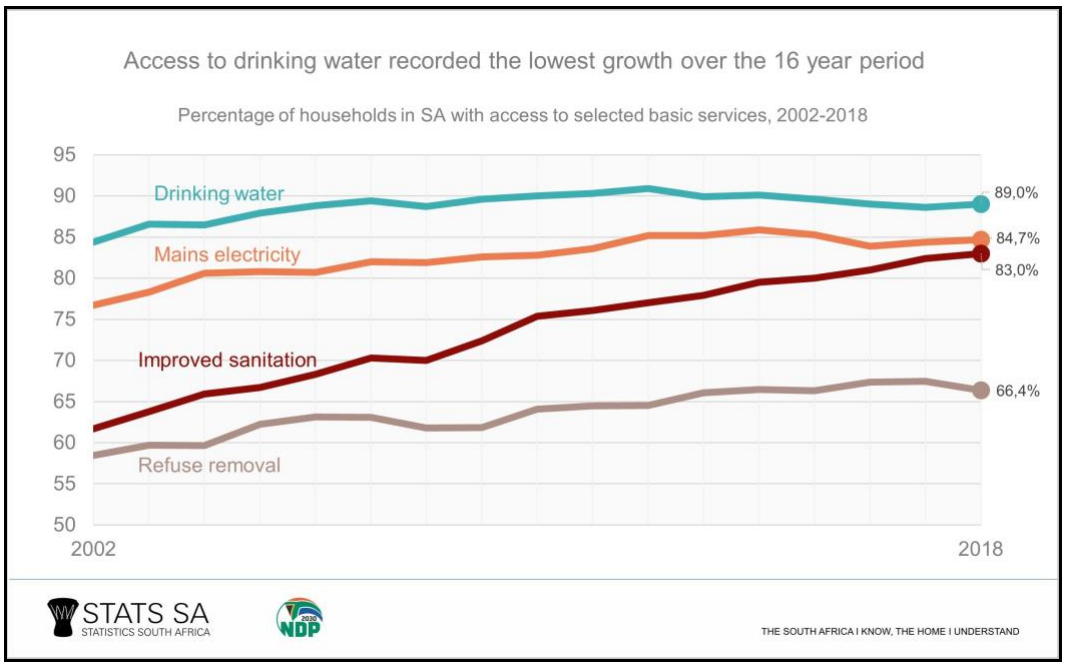


Figure 5.1 The relative growth is compared which outlines the cumulative growth over the period 2002 to 2018 for each service (Courtesy of StatsSA accessed on 15 August 2022).

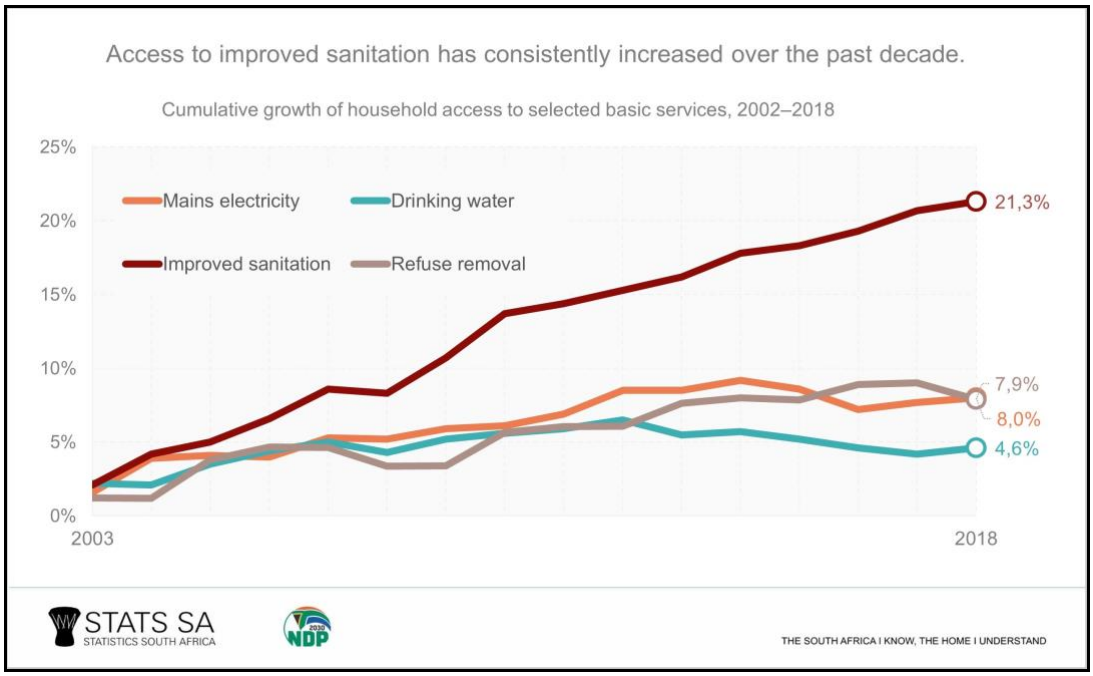


Figure 5.2 Access to improved sanitation between 2003 and 2018 shows an increase. (Courtesy of StatsSA accessed on 15 August 2022).

Improving access to information is also one of the key features Pan et. al. (2018) listed to reduce sanitation services backlogs in informal settlements. Access to information has proven to be a great hindrance in the data collection phase of this research when requests were made to all the Metropolitan municipalities in South Africa. Out of all the 8 metros that was approached in this project only 3 agreed for data to be collected about greywater issues in informal settlements. Water service officers just do not feel the obligation to participate in the research or share information about informal settlement issues. The limiting aspect of the

SANS 1732:201x standards is that the guide is only suitable for households which have access to waterborne sanitation. Informal settlements which rely on pit latrines and chemical toilets for sanitation services are thus excluded by the standards. Section 5 of the standards which deals with the installation of a greywater system is limited to waterborne sanitation and cannot be used for pit latrines and chemical toilets. The implementation of section 5 of the standard primarily requires municipal officials to fast track the removal of the bucket system, pit latrines and chemical toilets in informal settlements and provide the consumers with waterborne sanitation.

5.4.6 Availability of space and land suitability

The availability of living space in informal settlements is another limiting factor for the implementation of SANS 1732:201x. The character of informal settlements in the urban centres is one of overcrowding and lack of spatial planning. As a result, there are no demarcations to designate spaces for various functions. The tenure of every open space is irregular and can easily be occupied by tenants. The suitability of the land where some of the informal settlements are erected limits the implementation of the greywater standards. Some informal settlements are built on stormwater ponds, railway lines and arid land that is not suitable for the development of a sanitation system or repurposing of greywater for agricultural use. Wood et al (2001) provided guidelines of land planning for greywater disposal in formal settlements. The guidelines consist of 4 elements namely, settlement planning, service provision, greywater disposal, operation, and maintenance. Section 5 (5.1) of the standard provides 2 uses of greywater under the direct capture and reuse harvesting system namely flushing of the toilet or for agricultural irrigation. The direct capture and reuse system is a harvesting method which directly captures greywater without entering a wastewater piping system to use for irrigation or flushing. This a harvesting method that most informal settlement dwellers partially employ but not for the purpose of reuse.

5.5 SANS 1732:201 and greywater use risk control guidelines

The management of water related communicable disease outbreaks in South Africa is covered by the National Health of 2003 under the National Regulation of Communicable Disease Schedule. StatsSA (2017) describes communicable diseases as illnesses caused by pathogenic micro-organisms, such as bacteria, viruses, parasites, or fungi and can be spread, directly or indirectly, from one person to another. Communicable disease examples are tuberculosis, pneumonia, diarrhoea, malaria, measles, etc. The metropolitan municipalities record the highest deaths related to communicable diseases. The City of Cape Town (28 452) metro has the highest death rate in South Africa caused by communicable diseases per year followed by the City of Johannesburg (27 368) and City of Tshwane (25 344). Table 2.17 shows communicable diseases which are caused by exposure to polluted water. Water-borne

diseases, water-washed diseases, water-based diseases, and insect vector diseases are the 4 classifications of water related diseases.

Table 2.17 Classification of water related diseases (Manetu and Karanja, 2021).

Class	Route cause	Disease
Water-borne	Drinking contaminated water	Cholera, Amoebic dysentery, Bacillary dysentery (shigellosis), Cryptosporidiosis, Typhoid, Giardiasis, Paratyphoid, Balantidiasis, Salmonellosis, Campylobacter enteritis, Rotavirus diarrhoea, E. coli diarrhoea, Hepatitis A, Leptospirosis and Poliomyelitis
Water washed	Lack of clean water for washing.	Scabies, Typhus, Yaws, Relapsing fever, Impetigo, Trachoma, Conjunctivitis and Skin ulcers.
Water based	Host organisms that develop to human parasites.	Schistosomiasis, Dracunculiasis, Paragonimiasis and Clonorchiasis.
Insect vector disease	Organisms that need water to breed	Mosquito-borne diseases; Malaria, Yellow fever, Dengue fever, Filariasis and Fly-borne diseases; Onchocerciasis (river-blindness), Trypanosomiasis (West African sleeping sickness), Leishmaniosis (Kala-azar), Loiasis,

According to UN (2008) waterborne diseases are those diseases that are transmitted through the direct drinking of contaminated water with human or animal excreta. In addition, water washed diseases are those diseases which thrive in conditions with freshwater scarcity and poor sanitation while water-based diseases are infections caused by spread of organisms that develop in water and become human parasites. Insect vector diseases on the other hand are not related to drinking water but are caused by insect vectors such as mosquitoes and flies which needs water to breed. The stagnant water around shacks with mosquito infestations, greywater runoff mixed with storm water and poor sanitation services which Winter et al (2011) lists is amongst the factors which heightens the risks of water related disease outbreaks in informal settlements. The informal settlement networks which have greywater nuisances, poor sanitation, and lack of access to drinking water service are all prone to suffer from this water related diseases. The SANS 1732:201 of 2019 and Water Services Act of 1997 as wastewater management legislations fall short in mandating and highlighting the management of risks connected with the reuse of greywater and the steps that officials can take in case of

waterborne disease outbreaks. Results from this project shows that 82% of the officials are unaware of the documented operational procedures which must be followed if there should be a water related disease outbreak (refer to figure 6.4 in appendix).

Section 2 of the Act deals with the management response that local government officials are mandated to exercise when water related outbreaks occur. The result of this study shows that a substantial percentage of the officials tasked to deal with informal settlement issues are not privy to these emergency responses the law mandates. Section 12 (1) of the Act deals with the prevention of the transmission of communicable disease by animals, insects, parasites, and the prevention of malaria. The section mandates the occupier of land to take all reasonable measures to treat any collection of water or any other habitat in which mosquitoes can breed or live on such land in such a way that the breeding of mosquitoes is prevented or kept to the minimum. Casual tipping outside of shack dwellings causes ponding which leads to greywater nuisance factors like insect infestations (vector disease carriers), pathogen breeding, and odours. Informal settlements are an invasion of either government owned land or privately owned land. In other words, the legal tenure of occupancy does not rest with informal settlement dwellers. The responsibility of preventing the occurrence of water related diseases does not solely rest on the municipality but this Act mandates even informal settlement dwellers from carrying out practices that will serve as a breeding space for mosquito infestation. Public participation in the development and implementation of wastewater legislations is prescribed by the Constitution of 1996, White Paper on Local Government 1998, Municipal Structures Act 177 of 1998 and the Municipal Systems Act 32 of 2000. According to Dungumaro and Madulu (2003) public participation is an essential part of IWRM, and the use of knowledge, experience and opinions of local communities will ensure the successful and sustainable management of water resources.

5.6 Cooperative governance

The aim of this project is not limited to the review of the legislative framework which guides officials to manage greywater related challenges in South Africa's urban informal settlements but also looks to examine the quality of cooperative governance. The principle of cooperative governance is established in section 41 (1) (h) (iii) of the Constitution which mandates different government entities to co-operate with each other in mutual trust and good faith by informing one another of and consulting one another on matters of common interest. Section 41 (1)(h)(iv) mandates the different government entities to coordinate their actions and legislations with one another. Section 3 of the Municipal Systems Act of 2000 gives effect to this principle of cooperative governance by mandating the municipality to.

(a) develop common approaches for local government as a distinct sphere of government.

(b) enhance co-operation, mutual assistance and sharing of resources among municipalities.

(c) find solutions for problems relating to local government generally: and
(d) facilitate compliance with the principles of co-operative government and intergovernmental relations.

Appendix 1 of this study has 4 key questions which are related to cooperative governance that was sent to the various government officials. The purpose of the questions is to review the enactment of the Section 41 constitutional mandate of cooperation, and consultation on matters of mutual interest amongst the different government entities. Matthee (2011) in his investigation of public health policy implementation in South Africa highlights legislative ambiguity and cooperative governance as one of the leading challenges that impacts the management of public health related issues. Waterborne disease outbreaks are public health issues which this study discusses in relation to greywater management risks. Since greywater is associated with public health risk factors of waterborne disease outbreaks it is thus imperative to investigate the assertions of Matthee (2011) in this study. Waterborne disease outbreaks occur because of poor sanitation services. Even though progress has been made in South Africa concerning the provision of water services there is still a backlog of water supply and sanitation services. According to SALGA (2014/15) and COGTA (2014/15) water service backlog is caused by weak governance, monitoring, and evaluation. The other operational issues which cause poor service delivery to communities is;

- The disconnect between national budgets and requirements for water and sanitation financing.
- Plus, the lack of finance to meet investment requirements because of fragile municipalities.
- Inappropriate financing and pricing arrangements
- Slow pace of decentralization, particularly in relation to empowering local governments financially, in implementing water and sanitation interventions
- Lack of better accountability and responsiveness to communities.

Of interest in this study is the aspect of weak governance, and management (covered by monitoring and evaluation). There is also a need to assess if IWRM is effectively implemented by municipalities as a strategic solution to address wastewater related challenges in informal settlements. Question 18 in appendix 1 seeks to determine from the official's perspective if there is cooperative governance between the City, Department and COGTA. Figure 4.11 shows majority of the interviewees (10) think that there is cooperative governance between COGTA, the City and National Departments whilst 7 are unsure. The 58% of the interviewees agree that the constitutional mandate of cooperative governance is being implemented at the municipal level. The 42% of the interviewees which indicated having no knowledge of cooperative between either the City, National Departments is a significant figure. Question 19 (see Appendix 1) is analysed in Figure 4.12 and seeks to determine the strength of cooperative

governance between COGTA, the City and the Department particularly for addressing greywater management challenges in the Metro. Officials which agree that the cooperative governance between the City, COGTA and Department is adequate in helping address greywater challenges are 6 (and makes up 35%). The majority (41%) of the officials are unsure whilst 12% disagree and another 12% strongly disagree about the effectiveness of cooperative governance. The difference between the officials which agree with the ones which disagree is 11%. From these results it is thus conclusive that officials are not satisfied with the quality of cooperative governance as a tool to help manage greywater related issues in informal settlements.

Question 20 (in Appendix 1) tests the strength of the implementation of Section 41 (1)(h)(iv) of the constitution by local and national government entities. Figure 4.13 is an analysis of question 20 and examines if COGTA communicates its regulatory, monitoring and evaluation schedule with other stakeholders. The majority (8) of the officials agree that the department of COGTA does indeed effectively communicate its regulatory, monitoring and evaluation schedule with other stakeholders whilst 4 of the officials disagree. A total of 5 officials are unsure. The role of COGTA is to support the delivery of municipal services to the right quality and standard. The other function of COGTA is to promote good governance, transparency, and accountability, and to build institutional resilience and administrative capability. It is thus conclusive that the management of greywater in informal settlements requires not only sound policies but also good governance between the City, DWA, Human Settlements Department, COGTA & Treasury. National government is mandated in Section 154(1) of the Constitution to support and strengthen the capacity of municipalities to manage their own affairs, to exercise their powers and perform their functions by legislative measures and other means. The management of greywater issues in informal settlements can therefore also be viewed as a national competence of the Department of Water and Sanitation. Greywater challenges must be solved at the lowest layer of cooperative governance which is the City and Ward (household) interaction. The household (ward) and City relation is the microcosm of cooperative governance. The City handles policy development, user education, supplying and improving sanitation services and of maintaining the infrastructure thereof. The household in response is expected to use the municipal infrastructure as per specification and to exercise sound water use practices. However, SALGA (2014/2015) has highlighted that lack of better accountability and responsiveness to communities is one of the types of evidence of sanitation service backlogs. The management of greywater like any other water resource requires an integrated water resource management approach which will see cooperation between the households, ward, municipality, provincial and national government. According to UN (2008) the integrated water resource management approach is a way forward for efficient, equitable, sustainable development and management of South Africa's limited resources.

5.6.1 Monitoring & regulation of greywater use

SANS 1732:201 outlines the environmental risks that the excessive use of greywater constitutes. Excessive use of greywater for plant irrigation can potentially reduce yields because of salinity, nitrogen overload, specific ionic effects, and soil clogging (section 4 (4.2) (a, b, c, d). As a result, the soil can be degraded due to high sodicity and salinity and also contaminate groundwater. Moreover, uncontrolled use of greywater can cause reduced flows and higher solid contents causing blockages in the sewer system. The Water Services Act of 1997 is the legal document that gives to effect the regulation and monitoring of municipalities that manage the access and delivery of water services. The role of municipalities is to ensure that every person has access to water services whilst national government monitors if this function is performed. A constitutional duty is placed on national and provincial government to support and strengthen, through legislative and other means, the capacity of municipalities to manage their affairs, exercise their powers and perform their functions. Compliance to greywater policy is only possible if there is sufficient consumer education and legislative awareness at the municipal level. Figure 4.13 of the results shows the monitoring strength of COGTA as experienced by the officials. 47% of the interviewees agree that COGTA does communicate its monitoring schedule with the municipality. Whereas 29% of the participants disagree and 23,5% of the officials are unsure. Based on the results from these sampled municipalities, the strength of cooperative governance between national and local government is weak.

According to Carden (2008) greywater management solutions are likely to be effective in the informal settlement if dwellers are informed and consulted in the development of these greywater management solutions. A monitoring program by national government (for example the Department of Water and Sanitation) must also assess if municipalities implement policy and to examine if the users act per the guidelines provided and to avoid the excessive use of greywater which will harm the environment and increase public health risks. Consumer compliance to greywater policy can be encouraged by the municipality through incentives. The United States of America is the first country in the world to encourage compliance to greywater policy through incentives. States such as San Diego and Santa Clara in California and Arizona provide tax breaks and other financial incentives for residents that install greywater systems in their homes. The state of San Diego offers a rebate of between $150 - $250 for residential cloth washer systems and an added $1000 for greywater systems that do not follow the cloth washer system. In Santa Clara residents are offered $400 for installing a greywater system. The state of Arizona also offers residents up to $1000 for installing a system that can harvest greywater.

CHAPTER SIX
CONCLUSIONS

The aim of this study was to formally assess the legislative framework that governs greywater management in South Africa with special emphasis on urban informal settlements to recommend legal reform for institutional proficiency in the provision of water services. The various greywater studies have helped to improve stakeholder understanding about the vast nature of the greywater issues in informal settlements. In addition, the greywater studies have helped water service authorities to recognise greywater as a resource which can help to compensate for water shortages. The studies have led the government to formulate the SANS 1732:201x standard as a national policy on the safe use and management of greywater at a household level. It is clear from this study that the challenges associated with greywater management in the informal settlements are caused by water service delivery backlogs and thus institutional in nature. There is therefore an urgent need for municipal intervention in the roll out of improved sanitation services to informal settlement dwellers to help curb the greywater challenges. The higher the sanitation services that municipalities can deliver to the people the more efficient would be the implementation of the SANS 1732:201x standards in informal settlements. The Municipalities however can in the interim implement greywater management solutions which will ensure safe, hygienic liveable spaces in informal settlements. This study recommends the development of laundry houses and incentive-based regulation to collect, treat and reuse greywater for toilet flushing in informal settlements. The findings of this study are summarised the following way: Firstly, this study found that the challenges associated with greywater management in informal settlements are caused by water service delivery backlogs and thus institutional in nature. Secondly, the implementation of SANS 1732:201x standards is only possible if the sanitation service level of informal settlements is improved to waterborne sanitation. Thirdly, the Water Services Act of 1997 is ineffective to help manage greywater in informal settlements through reuse since the act does not clearly define and distinguish greywater from blackwater. Lastly, the study found that municipal workers in metropolitan municipalities do not uphold the principle of access to information enshrined in section 32 of the South African Constitution which states that everyone has the right of access to any information that is held by the State.

6.1 Recommendations

6.1.1 Informal settlement laundry houses

The SANS 1732:201x makes mention of two methods that can be used to harvest, recycle greywater for agricultural or toilet purposes. Issues such as water service level infrastructure, availability of space and suitability of land makes the reuse of greywater in informal settlements limited. The implementation of the standards requires the upscaling of water service provision in informal settlements from unimproved to improved flush toilet facilities. Municipalities must

get rid of chemical toilets, bucket system and pit latrines for the implementation of diversion, storage, treatment, and reuse systems to be in any way possible in informal settlements. In other words, a sewerage must first be in place with a greywater diversion system built alongside it. This method requires special intervention by the municipality in terms of speeding the rollout of the improved sanitation program in informal settlements. In addition, due to the public health, environmental nuisances, and waterborne disease outbreak risks the municipality should classify the installation of this greywater system in informal settlements as a basic legal requirement of waterservice provision. In other words, every urban informal settlement where water supply and sanitation services are provided must have a greywater diversion, storage, treatment, and reuse system in place. In addition, the systematic harvesting of greywater through laundry houses is a more effective solution since the general quantities that low-cost households produce is low. According to Olanrewaju and Ilemobade (2015) the quantity of greywater which is generated in low-income areas which experience water scarcity and/or with rudimentary water supply services (such as standpipes or wells) can be as low as 20-30 litres per person while high-income households with reticulation pipeline may generate several hundred litres per day. According to Morel and Diener (2006), Li et al. and Mandal et al. (2009) households with a pipeline generate 90-120 l/p/d of greywater. The reuse of greywater can reduce urban potable water demand by between 30% - 70% (Ilemobade et al, 2003 and Radcliffe, 2003). This study proposes the development of public laundry houses in each informal settlement as a means to implement the SANS1732:201x standards. The existing policy framework and strategies on the provision of waterservices through the installation of communal standpipes and toilets sets a good precedence and already gives the necessary latitude for the inclusion of a communal laundry system. The laundry houses can exclusively be used for washing dishes and doing laundry. This greywater diversion system can then be connected to the laundry houses and used to divert, store, treat greywater effluent and reuse it for the toilet facilities.

6.1.2 Incentive based regulation of greywater system

According to section 4 (4.2) (a, b, c, d) can potentially reduce yields because of salinity, nitrogen overload, specific ionic effects, and soil clogging. In addition, the soil can be degraded due to high sodicity and salinity and contaminate groundwater. Moreover, uncontrolled use of greywater can cause reduced flows and higher solid contents causing blockages in the sewer system. This study recommends the use of an incentive-based regulation approach like the blue and green drop program. The blue drop and green drop are an incentive-based regulation approach which was designed by the Department of Water Affairs to monitor WSAs standards compliance by the municipalities with the requirements for water supply and wastewater service management. The aim of this incentive-based monitoring approach was to establish excellence as the benchmark for wastewater services. The blue drop is an incentive-based regulation that focuses on drinking water and green drop focus on monitoring wastewater

service delivery. Municipalities receive Green Drop status when they achieve scores of 90% or higher, against stringent Green drop assessment requirements. Green Drop scores are given per individual wastewater system within the municipal area for process control, maintenance and management skills and wastewater quality monitoring purposes.

6.2 Limitations of the study

The study envisaged the use of questionnaires and personal interviews to collect data from the water service authorities. At first, permission was requested from the various municipalities to obtain ethical clearance from the University and call for the data collection process. This exercised proved to be a great challenge as only 3 Metros out of a possible 8 granted permission for data to be collected in their respective municipalities. The other limitation of the study was the access to information which was influenced by a range of factors. There was an overwhelming unwillingness from the municipal directors and other non-managerial staff to participate in the research despite the research permit which the City granted. The City of Tshwane is an example of a metro municipality which granted permit to conduct the study in the City but only one senior official in the water and sanitation department completed the questionnaires despite many attempts through emails, and telephone calls to get the other officials to participate. When the route of emails and telephone calls was not yielding any fruits, I decided to make a special trip to Pretoria and spent a few days trying to persuade the officials to take part but even this exercise yielded no fruits. Buffalo City and the Nelson Mandela Metro are other examples of municipalities outside the province of the Western Cape that I paid visits to persuade the officials to take part in the research after many failed attempts to reach the officials through emails and telephone calls.

The City of Joburg is the only exception in the research where access to information and municipal officials was never a problem. The City of Joburg with its entity of Joburg Water gave licence for data collection and responded to all the appeals to participate in the research through emails and telephonic persuasions without any hindrances. The City of Ekurhuleni refused upfront through email to take part in the research stating shortage of staff and a backlog of research requests they are still dealing with. The City of Mangaung was also contacted through emails and telephone calls but never gave any responses. The City could not be visited due to lack of financial resources since the research was not funded either by the University or other research entities. Since the researcher is based in the City of Cape Town and its former employee thus the Metro became the very first contact point for data collection. The City was also contacted via emails and telephone calls but this yielded no fruits. As a former employee of the City I then resorted to other means of getting the data by directly contacting former colleagues in the Water and Sanitation department and Informal Settlements Infrastructure engineering department to help complete the questionnaires, but this route also

yielded no results. The officials cited workload as a prime reason of not assisting. Lastly, the EThekwini City is the only municipality the researcher was not able to contact either through emails or telephone call out of the 8 Metros in the country.

Access to municipal officials and information was impacted by 2 noteworthy events namely the COVID-19 Pandemic and the Local Government Elections of 2021. The research was approved by the University in the first 3 months of 2020. However, when the data collection process had to start the country was plunged into the first COVID-19 lockdown which persisted for 2 years in stages. Officials could not be reached for a year since they were working from home and access to government premises was prohibited for non-employees. Attempts were however made to contact the officials via emails and telephone calls which proved to be another great complication since many relevant officials were either reported sick, deceased, or working from home with different email address and cell phone numbers. Notwithstanding all these challenges several officials were reached and given the questionnaires to complete following the easing of COVID-19 restrictions. As soon as the restrictions were eased in mid-2021, the minister of COGTA later gazetted the municipal elections scheduled for 01 November 2021. Informal settlements and the service delivery challenges around it are highly emotive and usually become the centre stage of political activism especially during the election season in South Africa. The release therefore of information to any entities outside the municipality becomes a huge challenge because of the risks and fears associated with the weaponing of service delivery issues to serve political ends.

South Africa has experienced legislative developments related to water and health services ever since the dawn of democracy. The various greywater studies have helped to improve stakeholder understanding about the vast nature of the greywater issues in informal settlements. The urgency of municipal intervention in the roll out of improved sanitation services in informal settlements have been highlighted by the studies. In addition, the greywater studies have helped water service authorities to recognise greywater as a resource which can help to compensate for water shortages. The studies have led the government to formulate the SANS 1732:201x standard as a national policy on the safe use and management of greywater at a household level.

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APPENDIX/APPENDICES

APPENDIX A: QUESTIONNAIRES

Topic: A review of the legal framework governing greywater management in South Africa's informal settlements.

QUESTIONNAIRE

Interviewees (Municipal Directors, Managers, Technical Directors)

INTRODUCTION

The aim of the study is to assess whether the water services legislative framework (in its current form) is an adequate guide to help City officials deal with a wide range of greywater management challenges with regards to urban informal settlements.

All information will be treated as confidential and the researcher undertakes not to link any information to the respondent. The respondents will not be required to identify themselves anywhere on this questionnaire.

Please circle your response in the appropriate square provided. For the open-ended questions, please respond clearly and briefly in your own words in the space provided.

Researcher: Mr Babalo Vala (Masters Candidate)

Dr. N. Malaza (Supervisor)

1. What language do you speak mostly at home?

Afrikaans	1	
English	2	
Sotho	3	
Xhosa	4	
Zulu	5	
Others please specify ……..	6	1

2. Gender

Male	1	
Female	2	2

3. Age

Below 20	1	
21 – 30	2	
31 – 40	3	
41 – 50	4	
51 and above	5	3

4. What is your highest educational qualification obtained?

Please specify	1	4

5. With which population group do you associate yourself with most?

Black	1

White	2
Coloured	3
Indian	4
Other please specify: ……..	5

5

6. For how long have you been working in this type of job, including previous jobs?

< 5 years	1
6 – 10	2
11 – 15	3
16 – 20	4
21 +	5

6

7. What is your department / section in the organization?

Infrastructure & Engineering	1
Water and Sanitation	2
Human Settlements	3
Public Health	4
	5
Other please specify: ……..	6

7

8. What is the nature of the job?

Internship	1
Causal	2
Contract	3
Permanent	4
Other please specify: ……..	5

8

9. Which religious belief group do you belong to?

Christian	1
Islamic	2
Jewish	3
Hinduism	4
Other please specify:	5

9

10. Please answer the following question.

Question	Yes	No	Unsure	
Are you aware of the **SANS 1732:201x** that guide greywater management in South Africa?	1	2	3	10

11. To what extent do you agree or disagree with the following statements?

Statement	Strongly agree	Agree	Unsure	Disagree	Strongly disagree	
The guidelines are clear enough to enable officials to respond effectively to greywater management challenges.	1	2	3	4	5	11

12. Please answer the following question.

Question	Yes	No	Unsure	
Are you aware of any greywater management challenges in the Metropolitan informal settlements?	1	2	3	12

13. If your answer to question (12) is yes, please elaborate.

…… …… …… …… ……	13

14. What are the major waterborne disease outbreaks the Metropolitan has had to deal with over the last 27 years?

…… …… …… …… ……	14

15. Please answer the following question.

Question	Yes	No	Unsure	
Are there any documented Municipal operational procedures that officials are required to follow when responding to waterborne disease outbreaks?	1	2	3	15

16. If your answer to question (15) is yes, please list these procedures

…… …… …… …… ……	16

17. What other challenges can you think of that are associated with greywater in informal settlements?

…… …… …… …… ……	17

18. Please answer the following question.

Question	Yes	No	Unsure	
Do you think that there is cooperative governance between the City and COGTA?	1	2	3	18

19. To what extent do you agree or disagree with the following statement?

Statement	Strongly agree	Agree	Unsure	Disagree	Strongly disagree	
The cooperative governance between the City & COGTA is adequate in addressing greywater management challenges in the Metro.	1	2	3	4	5	19

20. Has the City ever required the intervention of COGTA to help with greywater related management challenges in the informal settlements?

…… …… …… …… ……	20

21. To what extent do you agree or disagree with the following statement?

Statement	Strongly agree	Agree	Unsure	Disagree	Strongly disagree	
The City's response to greywater challenges in informal settlements is adequate	1	2	3	4	5	21

22. To what extent do you agree or disagree with the following statement?

Statement	Strongly agree	Agree	Unsure	Disagree	Strongly disagree	
COGTA effectively communicates its regulatory, monitoring & evaluation schedule with the City	1	2	3	4	5	22

23. Please answer the following questions.

Questions	Yes	No	Unsure	
Does the City have any greywater treatment system Programs in place?	1	2	3	23

24. If your answer to question (23) is yes, please list these Programs

…… …… …… …… ……	24

25. Please answer the following questions.

Questions	Yes	No	Unsure	
Does any of the informal settlements have infrastructure to divert greywater?	1	2	3	25

26. Please answer the following questions.

Questions	Yes	No	Unsure	
Is the re-use of greywater a common practice in the City?	1	2	3	26

27. Can you list the industries in the City which re-uses greywater?

…… …… …… …… ……	27

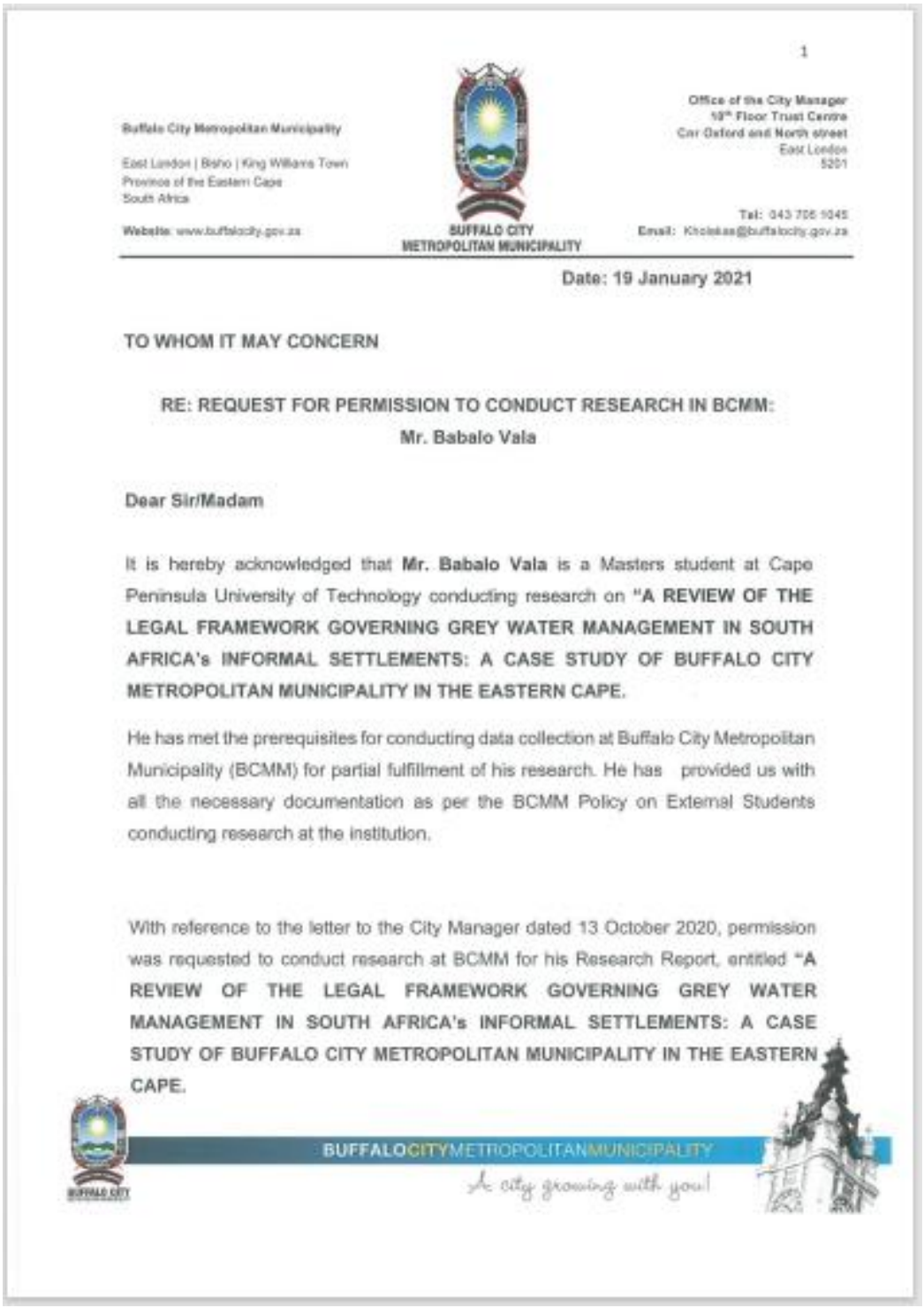
28. Please answer the following questions.

Questions	Yes	No	Unsure	
Does the Municipality have a legal process in place that requires industries to follow in order to treat & re-use greywater?	1	2	3	28

29. If your answer to question (28) is yes, please specify

…… …… …… …… ……	29

APPENDIX B: PERMIT LETTERS



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Buffalo City Metropolitan Municipality

East London | Bisho | King Williams Town
Province of the Eastern Cape
South Africa

Website: www.buffalocity.gov.za

BUFFALO CITY
METROPOLITAN MUNICIPALITY

Office of the City Manager
18th Floor Trust Centre
Cnr Oxford and North street
East London
5201

Tel: 043 705 1045
Email: Kholeka@buffalocity.gov.za

Date: 19 January 2021

TO WHOM IT MAY CONCERN

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN BCMM:
Mr. Babalo Vala

Dear Sir/Madam

It is hereby acknowledged that **Mr. Babalo Vala** is a Masters student at Cape Peninsula University of Technology conducting research on **"A REVIEW OF THE LEGAL FRAMEWORK GOVERNING GREY WATER MANAGEMENT IN SOUTH AFRICA's INFORMAL SETTLEMENTS: A CASE STUDY OF BUFFALO CITY METROPOLITAN MUNICIPALITY IN THE EASTERN CAPE.**

He has met the prerequisites for conducting data collection at Buffalo City Metropolitan Municipality (BCMM) for partial fulfillment of his research. He has provided us with all the necessary documentation as per the BCMM Policy on External Students conducting research at the institution.

With reference to the letter to the City Manager dated 13 October 2020, permission was requested to conduct research at BCMM for his Research Report, entitled **"A REVIEW OF THE LEGAL FRAMEWORK GOVERNING GREY WATER MANAGEMENT IN SOUTH AFRICA's INFORMAL SETTLEMENTS: A CASE STUDY OF BUFFALO CITY METROPOLITAN MUNICIPALITY IN THE EASTERN CAPE.**

BUFFALOCITYMETROPOLITANMUNICIPALITY
A city growing with you!

Figure 6.1 Buffalo City permit for data collection.

This request was scrutinized by the Information and Knowledge Management, Research and Policy Unit for further assistance, and approved in accordance with national and international research ethical and legal norms, standards and guidelines.

Mr. Babalo Vala was asked to provide the Unit with the necessary documentation, of which he subsequently did.

The relevant Officials to assist in the research were identified and will duly be informed about the research, and the fact that **Mr. Babalo Vala** has met all the prerequisites.

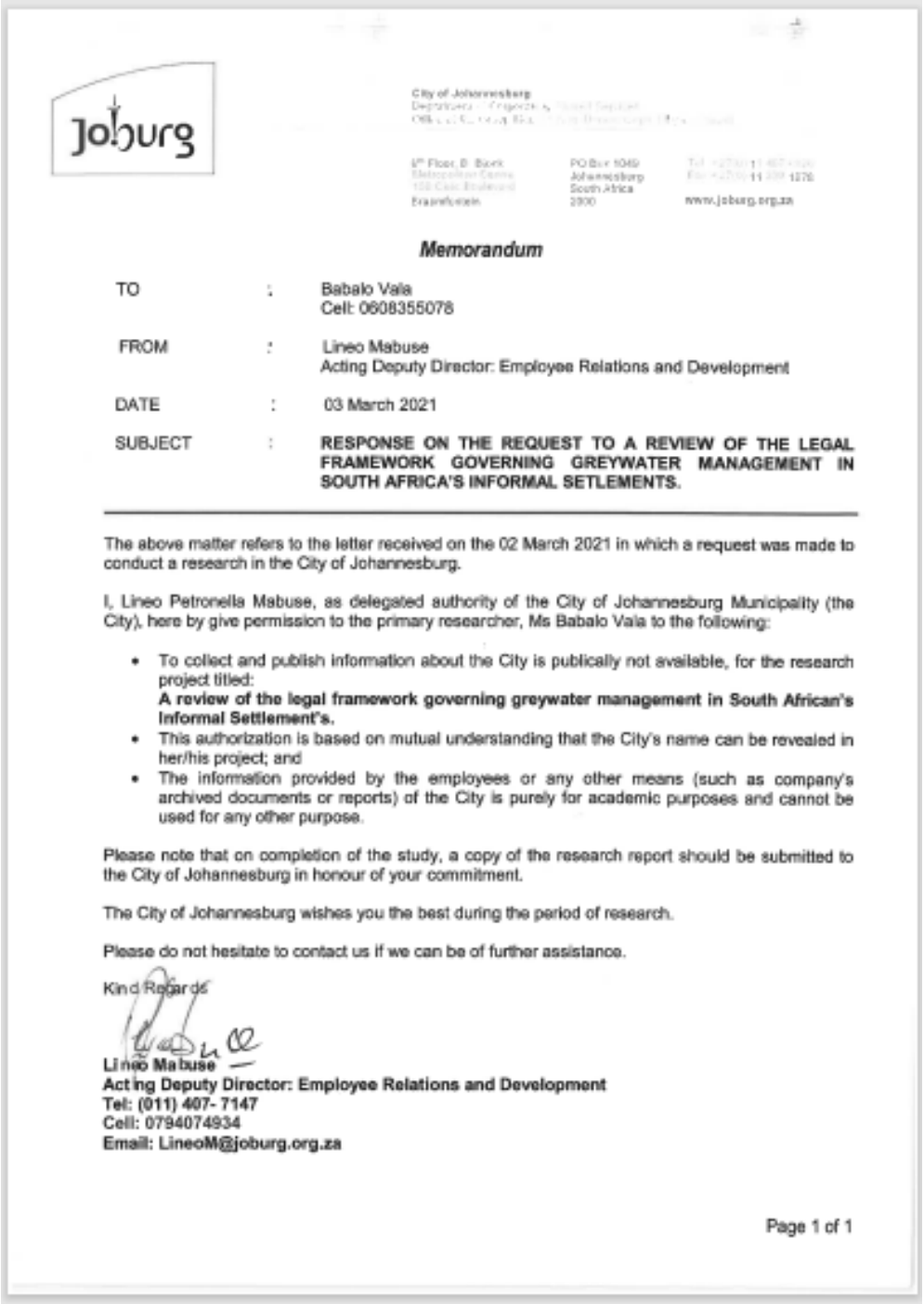
Their contact details will also be provided to him and he will be informed to contact them directly for assistance.

We wish **Mr. Babalo Vala** good luck in his research at Buffalo City Metropolitan Municipality.

MR. GCOBANI MSINDWANA
.....
HEAD: IKM, RESEARCH AND POLICY

MR A SIHLAHLA
.....
CITY MANAGER

APPROVED	~~NOT APPROVED~~



City of Johannesburg

PO Box 1049
Johannesburg
South Africa
2000

www.joburg.org.za

Memorandum

TO : Babalo Vala
Cell: 0608355078

FROM : Lineo Mabuse
Acting Deputy Director: Employee Relations and Development

DATE : 03 March 2021

SUBJECT : **RESPONSE ON THE REQUEST TO A REVIEW OF THE LEGAL FRAMEWORK GOVERNING GREYWATER MANAGEMENT IN SOUTH AFRICA'S INFORMAL SETLEMENTS.**

The above matter refers to the letter received on the 02 March 2021 in which a request was made to conduct a research in the City of Johannesburg.

I, Lineo Petronella Mabuse, as delegated authority of the City of Johannesburg Municipality (the City), here by give permission to the primary researcher, Ms Babalo Vala to the following:

- To collect and publish information about the City is publically not available, for the research project titled:
  A review of the legal framework governing greywater management in South African's Informal Settlement's.
- This authorization is based on mutual understanding that the City's name can be revealed in her/his project; and
- The information provided by the employees or any other means (such as company's archived documents or reports) of the City is purely for academic purposes and cannot be used for any other purpose.

Please note that on completion of the study, a copy of the research report should be submitted to the City of Johannesburg in honour of your commitment.

The City of Johannesburg wishes you the best during the period of research.

Please do not hesitate to contact us if we can be of further assistance.

Kind Regards

Lineo Mabuse
Acting Deputy Director: Employee Relations and Development
Tel: (011) 407- 7147
Cell: 0794074934
Email: LineoM@joburg.org.za

Page 1 of 1

Figure 6.2 City of Johannesburg permit for data collection.

CITY OF TSHWANE
IGNITING EXCELLENCE

City Strategy and Organisational Performance

Room D2EO01 | 2nd Floor, Block D | Tshwane House | 320 Madiba Street | Pretoria | 0002
PO Box 440 | Pretoria | 0001
Tel: 012 358 4749/5470 | Fax: 086 651 9998
Email: nosiphoh@tshwane.gov.za | www.tshwane.gov.za | www.facebook.com/CityOfTshwane

My Ref:	**Research Permission Letter\Vala**	Tel:	(012) 358 4559
Contact Person:	**Pearl Maponya**	Email:	PearlMap3@tshwane.gov.za
Section/Unit:	**Knowledge Management**	Date:	24 February 2021

Mr Babalo Vala
47 Douglas Crescent
Ravensmead
Cape Town
7493

Dear Mr Vala,

RE: A REVIEW OF THE LEGAL FRAMEWORK GOVERNING GREYWATER MANAGEMENT IN SOUTH AFRICA'S INFORMAL SETTLEMENTS

Permission is hereby granted to Mr Babalo Vala, Master of Environmental Health Candidate at the Cape Peninsula University of Technology (CPUT), to conduct research in the City of Tshwane Metropolitan Municipality.

It is noted that the aim of the research is to formally assess the legislative framework that governs greywater management in South Africa with special emphasis on informal settlements. The City of Tshwane further notes that all ethical aspects of the research will be covered within the provisions of CPUT Ethics Policy. You will be required to sign a confidentiality agreement form with the City of Tshwane prior to conducting research.

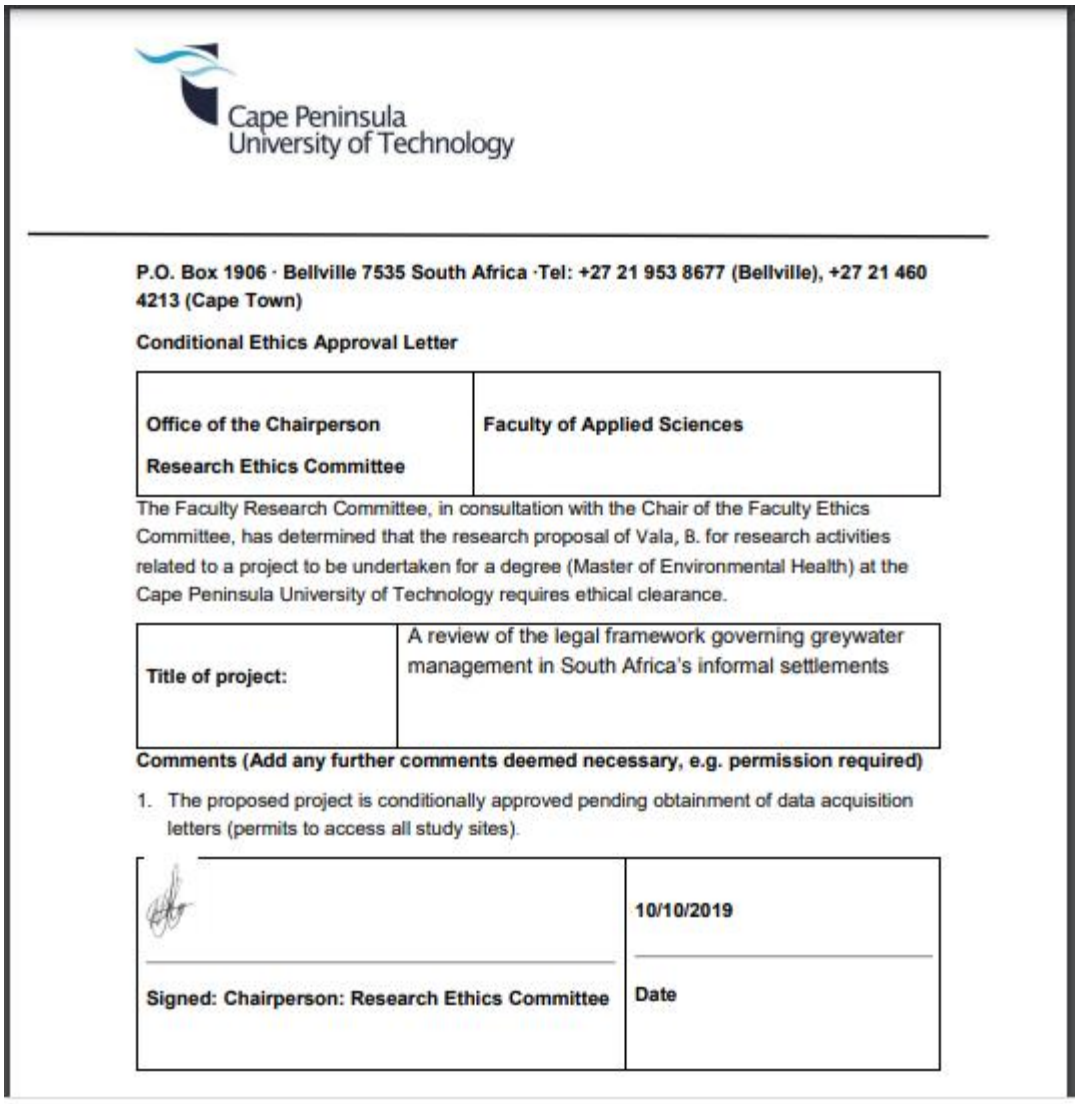
Relevant information required for the purpose of the research project will be made available as per applicable laws and regulations. The City of Tshwane is not liable to cover the costs of the research. Upon completion of the research study, it would be appreciated that the findings in the form of a report and or presentation be shared with the City of Tshwane.

Yours faithfully,

Pearl Maponya (Ms.)
DIRECTOR: KNOWLEDGE MANAGEMENT

Figure 6.3 City of Tshwane permit for data collection.

APPENDIX C: ETHICS STATEMENT



Cape Peninsula University of Technology

P.O. Box 1906 · Bellville 7535 South Africa ·Tel: +27 21 953 8677 (Bellville), +27 21 460 4213 (Cape Town)

Conditional Ethics Approval Letter

Office of the Chairperson **Research Ethics Committee**	**Faculty of Applied Sciences**

The Faculty Research Committee, in consultation with the Chair of the Faculty Ethics Committee, has determined that the research proposal of Vala, B. for research activities related to a project to be undertaken for a degree (Master of Environmental Health) at the Cape Peninsula University of Technology requires ethical clearance.

Title of project:	A review of the legal framework governing greywater management in South Africa's informal settlements

Comments (Add any further comments deemed necessary, e.g. permission required)

1. The proposed project is conditionally approved pending obtainment of data acquisition letters (permits to access all study sites).

Signed: Chairperson: Research Ethics Committee	**10/10/2019** **Date**

Figure 6.4 Ethics statement by Cape Peninsula University of Technology for this research project.

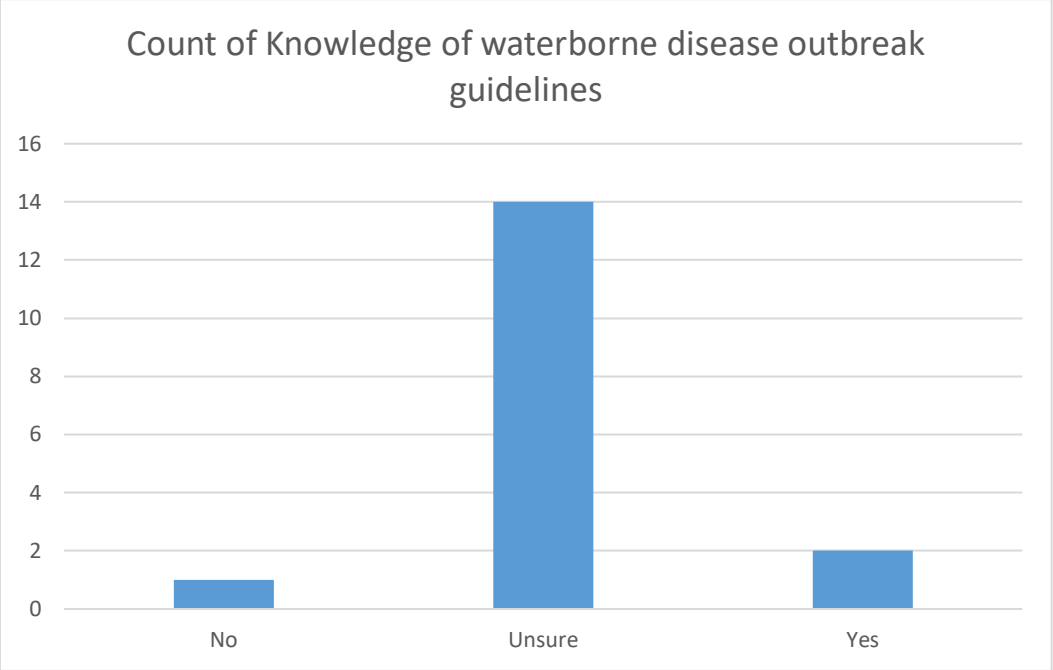


Figure 6.5 Count of knowledge of waterborne disease outbreak guidelines.