

**GIS MAPPING OF COMMUNITY PERCEPTIONS OF  
ILLEGAL WASTE DUMPING IN MBEKWENI, PAARL**

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for the degree Master of Arts (Geography) in the Department of Geography,  
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## **Plagiarism Declaration**

I declare that ‘GIS Mapping of Community Perceptions of Illegal Waste Dumping in Mbekweni, Paarl’ is my own work, that it has not been submitted before for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged as complete references.

Alexander Kimani

Signed:

December 2020



## **Abstract**

Illegal dumping is a global environmental problem that receives significant management and research attention from various fields of study. Illegally disposed waste (in all of its formats) can cause negative impacts on natural and human environments, and often requires multilevel interventions to abate, or to solve the resultant problems. The impacts of illegal or unsustainable disposal of waste on land, water bodies and the atmosphere contribute to various environmental problems and their levels of intensity at global, regional, national and local scales. Illegal waste disposal also infringes on fundamental human rights that are associated with clean and safe living environments.

Concerns for the public good and humane living conditions are therefore inextricably linked to waste generation and the ultimate disposal thereof, especially at the local/community level. This study seeks to explore the relationship between illegal waste dumping and society by investigating the spatial aspects and community perceptions and experiences of illegal waste dumping in Mbekweni, a township near the town of Paarl in the Western Cape province. As illegal dumpsites are not necessarily permanent features at fixed locations, a mixed-methods approach was followed to capture the dynamics that influence the quantitative and qualitative phenomena associated with such sites. The pragmatism theoretical framework was used as a supportive paradigm for mixed-methods research. Pragmatism advocates for the best research methods that produce the most effective results and are better at answering the research question. Hence, through the Pragmatic paradigm, mixed-methods research was chosen as the most suitable methodology which elevated different aspects of the research problem.

Spatial data was collected through the recording of quantitative variables such as location, temporality, size and accessibility of illegal dumpsites. Information about the perceptions and experiences of people who are, or feel that they are, impacted by illegal waste dumping was captured through the launching of a questionnaire and interview survey in areas where illegal dumpsites have reoccurred. The aims of the study were informed by data obtained from municipal management, spatial analysis and the mapping of quantitative and qualitative variables that may impact the geography and dynamics of the illegal dumpsites in the township.

**Keywords:** illegal waste dumping, GIS, mapping perception, Spatial analysis, waste management

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## Table of Contents

<b>Plagiarism Declaration .....</b>	<b>ii</b>
<b>Abstract.....</b>	<b>iii</b>
<b>Acknowledgements .....</b>	<b>iv</b>
<b>Table of Contents .....</b>	<b>v</b>
<b>List of Figures.....</b>	<b>ix</b>
<b>List of Maps .....</b>	<b>x</b>
<b>List of Tables .....</b>	<b>xi</b>
<b>List of Abbreviations .....</b>	<b>xii</b>
<b>Chapter 1: Introduction .....</b>	<b>1</b>
1.1. Rationale.....	1
1.2. Research aims and objectives .....	3
1.3. Study area .....	5
1.3.1. Introduction .....	5
1.3.2. Historical context .....	6
1.3.3. Context of the study .....	7
1.4. Pragmatism as theoretical framework .....	8
1.5. Chapter outline .....	9
<b>Chapter 2: Literature Review.....</b>	<b>11</b>
2.1. Introduction .....	11
2.2. Legislative framework of waste management in South Africa .....	11
2.3. Contextualising waste management in South Africa.....	14
2.4. What is illegal dumping?.....	17
2.5. Characteristics of illegal/indiscriminate dumping.....	19
2.6. Causes of illegal/indiscriminate dumping .....	20
2.6.1. Institutionalised racism.....	20
2.6.2. Social disorganisation theory .....	21
2.6.3. High amounts of waste generation per capita.....	22
2.6.4. Social norms .....	22
2.6.5. Increased Population growth.....	23
2.6.6. Lack of concern among some members of society.....	23
2.6.7. Laziness .....	24
2.6.8. High disposal charges.....	24
2.6.9. Corruption .....	24
2.6.10. Inadequate control structures and mechanisms .....	25
2.6.11. Inadequate education .....	25
2.7. Effects of illegal/indiscriminate dumping .....	26
2.7.1. Health and well-being .....	26
2.7.2. Tourism .....	27
2.7.3. Agriculture.....	28
2.7.4. Fauna and flora .....	28
2.7.5. Other.....	29
2.7.5.1. Smell.....	29
2.7.5.2. Property value.....	29
2.7.5.3. Land, air, soil and water pollution .....	29
2.7.5.4. High clean-up and maintenance costs .....	30
2.8. Perceptions of and attitudes towards illegal dumping.....	31

2.8.1. Introduction .....	31
2.8.2. Convenience and distance .....	32
2.8.3. Cost.....	32
2.8.4. Other perceptions .....	33
2.9. Studies done on solid waste management (African and global).....	33
2.10. Solutions for illegal dumping .....	34
2.10.1. Government regulations .....	35
2.10.2. Higher penalties.....	35
2.10.3. Control structures and mechanisms.....	35
2.10.4. Technology.....	36
2.10.5. Reduced dumping charges at legal dumping places .....	36
2.10.6. Minimising consumption.....	36
2.10.7. Education.....	37
2.10.8. Reuse and recycle.....	37
2.11. GIS and solid waste management.....	37
2.11.1. Concept of solid waste management .....	37
2.11.2. Reasons for using GIS in solid waste management.....	38
2.12. Conclusion.....	39
<b>Chapter 3: Research Methodology .....</b>	<b>41</b>
3.1. Introduction .....	41
3.2. Research design .....	44
3.3. Pragmatism in mixed-methods research.....	45
3.4. Sampling methods .....	47
3.4.1. Purposive sampling .....	48
3.4.2. Convenient sampling.....	49
3.5. Geo-locating using GPS in the field and web-based systems .....	50
3.5.1. TrashOut.....	50
3.5.2. GPS Fields Area Measure .....	52
3.6. Qualitative interviews.....	54
3.7. Data analysis.....	55
3.7.1. Mapping and analysis of illegal dumping .....	55
3.7.2. GIS application and spatial data layering .....	56
3.7.3. Spatial statistics tools: spatial autocorrelation (Global Moran's I) .....	58
3.7.4. Data management .....	61
3.7.5. Content analysis .....	62
3.8. Conclusion.....	64
<b>Chapter 4: Research Results and Analysis.....</b>	<b>65</b>
4.1. Introduction .....	65
4.2. GIS map visualisation.....	65
4.2.1. Location map.....	67
4.2.2. Illegal dumpsites in relation to disposal facilities .....	69
4.2.3. Heat map of illegal dumpsites .....	73
4.2.4. Size categories of illegal dumpsites .....	75
4.2.5. Waste composition .....	81
4.2.6. Riverine waste .....	83
4.2.7. Annoyances emanating from illegal dumps .....	91
4.2.8. Illegal dumping and open spaces.....	94
4.3. Spatial statistics analysis .....	94
4.3.1. Optimised Hot Spot Analysis .....	94
4.3.2. Illegal dumpsites hot spot map .....	97
4.3.3. Spatial autocorrelation: Introduction.....	97

4.3.4. Spatial autocorrelation: Illegal dumpsite sizes .....	98
4.3.5. Spatial autocorrelation: Waste composition .....	100
4.3.6. Significance of the Optimised Hot Spot Analysis .....	102
4.3.6.1. Street configuration .....	102
4.3.6.2. Proximity to streams .....	104
4.3.6.3. Open peripheral areas .....	104
4.4. Questionnaire Results .....	105
4.4.1. Awareness of illegal dumping .....	105
4.4.2. Temporality and frequency of illegal dumping .....	105
4.4.3. The occurrence of illegal dumping .....	106
4.4.4. Reasons for illegal waste dumping .....	107
4.4.5. Effects of illegal dumping .....	109
4.4.6. Sighting of animals and pests .....	111
4.4.7. Waste composition reported by residents .....	112
4.4.8. Household waste disposal methods .....	113
4.5. Interviews .....	114
4.5.1. Reasons for illegal dumping .....	114
4.5.2. Unemployment and social disorganisation as a driver of illegal dumping .....	117
4.5.3. Perceived relationship between illegal dumping and children .....	118
4.5.4. Residents' perception of the Drakenstein Local Municipality .....	120
4.5.5. Household waste removal satisfaction .....	121
4.5.6. Mbekweni's waste facilities .....	122
4.5.7. Suggestions for waste disposal improvement .....	124
4.6. Conclusion .....	125
<b>Chapter 5: Discussion .....</b>	<b>127</b>
5.1. Introduction .....	127
5.2. Accountability of illegal dumping in Mbekweni .....	127
5.3. Disparity of service delivery .....	128
5.4. Necessity vs criminality .....	130
5.5. Relationship between distance and convenience .....	131
5.6. Changing behaviour .....	132
5.7. C&D waste as a priority waste stream .....	134
5.8. Opportunity reduction .....	136
5.9. Impact of proximity of illegal dumpsites to households .....	137
5.10. Potential environmental consequences of illegal dumping in Mbekweni .....	138
5.11. Reflection on ethical concerns .....	142
5.12. Research challenges and limitations .....	143
<b>Chapter 6: Conclusion and Recommendations .....</b>	<b>146</b>
6.1. Summary of key research findings .....	146
6.2. Conclusion .....	148
6.3. Recommendations .....	149
6.3.1. Practice recommendations .....	149
6.3.2. Policy recommendations .....	152
<b>Reference List .....</b>	<b>153</b>
<b>Appendices .....</b>	<b>177</b>
Appendix A: National Legislation .....	177
Appendix B: Questionnaire .....	181
Appendix C: Mbekweni Township Reference Map .....	184
Appendix D: Illegal Dumpsites Before and After Being Cleared .....	185

Appendix E: Mbekweni Mini Drop-off Facilities ..... 186  
Appendix F: Illegal Dumping Mitigation Design Features ..... 188



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## List of Figures

Figure 1: TrashOut mobile application

Figure 2: GPS Fields Area Measure mobile application

Figure 3: Attribute table

Figure 4: Mathematic equation of the Global Moran's I statistic

Figure 5: Mini drop-off facility 1

Figure 6: Mini drop-off facility 2

Figure 7: Size categories of illegal dumpsites

Figure 8: Illegal communal dumpsite 1

Figure 9: Illegal communal dumpsite 2

Figure 10: Communal dumpsites in relation to the surroundings

Figure 11: Pie chart showing the various dumpsite waste compositions

Figure 12: Fluvial system in Mbekweni

Figure 13: Waste composition of dumpsites found near streams

Figure 14: Dumpsite alongside a river bank

Figure 15: Dumpsite situated in stream water

Figure 16: Waste spilling over into stream

Figure 17: Another dumpsite alongside a river bank.

Figure 18: Spatial autocorrelation result of illegal dumpsites and size

Figure 19: Tabular summary of spatial autocorrelation results

Figure 20: Spatial autocorrelation result of illegal dumpsites and waste composition

Figure 21: Tabular summary of spatial autocorrelation results

Figure 22: Areas of highest clustering of illegal dumpsites

Figure 23: Historical archive of community development at site A

Figure 24: Temporality and frequency of illegal dumping reported by residents

Figure 25: Day and time of reported illegal dumping occurrences

Figure 26: Effects of illegal dumpsites reported by residents

Figure 27: Animals spotted at illegal dumpsites by residents

Figure 28: Waste types at illegal dumpsites reported by residents

Figure 29: Household waste disposal methods reported by residents

## **List of Maps**

Map 1: Location map of Mbekweni Township

Map 2: Location map of illegal dumpsites in Mbekweni

Map 3: Illegal dumpsites in relation to formal waste facilities

Map 4: Heat map of illegal dumpsites

Map 5: Size categories of illegal dumpsites

Map 6: Waste composition of illegal dumpsites

Map 7: Proximity of illegal dumpsites to river streams

Map 8: Annoyances related to illegal dumpsites

Map 9: Illegal dumpsites in relation to open unused spaces

Map 10: Hot spots of illegal dumpsites



## List of Tables

Table 1: Cross-products derived from hypothetical Global Moran's I statistic calculation

Table 2: Awareness and witnessing of illegal dumping



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## **List of Abbreviations**

CBO: Community-based organisation

CoCT: City of Cape Town

C&D: Construction and demolition

CSIR: Council for Scientific and Industrial Research

DEA&DP: Department of Environmental Affairs and Development Planning, Western Cape

DEFF: Department of Environment, Forestry and Fisheries

DSI: Department of Science and Innovation

EIA: Environmental impact assessment

EPR: Extended producer responsibility

EPWP: Expanded Public Works Programme

GDP: Growth Domestic Product

GIS: Geographic information system

IWMP: Integrated waste management plan

MSA: Municipal Systems Act 32 of 2000

MSW: Municipal solid waste

NDP: National Development Plan

NEMA: National Environmental Management Act

NEMWA: National Environmental Management: Waste Act 59 of 2008

NGO: Non-governmental organisation

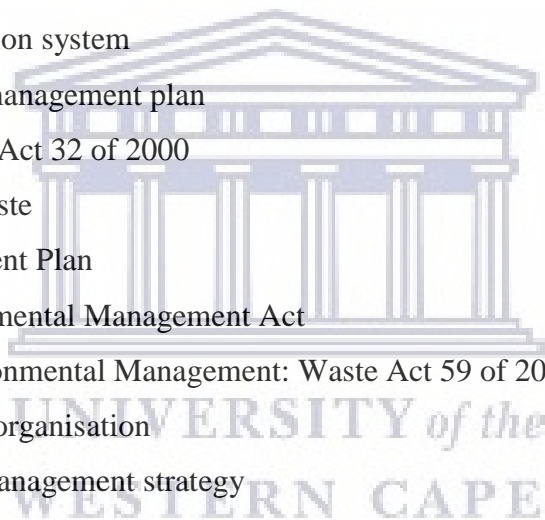
NWMS: National waste management strategy

POP: Persistent organic pollutant

SDF: Spatial Development Framework

UK: United Kingdom

US: United States



## **Chapter 1: Introduction**

### ***1.1. Rationale***

Waste impacts all facets of society and, if not treated and managed appropriately, could have far-reaching adverse effects on public health and the environment (Warunasinghe and Yapa, 2016). Waste management is a growing issue that concerns everyone, because it is directly related to society's unsustainable consumption and production behaviours. In the twenty-first century, waste management has become one of the most essential functions and services in society, especially in cities, where most populations now tend to be concentrated (Wilson and Velis, 2015). Furthermore, waste management is a fundamental human right. Section 24 of the South African Constitution provides everyone with the right to a healthy and clean environment. Waste management, particularly sanitation, is essential for modern society to function properly and in order to have a progressive economy. According to Wilson and Velis (2015:1051), waste management services are as important as the provision of other essential services such as potable water, food, shelter, energy and transport.

Nevertheless, waste management is an often-neglected part of service delivery in many countries, with the result that society and the economy often bear the negative consequences of poor waste management. Dlamini, Simatele and Kubanza (2019:250) assert that generators of waste such as individuals or entities might choose the cheapest alternative possible if proper policy and legislation are not implemented effectively. More often than not, this alternative tends to be illegal waste disposal or dumping on vacant land or even in river courses. It is often difficult to calculate the cost of illegal waste disposal because it is by nature uncontrolled and therefore not managed or measured, although Guerrero, Maas and Hogland (2013:223) note that inefficient waste management and weak policy implementation frequently lead to an increased cost of waste management services.

Management of illegal dumping is one of the most pressing contemporary problems confronting the world (Ferronato and Torretta, 2019). This is partly because rapid economic development and population growth have led to an excessive amount of waste being generated daily – in many cases, more than what many waste management systems can control. According to Jiang et al. (2020:285), the world generated approximately 2.01 billion tonnes of waste per year, which is projected to increase to 3.40 billion tonnes by 2050. Furthermore, an

additional estimated 100 million tonnes of waste are dumped illegally across the world yearly (Guerrero, Maas and Hogland, 2013), despite the fact that illegal dumping has extensive environmental, health and social effects. It is also an expensive maintenance problem for public land management, with municipalities often bearing the expenses related to the cleaning up and removal of unlawfully dumped waste (Brandt, 2017).

Illegal dumping can be described as the unauthorised disposal of waste in areas, whether public or private, that are not assigned for waste disposal or waste processing (Vambol et al., 2019). Waste produced by humans requires strategic management, as the natural environmental processes dedicated to disposal and repurposing are unsuitable for breaking down and recycling excessive volumes of unwanted materials adequately and sustainably (Ayres, Holmberg and Andersson, 2001). Furthermore, illegally disposed waste that contains chemicals such as asbestos can be incredibly harmful to humans and wildlife (Guerrero, Maas and Hogland, 2013). Illegal dumping also attracts pests such as rats, rodents and weeds into natural environments, blocks drains and worsens erosion by stifling vegetation (Hung, Ma and Yang, 2007). The location of illegal dumps is an area of focus mainly because of how illegal dumps can affect groundwater, people's health, the environment and the general aesthetic appeal of an area. Illegal dumps are commonly found at remote locations and near major roadways; the proximity of roads and an area's public accessibility usually strongly influence the location of illegal dumps (Hung, Ma and Yang, 2007). Glanville and Chang (2015:4) suggest that an intricate pattern of economic, environmental and social factors affect the geography of illegal waste disposal sites. Illegal dumping may be prevalent in a specific area for a myriad of reasons, the most common of which include a lack of financial capability of disposing waste correctly, and a lack of interest in making efforts to recycle or dispose of waste correctly. Strangely, studies have found that it is usually less costly to dispose of waste correctly than it is to use the time, effort and energy necessary to dump waste illegally (Ferronato and Torretta, 2019).

Like many high-density residential areas, Mbekweni, a township in the Drakenstein Local Municipality in the Western Cape Province of South Africa, is characterised by illegal waste dumping. Based on people's poor standard of living and related issues, Mbekweni can be considered the most poverty-stricken area in this municipality, which is also comprised of bigger towns such as Paarl and Wellington and smaller ones such as Gouda and Saron. It is also the area where service delivery is most lacking (Drakenstein Integrated Development Plan, 2018). On reconnaissance drives and pilot visits to Mbekweni and other residential areas of

Paarl and Wellington, it was evident that illegal dumps of various sizes and compositions were most apparent in the township compared to other regions in the municipality. Initial contact with the municipal officials also confirmed the undesirability of illegal waste dumping in Mbekweni. Illegal waste dumping occurs in both the formal and informal parts of the township. It must be noted that these conditions require thorough investigation in addition to mere baseline data collection about illegal waste dumping in the study area.

Spatial analysis based on a general mixed-methods approach was used for this investigation. Spatial analysis is defined as the analysis and extraction of new information about phenomena distributed in space (Fotheringham and Rogerson, 2013). The study uncovered various underlying dimensions about illegal dumping in the township through the capturing and analysis of spatial and perception data. Spatial variables of the sites, as well as the perceptions of people affected by them, were captured, analysed and summarised using geographical information system (GIS) mapping as an output. Participatory GIS or PGIS is the process of capturing local community-based knowledge and combining it with expert knowledge and geospatial technologies to create an integrated GIS database (Osha and Weiner, 2006). In this process, meaning and context are added to spatial data or geographical phenomena, thereby producing robust data and novel findings. As participants in this study were not actively involved in participatory techniques such as sketch mapping and transacting in the creation of map outputs, this study could therefore be viewed as making use of indirect participatory GIS.

The relationship between illegal waste dumping and society is often explained through stereotypical narratives such as inefficient formal waste management services, ease of using the free waste stream, the general absence of duty of care by the poor and lack of environmental health consciousness. This study argues that these narratives are not the only analytical tools available, and the purpose of this study is therefore to investigate more thoroughly the spatial and perceptual complexities informing illegal waste dumping in Mbekweni.

## **1.2. Research aims and objectives**

The study aims to determine and assess the impact of illegal dumping in Mbekweni as perceived by the community through the use of spatial and perception data.

Objectives of the study include:

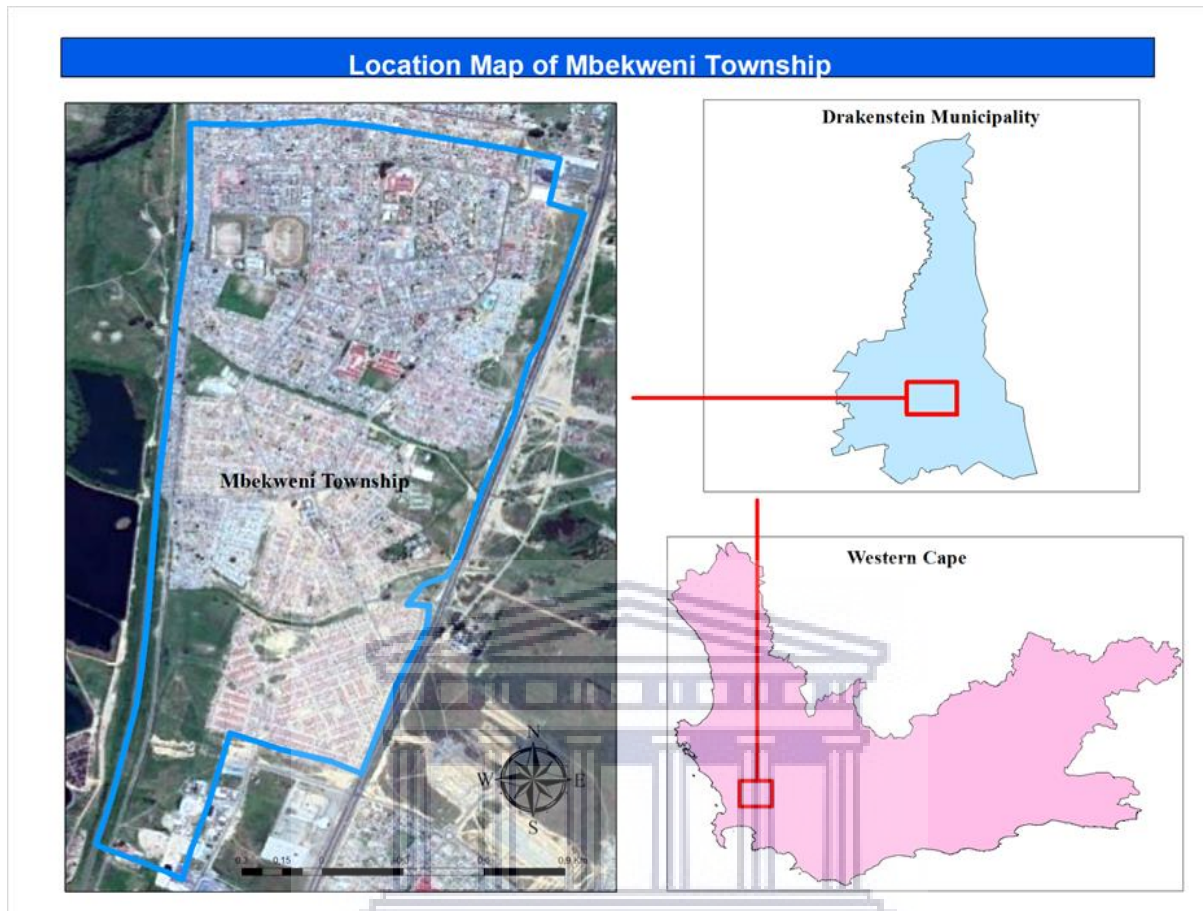
1. To understand and show how spatial variables such as location, temporality and accessibility of illegal dumpsites can contribute to the perpetuation of (and increase in) the activity at specific sites.
2. To understand and show how spatial variables such as location, temporality and accessibility of illegal dumpsites can contribute to the cessation of the activity at specific sites.
3. To explore reasons for illegal waste dumping by residents of Mbekweni as well as by outsiders.
4. To capture the perceptions of residents as to how illegal dumpsites impact them, their environmental duty of care and their place-space affinity.
5. To assess the prospects for more sustainable solutions to illegal waste dumping in communities characterised by severe socio-economic challenges such as Mbekweni.



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### 1.3. Study area



Map 1: Location map of Mbekweni Township

#### 1.3.1. Introduction

The Drakenstein Local Municipality is a focus of the Research Chair in Waste and Society's Clean City/Town project funded by the Council for Scientific and Industrial Research (CSIR). The Waste Research, Development and Innovation Roadmap is based on exploring the diversity of perceptions regarding urban cleanliness as well as societal behaviour towards reducing and diverting solid waste from landfills. After some pilot visits to the Drakenstein Local Municipality, Mbekweni was earmarked for this particular study. The pilot visits indicated the prevalence of illegal dumpsites throughout the township. Mbekweni has an approximate population of 30 875 people, and the majority of people there are Black Africans (97%) who predominantly speak isiXhosa (Firth, 2011). It is important to note that the population has likely increased, as the last census was conducted in 2011. Due to a lack of investment in infrastructure, some distinct Apartheid legacies are evident today. Mbekweni township has approximately 8 339 households (Firth, 2011), which are characterised by a

mixture of formal and informal dwellings (Drakenstein SDF, 2016). According to the Drakenstein Integrated Development Plan (2018:44), most residents live in shacks which measure approximately 10 m<sup>2</sup>.

Mbekweni is a poor urban township approximately 60 kilometres from Cape Town. It is situated in the Berg River Valley between the towns of Paarl and Wellington, and is part of the local municipal of Drakenstein (Drakenstein SDF, 2016). The central railway line borders the township in the west and Jan Van Riebeeck Drive, a main road, borders the township in the east. Additionally, Mbekweni is situated along a critical wetland area which houses the Paarl Bird Sanctuary and forms part of the Berg River system.

### *1.3.2. Historical context*

Mbekweni was established in the 1940s as a township where black migrants and black residents were forced to relocate (Drakenstein SDF, 2016). Many other African people were also drawn to Mbekweni due to the seasonal work that was available at the fruit farms near Paarl and Wellington. These same farms later became a source of jobs mostly in the form of ordinary labour. As agriculture eventually expanded, other noticeable developments and industries such as textile, canning and tobacco also started to flourish. The OR Thambo Informal Area Community Risk Assessment Report (2011) reports that there was a further influx of people, mainly of African descent, around 1940 and 1950. However, according to this same report (2011:15), the City Area Consolidation Act of 1945 was later introduced, which prevented many incoming Africans from seeking and establishing residency in the 'white area' of Paarl. It also meant that all labourers without a job for ten or more consecutive years with the same employer or those who had not lived in the same place for more than fifteen years automatically became illegal residents. Möller (1959 cited in OR Thambo Informal Area Community Risk Assessment Report, 2011:15) notes that after 1954 a large number of people who had formally lost their homes and properties in Cape Town suburbs such as Bellville and Wynberg migrated to Paarl and Mbekweni. Möller also states that in 1938 there were as few as 439 African people living in Paarl, but by 1946 the number had increased by approximately 508%. By 1948 around 3 261 African people had moved into Mbekweni and were establishing housing for themselves. Möller mentions that the 3 261 people comprised 650 families, and that, at the time, there were more men living in Mbekweni than women, as women and other family members joined the

men later (Möller, 1959 cited in OR Thambo Informal Area<sup>1</sup> Community Risk Assessment Report, 2011:15). Although 86% of all residents living in Mbekweni in 1959 were isiXhosa speakers, almost 70% of isiXhosa speakers were born in the Paarl area and were five years old or younger (OR Thambo Informal Area Community Risk Assessment Report, 2011).

In 1989, close to 40 years later, the population in Mbekweni had grown to approximately 20 000 people (OR Thambo Informal Area Community Risk Assessment Report, 2011), and community groups and kinships were established in Mbekweni based on which areas they came from or were removed from under the Group Areas Act.

The Community Council Act of 1977 allowed Paarl to inaugurate a new system of township management which consisted of a community council. The community council authorised elected residents in Mbekweni and other South African township settlements to represent the interests of the African community. However, residents in Mbekweni largely did not accept this new system, because those elected representatives still had little or no decision-making power. This eventually changed with the implementation of the Black Local Authorities Act of 1982, which allowed the elected township councillors to have more decision-making power. After South Africa became democratic in 1994, a local government ward system was introduced. Within this system, Mbekweni is currently divided into eight different wards with a different elected councillor controlling each ward (Drakenstein Integrated Development Plan, 2018).

### *1.3.3. Context of the study*

Over the last several years, there have been concerns over the lack of land and environmental resources available for the establishment of additional and much-needed landfill sites and other waste management infrastructure in the Drakenstein Local Municipality. These concerns are in part due to the growing issue of illegal waste dumping in the Drakenstein Local Municipality, specifically in Mbekweni (Drakenstein Integrated Development Plan, 2018). Mbekweni has been most affected by the lack of waste management facilities, due to the informality of infrastructure in the township. The Drakenstein Integrated Development Plan (2018:46) reports

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<sup>1</sup> Black people refers to black residents and migrants who are citizens of South Africa. Africans refers to black people not originally from South Africa but had migrated to South Africa from neighboring countries such as Mozambique and Zimbabwe.

that refuse collection takes place once a week in the Drakenstein Local Municipality. Other 'informal' waste disposal options such as skips and drop-off facilities have been provided in areas such as Mbekweni for additional domestic waste disposal and to help alleviate illegal dumping. However, based on observations made during the data-collection process, it is apparent that the skips are not being collected regularly. This was acknowledged by municipal officials. It was clear that the skips are rapidly turning into dumping sites, as numerous black bags and other kinds of domestic waste are dumped around them, thereby creating piles of garbage.

Mbekweni's historical antecedent and its present reality as an impoverished and informal community certainly make service delivery such as waste collection services particularly challenging. Among some of the challenges that the Drakenstein Local Municipality encounters in Mbekweni include the vast non-standard homes and settlements without passable routes for collection trucks, thus mostly leading to irregular waste collection, especially in informal areas. Irregular waste collection, and the lack of additional infrastructure, further exacerbate illegal waste disposal. Additionally, the acute poverty in the area means that residents lack disposable income to spend on household waste management resources such as black bags and additional bins, thus placing the burden of providing those resources on the municipality, which also leads to an increased cost of municipal waste management. All these challenges directly and indirectly lead to illegal waste disposal in Mbekweni, and the complexity of the socio-economic issues in Mbekweni makes these challenges, particularly waste management problems such as illegal dumping, difficult to confront.

#### ***1.4. Pragmatism as theoretical framework***

The study draws on some fundamental principles of the pragmatism paradigm. Pragmatism was first conceptualised as a methodological approach in the US around 1860-1930, and the neo-pragmatic period emerged around 1960, lasting to the present day (Maxcy, 2003 cited in Cameron, 2011). Some prominent philosophers who had a significant influence on pragmatism include William James, John Dewey, Charles Sanders Peirce and Herbert Mead. For pragmatists, reality is always changing based on our actions. Simply put, pragmatism can be taken as a practical approach to a problem. Parvaiz, Mafti and Wahab (2016:20) state that ideas formulated about a particular human problem or phenomenon should be done in an attempt to find a solution to that social problem; therefore, the concern of pragmatism is to find out what

works and what enables solutions to problems. In other words, ‘the engagement in philosophical activity should be done to address problems’ (Biesta, 2010:97).

Cameron (2011:101) states that pragmatism has particularly strong connections with mixed-methods research, and therefore mixed-methods researchers often link their methodology with pragmatism. Within the context of this study, pragmatism is applied as a theoretical lens for the purpose of searching for realistic and practical solutions to a real-world issue (illegal dumping). The ontological stance of pragmatism is that reality is the practical effect of ideas (Russill, 2016). Pragmatism aids in assessing what is practical when looking at a complex and multifaceted issue such as illegal dumping. The goal is that, through the use of a pragmatic framework, concepts that emerge from this research may support action and practicality.

### ***1.5. Chapter outline***

This study is comprised of six chapters. The first chapter provides a general introduction which includes the rationale of the study and the aims and objectives of the study. This chapter also focuses on Mbekweni Township, the case study area of the research, and provides a general background and historical account of this study area within the context of the issue being researched, illegal dumping.

The second chapter covers the main literature reviewed for the study. I discuss literature from various sources regarding illegal dumping, waste management legislation and sustainable frameworks for waste management. The chapter provides an overview of municipal waste management practices in South Africa, as well as the issues that emanate from waste management inefficiencies in South Africa. It also outlines the various legislative and sustainable waste management frameworks in the country, and examines the issues around illegal dumping and its impact on human health and the environment. Lastly, the chapter highlights sustainable solutions that could curb illegal dumping.

The third chapter provides the methodological approach used in the study. I discuss the primary methodological approach, a mixed-methods approach, and also mention the specific methods used to gather data, such as semi-structured interviews and GIS applications. The chapter also underlines specific analytical tools and methods (such as GIS spatial statistics and content

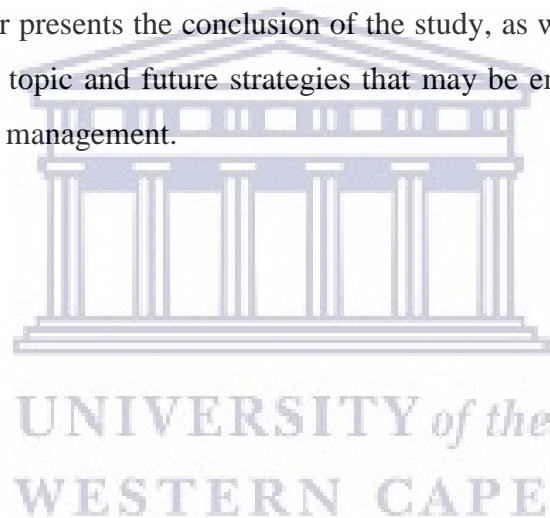


analysis) that were used to analyse and draw inferences from the data that was gathered.

The fourth chapter analyses the data collected for the research and presents the findings of the report. The chapter firstly presents the GIS data through GIS-created maps and tools. It then analyses the quantitative questionnaire results through various graph outputs and descriptive analysis and, lastly, organises the interview results according to themes generated from the qualitative semi-structured interview data.

The fifth chapter examines and explores the various linkages and relationships between the quantitative and qualitative results in a discussion format. Triangulation between the research results and literature is also conducted in this chapter.

The sixth and final chapter presents the conclusion of the study, as well as recommendations for future research on the topic and future strategies that may be employed with regards to illegal dumping and waste management.



## **Chapter 2: Literature Review**

### ***2.1. Introduction***

In this chapter, I provide a general background and literature review against which this study takes place. The literature review helped to develop a suitable methodology for the data collection and analysis of this study. I have thus attempted to discuss illegal waste dumping within the context of the existing literature. By referring to existing research in this area, I highlight various challenges faced by waste management in South Africa as a whole. I was able to identify specific gaps in the literature, specifically about people's perceptions of illegal dumping and other waste management issues, and I attempt to address these gaps with this particular study.

The literature review covers various topics relating to illegal dumping and waste management challenges, such as current waste management challenges globally and in South Africa in particular. I also provide a summary of various waste management legislations that govern waste management in South Africa, and how specific gaps in the legislation have led to issues such as illegal dumping. In addition, the literature review also looks at the various impacts and effects of illegal dumping as well as various perceptions related to illegal dumping. Furthermore, the causes of illegal dumping are highlighted. A review of possible solutions for illegal dumping is provided. Lastly, the practical applications of GIS in waste management are explained.

### ***2.2. Legislative framework of waste management in South Africa***

The three tiers of government in South Africa are responsible for addressing the unlawful disposal of waste and associated issues through legislation and regulations. The national Department of Environment, Forestry and Fisheries (DEFF) is the preeminent authority responsible for waste management in South Africa. At a provincial level, environmental authorities such as the Department of Environmental Affairs and Development Planning (DEA&DP) in the Western Cape Province are responsible for regulating waste management and handling waste management matters. Generally speaking, municipal authorities govern and operate at the grassroots level, and are responsible for enacting many of the legislature passed at the provincial and national level. According to South Africa's Constitution, municipalities

must provide waste collection, removal, storage and disposal services within their specific boundaries.

The National Environmental Management: Waste Act of 2008 (NEM:WA) is the primary legislation for waste management in South Africa. It provides a broad legal framework for waste management in South Africa, emphasising the waste management hierarchy (see Appendix A for full legislation).

Some of NEM:WA's primary goals include environmentally sound waste management, diversion of waste from landfills and utilisation of waste where possible. NEM:WA (2008) promotes an integrated waste management approach which reduces the negative impacts of waste on the environment. It also requires that all municipalities develop an integrated waste management plan (IWMP) as part of their integrated development plan (IDP). Municipal and provincial IWMPs set out the strategies to achieve appropriate waste collection standards in each community. In these plans, the municipalities set targets and describe how they will achieve them.

Therefore, the Western Cape has its own dedicated plan for waste management. Most recently, this is the Western Cape 2nd Generation Integrated Waste Management Plan 2017-2022. This plan was developed by the DEA&DP to meet NEM:WA's requirements, and as a reform of the Western Cape 1st Generation IWMP. This updated IWMP aims to improve the current integrated waste management practices in the province. It also sets out four new goals to help achieve waste management in the Western Cape. These goals include strengthened education and advocacy for integrated waste management, improved implementation of the IWMP, better use of resources and improved compliance with environmental regulations to ensure a safe and healthy environment for people.

On a municipal level, the Municipal Systems Act of 2000 requires that municipalities provide waste collection and disposal infrastructure (such as drop-off facilities). The National Environmental Management Act of 1998, which falls under Section 24 of the Bill of Rights in the Constitution of South Africa, provides every South African with the right and opportunity to live in a clean and healthy environment. This fundamental right underpins environmental policy and law, particularly the environmental legislation framework established by NEM:WA (2008). According to the National Waste Management Strategy (NWMS) (DEFF, 2020:53),



NEM:WA (2008) fundamentally reformed the law regulating waste management and for the first time provided a coherent and integrated legislative framework addressing all the steps in the waste management hierarchy). Furthermore, NEM:WA (2008) introduced several additional guiding principles into South African environmental legislation, including the life-cycle approach to waste management, producer's responsibility, and the polluter pays principles.

Regarding pollution from illegal dumping, the National Environmental Management Act of 1998 places the duty of care on any person who may cause significant pollution or degradation of the environment, requiring them to institute measures to either prevent pollution from occurring or to minimise and rectify the pollution or degradation where it cannot be avoided. The white paper on Integrated Pollution Management for South Africa of 2000 describes illegal dumping or any other activity related to the unlawful waste disposal as 'an environmentally and socially unacceptable practice' (Integrated Pollution Management for South Africa, 2000).

On the local level of waste management, the 'responsibility of managing landfills was given to the local municipalities under the Municipal Systems Act' (Schenck et al., 2019:81). Furthermore, the municipal IWMPs, like the 3rd generation City of Cape Town (CoCT) IWMP, set out specific targets, which include the development of a regional landfill, exploring waste technologies (such as landfill gas harvesting and composting plants) and increasing the provision of waste services, especially for informal settlements and backyard dwellings.

The national norms and standards for the disposal of waste to landfills, outlined in the 2020 NWMS, provides appropriate measures for disposing waste to landfills (that is, pinpointing what can and cannot be disposed of). The NWMS is a government-wide strategy that applies to all organs of state responsible for waste management, including the private sector and citizens of South Africa (NWMS, 2020). The NWMS is based on the fundamental principles of the waste management hierarchy, the three Rs: reduce, reuse and recycle. Furthermore, the NWMS informs the waste management trajectory going forward. Karani and Jewasikewitz point out that the long-term and overall aims of the NWMS include:

identifying and quantifying the main waste streams generated and how much ends up in streams; impact water quality and the surrounding environment; understanding the reasons for poor community waste management; servicing and littering; classifying the status and capacity of landfills with particular reference to hazardous waste. (2007:164)

This shows that South Africa has a good foundation for waste management realised through a comprehensive legislative and policy framework.

### **2.3. *Contextualising waste management in South Africa***

The waste management strategy in South Africa is mainly based on the landfilling of mixed waste (Godfrey and Oelofse, 2017). However, reduce, reuse and recycling strategies should be implemented to reduce the waste stream to landfilling. Waste collection services serve the purpose of separating and removing waste from communities for good health and people's well-being (Managa, 2012). For instance, in a situation where standard household waste collection services are administered less than once a week, a common housefly's life cycle may become continuous and inimical to healthy living. Waste collection, therefore, needs to be reliable and consistent (Koelble and LiPuma, 2010), as waste collection services currently differ across South Africa and are mostly dependent on community structures, municipalities and geographic distribution. In this sense, a one-size-fits-all approach remains unsuitable for waste collection (Russell and Bvuma, 2001). The Council for Scientific and Industrial Research (2010:19) also notes that service levels in South Africa vary between kerbside collection, organised transport to central collection points, community transfer to a central collection point and on-site disposal.

Essentially, resources such as collection trucks play a massive role in waste collection in South Africa; however, this type of waste collection and transportation method can be expensive and cumbersome. It is often costly to operate fleets of waste trucks, and the costs are too high for many municipalities in South Africa to bear (Council for Scientific and Industrial Research, 2010). Therefore, service delivery often becomes hindered, and municipalities cannot adhere to their legal mandates enacted by NEM:WA (2008). Dlamini, Simatele and Kubanza (2019:252) posit that limited budgets are often the cause of many service delivery issues in municipalities. Due to the heterogeneity of landscapes across South Africa, many places are situated in rural areas and far from main cities and central nodes, which compounds the municipalities' challenges to carry out efficient and timely service delivery. Many rural areas in South Africa have considerable backlogs in service delivery, such as in waste collection. These rural areas are usually without the needed infrastructure for waste management, while long distances for waste collection trucks to cover certainly add to the overall lack of service

delivery.

Managa (2012:2) notes that informal settlements are often affected by similar service delivery backlogs. In the case of informal settlements, the issues arising from the configuration of the settlements, which consists of informal dwellings (shacks) and narrow roads frequently plagued by potholes, have all compounded the difficulties faced by conventional waste collection trucks to access and navigate the communities (Council for Scientific and Industrial Research, 2010). The political and socio-economic landscape of South Africa is also characterised by huge inequalities (e.g., poor education, lack of employment), as many South Africans are living in abject poverty (Turpie, Marais and Blignaut, 2008). Many people struggle to afford essentials, so a common issue regarding waste collection in many communities is that people cannot afford waste collection resources such as black bags. Some municipalities do provide black bags for poor communities, but this is inconsistent (Nleya, 2011).

Meanwhile, an absence of black bags may lead to community littering and illegal dumping as people look to clear their homes of waste and choose the next best available (albeit irresponsible) option. Within an integrated waste management solution for rural areas and informal settlements, municipalities may provide storage and communal skips. However, facilities such as communal skips often become part of the issue regarding cleanliness in the community (Russell and Bvuma, 2001). As observed, people in rural communities and informal areas utilise equipment such as wheelbarrows to transport their waste to communal skips. In certain instances, the problem occurs when waste loads are too heavy to throw into the skips, which are mostly too high. This situation usually forces people to dump their waste around communal skips. Over time, the area outside of the skip rather than the skip's inside becomes filled with waste. The surrounding areas become a big waste dump, which may encourage community members to continue dumping waste (Council for Scientific and Industrial Research, 2010). Alexander (2010:27) similarly points out that an environment strewn with litter and garbage is likely to encourage further illegal dumping in that specific spot or area, resulting in an increased surface area over time. The Council for Scientific and Industrial Research (2010:78) reiterates that the constant cleaning of illegal dumps is costly and counterproductive and negatively affects or limits resources that could be used elsewhere.

South Africa's high social inequality and its large unemployed population have always presented unique challenges for equitable and dependable service delivery. One such issue that

has become a national priority is job creation and employment. Service delivery, especially waste management services, has been viewed as job creators, which has placed immense pressure on authorities by forcing them to choose labour-intensive methods in favour of creating more jobs over more cost-effective and efficient alternatives (Alexander, 2010). The waste management system in South Africa has long had a propensity for labour-intensive methods of waste management over more mechanised methods. This allows for the waste sector to employ large numbers of labourers even though it increases the cost of waste management services expended by the municipality and other government budgets, which affects the people of the country (Council for Scientific and Industrial Research, 2010).

A common challenge in waste management which has confronted both South Africa and the rest of the world this last decade is the decreasing availability of landfill airspace. This challenge is primarily caused by closed and decommissioned landfills (due to non-adherence to environmental management requirements) and an increase in waste generation, which has reduced the lifespan of many landfills in South Africa. It has become incredibly challenging to commission new landfills, as land has become exceptionally valuable and competition for owning land has increased. Therefore, it is more critical than ever to increase efforts to divert waste from landfills through reuse, reduce and recycle policies. Also, the sporadic proliferation of settlements and housing has led to a unique situation where many settlements increasingly encroach on landfills' buffer zones, thereby reinforcing issues of health and community well-being.

In some cases, informal waste workers live close to landfills in order to access the landfill and recyclables as often as possible. Issues of landfill encroachment are also due to a lack of cooperation between landfill operators and municipalities. Conflicting environmental impact assessments (EIAs) can also cause issues when selecting landfill sites and landfill planning is not integrated into municipalities' spatial planning, thus leading to conflicting land usage where residential areas and landfill zoning are approved adjacent to each other (Council for Scientific and Industrial Research, 2010). In some cases, landfills are managed by private entities and failure to establish mutual collaboration between them and municipalities also usually leads to zoning issues and misunderstandings (Council for Scientific and Industrial Research, 2010).

#### 2.4. *What is illegal dumping?*

Illegal dumping, also officially known as illegal waste disposal, is defined as waste disposal in an area that is not licenced or appropriate for waste disposal (Dladla, Machete and Shale, 2016). Other terms used for illegal dumping include fly-tipping (used primarily in the UK) and open dumping. Illegal dumping is often an intentional act and, for this reason, it is considered unlawful and an act that poses health risks to people (Achor, Ehikwe and Nwafor, 2014). Illegal dumping is different from littering based on the amount of waste. Littering typically includes discarding small amounts of waste such as food packages, cigarette butts and chewing gum (Kodua and Anaman, 2020), while illegal dumping often varies from small bags of household waste to larger-scale dumping such as construction and demolition (C&D) waste or mass open dumps. Nagpure (2019:55) states that typical waste items disposed of illegally include general household rubbish, large and bulky domestic items such as mattresses or furniture, organic garden waste and chemical substances. For this reason, illegal dumping is a constant and highly visible problem which significantly deteriorates the aesthetics of a community and poses health risks (Quesada-Ruiz, Rodriguez-Galiano and Jordá-Borrell, 2019). Relatedly, Sotamenou, De Jaeger and Rousseau (2019:323) note that one of the biggest problems with illegal dumps is that it attracts additional dumping in an area because people perceive the area to be a safe spot to dump (Wekisa and Majale, 2020); the consequence of illegal dumping is often a chain reaction of additional dumping.

It is essential to distinguish between illegal dumping and other forms of dumping, such as indiscriminate dumping. Unauthorised disposal of waste that is legally prohibited by law is considered illegal dumping (Henry, Yongsheng and Jun, 2006). In contrast, indiscriminate dumping is unauthorised disposal of waste which is not necessarily prohibited by law. In South Africa, for instance, the act of unauthorised disposal of waste is not permitted by law and is therefore considered illegal waste disposal or illegal dumping. The Constitution of the Republic of South Africa (1996) provides the foundation for environmental regulation and policy. Specifically, the Bill of Rights (Section 24 of Chapter 2) as set out in the Constitution of South Africa guarantees everyone the right of access to an environment that is not harmful to their health and well-being and to have the natural environment protected for the benefit of current and future generations. Any type of act that contravenes this right is therefore considered unlawful and illegal. Illegal dumping limits everyone's right to access a clean environment, potentially affecting people's well-being and the environment.



Factors that lead to illegal dumping are often complex and vary from region to region. Sotamenou, De Jaeger and Rousseau (2019:325) summarise the reasons into four factors: education, socio-economic characteristics (employment), community structure and availability of resources. Wright, Smith and Tull (2018:32) add that a greater level of education may influence an individual's decision to dispose of waste correctly because they know better. A community's socio-economic factors define the extent to which people are willing to follow the rules. When there is low employability and other social elements, community members become disgruntled and their trust in the authorities is significantly degraded (Yang, Fan and Desouza, 2020). This specific aspect also relates to the social disorganisation theory, which states that crime is more likely to take place unabated in a community if there is high population turnover, ethnic heterogeneity and poverty (Brandt, 2017). These elements affect social integration, thus eroding community surveillance and community pride. Economic characteristics such as low employment and high poverty are most common in developing countries. Community structure such as the configuration of roads and houses and their accessibility can also influence illegal dumping (Babaei et al., 2015). Areas that are easily accessible and hidden from public view are often targeted due to a lack of community surveillance. The possibility of not being caught dumping waste illegally greatly increases the incentive for dumping.

Antoni and Marzetti (2019:324) assert that illegal dumping has become a prevalent issue in the US and Europe due to consumption patterns which have increased over the last 20 years. While a higher level of consumption has led to a higher level of overall waste production (Okot-Okumu and Nyenje, 2011), higher waste production is strongly correlated with increased illegal dumping levels because some waste management systems do not have the capacity to deal with increased collection and disposal. Triassi et al. (2015:2117) affirm that some waste ends up in landfills and illegal dumps mostly because society has become more consumer driven. Furthermore, Antoni and Marzetti (2019:324) maintain that as a society we no longer use and fix old stuff such as appliances, because people are in constant search for newer and better things while old products are disposed of, with a high propensity of doing it illegally. Sotamenou, De Jaeger and Rousseau (2019:323) note that, in more impoverished communities, illegal dumping is sometimes regarded as a minor issue, while other problems such as housing and employment take precedent. Individuals are susceptible to being influenced in thinking a certain way and doing certain things within community structures. Therefore, if illegal dumping becomes an accepted norm and standard within a community, other members are

likely to be influenced to participate in similar practices. D'Amato et al. (2018:57) believe that social norms and the behaviour of people you regularly interact with play an essential role in how likely you are to accept or reject the idea of illegal dumping.

In many countries, illegal dumping is considered unlawful because of the harm and risk it causes to human well-being and the environment. Illegal dumping has environmental and social costs associated with it. The two most significant environmental costs of illegal dumping include the degradation of landscapes, including plant and animal habitats (Ayotamuno and Gobo, 2004), and land degradation, which leads to a reduction in biodiversity value and hinders revegetation (Vaverková et al., 2019). Furthermore, illegally dumped bulky waste or large volumes of waste can alter the ordinary drainage course, especially during the rainy months. This alteration can lead to flooding (Okot-Okumu, 2012; Cruvinel et al., 2019). This is why illegally dumped waste in some regions is considered a flood risk (Vaverková et al., 2019). Also, one of the most significant social costs of illegal dumping is the degradation in a community's aesthetic amenity, which deters people from going to certain places because they are marked as undesirable. Importantly, Dladla, Machete and Shale (2016:477) emphasise that illegal dumping attracts and encourages further illegal disposal and other criminal activities, decreasing community pride.

## **2.5. Characteristics of illegal/indiscriminate dumping**

Illegal dumpsites are usually associated with being hazardous or non-hazardous. They are also sometimes characteristic of deeper issues at play such as social disorganisation and institutionalised racism. The section below focuses on exploring through literature how underlying societal issues such as social disorganisation and institutionalised racism can lead to illegal dumping.

Illegal dumped waste can consist of both hazardous and non-hazardous waste; most individuals who dump waste illegally do not consider the kind of waste they dispose of (Crofts et al., 2010). Hazardous waste that is often dumped illegally includes used batteries, paint, oil, chemicals and most industrial wastes (Ruffell and Dawson, 2019). Non-hazardous waste products often illegally dumped include used tires, used furniture, household garbage and waste wood (Europol, 2013).

## 2.6. Causes of illegal/indiscriminate dumping

The reasons as to why illegal dumping occurs are varied and complex. Improper waste disposal is a complicated social, monetary and environmental problem that can most effectively be dealt with by recognising its underlying causes (Webb et al., 2016). In most situations it is a combination of many factors such as high waste generation, social norms and high disposal costs. Various possible causes or reasons for illegal dumping which are indicated by literature are provided below. The concepts of institutionalised racism and social disorganisation are also discussed, as they are useful tools with which to describe the root causes of a variety of different crimes, including improper or indiscriminate waste disposal (Interpol, 2015).

### 2.6.1. Institutionalised racism

Institutionalised racism is a type of implicit racism in which white people do not want to behave publicly in a harmful or dangerous way against minority groups but support organisations with discriminatory policies, laws or regulations (Dorn, Van Daele and Vander Beken, 2007).

In the US, for instance, several freedoms are still unavailable to marginalised groups today because of systemic prejudice, even decades after the Civil Rights Movement and the passage of the 1964 Civil Rights Act (Rattansi, 2017). Minority communities of colour have increased challenges in accessing better-paying jobs, public schools and safe living conditions due to systemic prejudice, which has kept most white communities in influential positions. Such challenges contribute to inadequate education, jobs and health care in minority communities, with increased crime rates, including indiscriminate dumping. Thus, the bulk of ethnic groups make up the highest proportion of indiscriminate dumping victims or perpetrators (Gibbs, McGarrell and Axelrod, 2014).

While South Africa's history is different from that of the US, our long history of institutionalised racism in the form of colonialism and Apartheid means that the effects of systemic discrimination against black and coloured communities (which in South Africa, unlike in the US, comprise the majority of the population) are still being felt today. Such effects can be seen in nearly every area of South African society, including waste management. On a



basic level, it means that the communities in South Africa most affected by poverty, unemployment, weak infrastructure and poor service delivery (all of which are a factor in illegal dumping) are nearly always communities with mostly black or coloured populations, such as the township in this study, Mbekweni.

### 2.6.2. *Social disorganisation theory*

The theory of social disorganisation works to enhance understanding of why certain societies experience higher crime rates than others (Huisman and Van Erp, 2013). Increased crime rates often characterise socially disorganised societies due to increased population growth, ethnic heterogeneity and poverty and ethnic heterogeneity (Massari and Monzini, 2004). Societies may be uncoordinated physically and socially. Actions such as drinking in public or verbal abuse cause social disturbance, while structural dysfunction can be seen in unlawfully discarded waste, litter, vandalism, neglected cars and paraphernalia for drugs (Dorn, Van Daele and Vander Beken, 2007).

The theory/principle of social disorganisation suggests that societies can regulate the frequency of crimes and avoid them by mutual oversight (Van Erp and Huisman, 2014). Unofficial monitoring of neighbourhoods or other citizens, avoiding dangerous areas or the confrontation of suspicious persons are all part of mutual oversight (Liddick, 2015). Societies can correct themselves when they have powerful social connections that create and communicate group norms (White, 2018). However, there is no potential for a socially disorganised group to address or avoid criminal problems, due to a lack of contact (Situ and Emmons, 2012). Social relations are often absent or insufficient when society consists of tenants or people of various diverse cultures, leading to social disorganisation and escalated crime (Barnett and Mencken, 2002). In public facilities and social structure, low-income or marginalised persons frequently live in the most impoverished locations of cities devoid of proper environmental health maintenance mechanisms (Sahramäki, Korsell and Kankaanranta, 2015). Improper waste disposal is thus a key contributor to physical disorganisation within various societies (Tompson and Chainey, 2011).

Social disorganisation theory can be linked to illegal dumping from the perspective that environmental crimes such as illegal dumping are likely to take place in a community with high social disorganisation. High social disorganisation results from a lack of natural surveillance,

which is the ability of people within a community to look out for and monitor the community in a bid to track down suspicious activities and confront these specific activities or their perpetrators. This is possible through strong collective supervision and a general pride and duty of care present within the community. However, based on the social disorganisation theory, communities with high turnover, poverty and ethnic heterogeneity find it difficult to collectively supervise themselves due to weak social networks. Likewise, communities which have high poverty levels are unlikely to be concerned with issues of community cleanliness and community milieu mainly because livelihoods take precedent. Sampson and Groves (1989:780 cited in Barnett and Mencken, 2002:375) point out that communities with low income levels do not have the financial means and human capital to protect community values, principles and interests. They are therefore less likely to participate in neighbourhood associations such as neighbourhood watches. Furthermore, a lack of strong social networks might deter individuals within the community from confronting perpetrators committing a specific crime. Brandt (2017:3) therefore emphasises that a socially disorganised community does not possess the capacity to stop or prevent crime from taking place, mainly as a result of poor communication. Meanwhile, perpetrators of crimes such as illegal dumping, for instance, might exploit this aspect within a community and these crimes may go unchecked.

#### 2.6.3. High amounts of waste generation per capita

The amount of waste generated per capita is rising substantially (Chiu, Leclerc and Townsley, 2015). Many developing nations now strive to live lifestyles modelled on high-income Western countries (Simpson et al., 2013). This means purchasing the latest items and using expensive cars. However, aiming for this type of lifestyle would significantly increase the total amount of global waste generation (Stretesy, 2016). Thus, with the exponential rise in waste output, the risk of improper disposal is indeed likely to accelerate (Guerrero, Maas and Hogland, 2013; Fortney, 2013). Waste management services are unable to cope with increased waste generation (as a result of wastefulness, increased consumption) due to outdated management practices and lack of resources for expansion of services and facilities.

#### 2.6.4. Social norms

Improper solid waste disposal is not treated as a significant problem in many nations. Many individuals view it as a minor concern instead of a felony (Faure and Visser, 2014). Humans

are thought to be significantly affected by the persons they often associate with (Emery and Watson, 2014). This implies that an individual is more likely to perceive improper waste disposal as an acceptable way of getting rid of their refuse when their close friends do not perceive it as a serious concern or if their close friends deliberately participate in improper disposal. Therefore, social expectations and the actions of people nearest to an individual play a critical role in deciding how probable it is that a person will embrace or oppose improper disposal (Shinkuma and Managi, 2018).

#### 2.6.5. Increased Population growth

The increasing global population is one of the causes of increased illegal waste disposal (Finnish National Monitoring Group, 2013). Because the overall volume waste generated is essentially associated with the total human population on earth, growth in the population often means a rise in the quantity of total waste produced. Many individuals might use authorised waste disposal places to get rid of large amounts of waste; however, there might be a minimal but still substantial number of individuals who unlawfully dump their waste in unauthorised locations.

This issue is likely to intensify as the population continues to grow because more waste is continually generated; thus, improper disposal of waste is also expected to accelerate (Brandt, 2017). Furthermore, an increase in population means that land becomes limited. Humans start to occupy places that would otherwise have been used for proper waste disposal (Charts, 2016). Occupying areas designated for waste disposal means that future and current populations will lack places to dispose of waste properly, thus immensely contributing to illegal and indiscriminate dumping (Ciura, Łukasiewicz and Malinowski, 2017).

#### 2.6.6. Lack of concern among some members of society

The occurrence of illegal dumping comes down to the decisions of individual community members and sometimes the decisions that some community members make are to the detriment of the rest of the community. A percentage of a community may not be concerned about improper disposal and its implications (Crofts et al., 2010). Individuals may have several issues that affect their lives. If there are so many life concerns, individuals may focus on those

issues that more directly impact their lives and neglect important community initiatives such as solid waste management (Environmental Protection Agency, 2017). They then prioritise their concerns so that they prevent errors and actions that have the most negative consequences on themselves. This can lead to a condition where concerns and adverse effects on society are overlooked (Hanuman, 2019). Thus, people's indifference and lack of concern can also add to the issue of improper disposal.

#### 2.6.7. Laziness

Another cause for improper disposal may be that individuals are too lazy to carry or drive their garbage to authorised disposal places (Ichinose and Yamamoto, 2011). Instead, these lazy individuals end up disposing of waste in the woods or other isolated areas where the authorities may not identify them (Ishii, Furuichi and Nagao, 2016). They choose to dispose of waste in places near them irrespective of whether such places are official for dumping or not. As individuals are likely to become more relaxed over time, unauthorised disposal due to laziness will probably accelerate in the future (Jordá-Borrell, Ruiz-Rodríguez and Lucendo-Monedero, 2014).

#### 2.6.8. High disposal charges

Another cause of improper dumping is high disposal charges (Kubásek and Hřebíček, 2013). The greater the dumping costs, the greater the motivation for individuals to unlawfully dispose of their waste and the lower the incentive for disposing of waste appropriately (Matos, Oštir and Kranjc, 2012). This is particularly true in developing nations where individuals or small companies either do not have sufficient resources or do not want to invest their resources in the proper disposal of waste. Din and Cohen (2016:436) mention that countries with a low GDP per capita such as the Democratic Republic of the Congo struggle immensely with waste management practices such as collection and disposal due to lack of funds and resources from the public or private sector.

#### 2.6.9. Corruption

Bribing and corruption play a key role in contributing to improper waste disposal. Large corporations have the means to corrupt state and local workers or other government agencies (through bribery) to receive special services or benefits (Matsumoto and Takeuchi, 2018).

Large companies can manipulate authorities to get rid of their refuse by improper disposal. Such actions are usually taken in an effort to circumvent the financial costs of proper waste disposal. This could be particularly true for hazardous materials that would be reasonably costly to manage and dispose of properly (Mihai and Taherzadeh, 2017).

#### 2.6.10. Inadequate control structures and mechanisms

Control structures and mechanisms such as regular waste disposal supervision and monitoring of proper waste management procedures are an important tool for ensuring sound waste management within a community or municipality. When authorities who are responsible for carrying out waste management services are held accountable, it ensures that the job is done properly and that authorities adhere to proper duty of care in their jobs. Additionally, control structures hold citizens accountable for environmental cleanliness and encourage them to take responsibility for their environment. A lack of control structures and mechanisms may lead to negligence by officials or community members. Shortage of control structures can present a challenge to preventing illegal dumping. Orlova et al. (2017) mention that in many countries a shortage of control structures is evident. In certain situations, there are insufficient workers to monitor the conduct of an individual's garbage disposal. For instance, it is easier for individuals to dump their waste in plantations or other places because insufficient officials monitor these areas. Besides, there may also be inadequate financial resources for more frequent monitoring of improper disposal (Sasao, 2016).

#### 2.6.11. Inadequate education

Poor education is a major barrier for environmental sustainability. Education is an important tool for knowledge transfer, especially with regards to knowledge about environmental duty of care and proper environmental management. Many individuals might not even comprehend the adverse effects of improper/unlawful disposal on our climate, particularly in nations where the issue of unlawful waste disposal is grave (Sigman, 1998). Sometimes, this could be due to a lack of schooling. In certain nations, even school-age children have to work and contribute to the household income (Sigman, 1998). However, working may discourage them from attending school, leading to a lack of primary education and limited knowledge regarding waste management. Lack of knowledge is a key predisposing factor to unlawful/indiscriminate dumping as individuals lack the necessary know-how relating to managing waste appropriately

(Watkins, 2015).

## ***2.7. Effects of illegal/indiscriminate dumping***

Illegal/indiscriminate dumping has environmental, social and economic effects. Illegal dumping is an intrinsically environmental issue which has an effect on all the other realms of society. The main reason that illegal dumping can be destructive to societal functioning is because it has far-reaching effects, the most significant being human health and well-being. The main impacts of illegal dumping are identified in this section. These impacts include human health, tourism and fauna and flora. Other effects of illegal dumping such as odour, environmental degradation and economic effects such as high clean-up costs are also explained in this section.

### ***2.7.1. Health and well-being***

Dumping refuse in illegal areas presents significant health risks for both adults and minors (Crofts et al., 2010). For example, children can use old appliances for a playhouse, possibly resulting in them getting stuck inside. Moreover, for both adults and minors, distended nails or cutting edges may cause cuts that result in infections. Individuals can unintentionally be subjected to chemicals or contaminants that are hazardous.

By attracting ‘unwelcome visitors’, improper waste disposal is also a danger to human health (Ruffell and Dawson, 2019). These places may be a breeding place for insects and animals that bear harmful infections. Scrap tyres, for instance, are suitable for mosquito breeding. They reproduce 100 times quicker than average in humid and moist climates. These organisms can bear life-threatening infections, including yellow fever, dengue fever, malaria and encephalitis. Additionally, other organisms or animals (such as rodents) can congregate around improperly disposed sites and transmit additional health hazards (Europol, 2013).

Among the waste products can be toxic substances such as shattered glass and needles (Interpol, 2016). Broken or shattered glass can inflict wounds that could escalate to more severe medical issues, such as diseases and infection. Old needles can scratch humans and animals unintentionally. This is hazardous since whatever substance was originally on the needle is not



known by the victim. It may have contained dangerous substances that, when introduced into the bloodstream, are deadly. The occurrence of wildfires, either by combustion or ignition, is also more frequent at these illegal dumpsites (Baird, Curry and Cruz, 2014). The fires are harmful to those residing in the neighbourhood and the individuals who put out the wildfires. These sites can contain obsolete combustible materials that can combust or explode at any time (Dorn, Van Daele and Vander Beken, 2007). Some compounds can also emit toxic smoke that is harmful to human health.

Giusti (2009:3) also mentions several direct and indirect health issues associated with illegal dumping. Direct health issues can come from direct exposure to harmful chemicals and substances in waste, emissions from the incineration of waste as well as vermin and odours that emanate from dumpsites (Triassi et al., 2015). Indirect health issues can arise from water, soil and food contaminated by illegal waste and can affect health and communities beyond the source of illegal waste dump contamination. Water is used for drinking and other developmental purposes. Therefore, the pollution of surface water such rivers is detrimental to human health. Additionally, nuisances emanating from unlawful waste disposal that may affect human health include landscape deterioration and littering (Fazzo et al., 2017). The seriousness of health impacts from illegal dumps is one reason municipalities must ensure regular clean-up efforts. Fazzo et al. (2017:5) likewise conclude that it is of utmost importance that waste is managed in an environmentally sound manner for community well-being.

### 2.7.2. *Tourism*

Individuals generally want to enjoy their holiday in clean places free from contamination (Faure and Visser, 2014). Tourists are more likely to move to other holiday destinations whenever waste is disposed of indiscriminately (Emery and Watson, 2014). The tourist industry is the most significant income stream for many nations. Consequently, for these nations, improper waste disposal can pose a very severe threat to their ability to maximise revenue from tourism. However, many countries are knowledgeable about this issue. They are taking steps to minimise improper waste disposal in order to maintain beaches and other natural resources and keep them as safe and clean as possible (Finnish National Monitoring Group, 2013). Although there are no tourism activities in Mbekweni Township, the general cleanliness does affect the overall aesthetic appearance of Paarl as a touristic destination. Especially because one of the major roads in Paarl such as the Jan Van Riebeeck Drive pass by Mekweni

Township.

### 2.7.3. Agriculture

Improper waste disposal can also adversely affect agricultural activities (Brandt, 2017). If the soil gets polluted due to improper waste disposal, it can affect crops and eventually affect animals (Charts, 2016). Animals eating produce grown in polluted locations are likely to consume toxic chemicals harmful to them or to the humans that consume them. Since the environmental requirements for food and plants are stringent, producers may not be allowed to sell their agricultural produce for industrial uses. They may suffer quite severe financial losses as a result of improper waste disposal. This particular point is related to Mbekweni due to the fact that Mbekweni is located close to agricultural lands in Paarl, only separated by the Berg River. The proximity of the Berg River also matters as improper waste disposal in Mbekweni would likely affect and pollute the river which is often used as a water irrigation source for farm lands in Paarl.

### 2.7.4. Fauna and flora

Improper waste disposal can cause extreme adverse effects on biodiversity (Ciura, Łukasiewicz and Malinowski, 2017). Ciura, Łukasiewicz and Malinowski (2017) found harmful chemicals in a portion of the refuse deposited in woodlands or other natural habitats in the Olsztyn district in Poland. Animals can be affected by these chemicals when they come into contact with them. In addition, animals may also be infected with dangerous disease-causing organisms found in the refuse, which may cause infections to spread via the food chain among various animals. Animals can also suffer from a shift in their everyday living standards because of improper solid waste disposal. Many animals respond very sensitively to a shift in their usual living standards and often avoid interaction with human beings and with human-made goods and items. Improper waste disposal can also cause animals to migrate to other, less-polluted areas, where they feel more secure with their natural surroundings (Crofts et al., 2010).

Improper waste disposal poses many risks to marine life (Environmental Protection Agency, 2017). Many corporations and industries dispose of their toxic waste in water bodies in nations with weak environmental regulations (Hanuman, 2019). Doing so can harm aquatic animals, together with many other water species such as aquatic plants. Many of these water species



will suffer from dangerous components and may even die due to the detrimental impact of contaminants introduced through industrial and municipal waste.

Plants are often adversely impacted by improper waste disposal as they draw growth elements from the soils contaminated as a result of indiscriminate dumping (Ichinose and Yamamoto, 2011). The harmful elements are likely to be transmitted to humans and animals that consume these plants. Certain landfill substances can also modify the soil's pH level, resulting in some plants' death. Since crops are typically very susceptible to a shift in acidity levels, improper disposal can adversely impact plant growth behaviour.

#### 2.7.5. *Other*

##### 2.7.5.1. *Smell*

Improper waste disposal can also create acrid odours that affect surrounding regions (Gibbs, McGarrell and Axelrod, 2014). This is particularly true if there are vast quantities of organic materials throughout the disposal site. These components release an odour when broken down by decomposing microorganisms. The odour emanating from improperly dumped waste is likely to make the environment unfit for human settlement. The gases causing the odour may also be harmful to the health of humans.

##### 2.7.5.2. *Property value*

If the issue of unlawful waste disposal is extreme, property values will probably decrease in the affected locations (Huisman and Van Erp, 2013). Typically, people prefer not to live in or near polluted areas. However that is not the case for people in developing countries as sometimes the only options available are desolate and polluted environments due to poverty. Thus, improper disposal renders some locations undesirable, eventually decreasing the value of property within these areas. In a study by Abel (2014), respondents in the eThekweni Municipality pointed out that illegal dumping was one of the primary reasons that made an area of residence unlikable and undesirable. This shows that illegal dumping can negatively affect people's perceptions of their environment and surroundings.

##### 2.7.5.3. *Land, air, soil and water pollution*

Improper waste disposal also results in land contamination. Waste that is improperly deposited on land will cause the physical shape of the affected locations to deteriorate. Furthermore, it will also impact the natural environmental system, as part of this refuse is likely to release hazardous chemicals.

Indiscriminate dumping is a significant cause of air pollution (Massari and Monzini, 2004). Illegal dumping sites contain substances that release toxic components into the atmosphere as they decompose (Van Erp and Huisman, 2014). Carbon dioxide or other gases that have harmful effects on the atmosphere can be part of these components. Releasing large amounts of carbon dioxide into the atmosphere is a contributor to global warming.

Improper waste disposal is also a key cause of water contamination (Liddick, 2015). In certain situations, municipal and industrial waste is disposed of in rivers or wetlands (White, 2018). This problem is severe in developing nations, as many lack proper waste management procedures and adequate control mechanisms. The water in rivers and other water bodies is often subject to pollution by dangerous chemicals and toxic compounds (Situ and Emmons, 2012). Furthermore, groundwater can also be polluted if waste is unlawfully disposed of in woods or other unauthorised areas. This may occur due to leaching.

Soil is also negatively impacted by improper waste disposal (Tompson and Chainey, 2011). Certain waste components may be hazardous or poisonous and may drain into the soil because of heavy rains (Chiu, Leclerc and Townsley, 2015). The soil in the affected locations is bound to be polluted, which may eventually contribute to groundwater pollution and negatively impact the plants that grow in the affected areas.

#### *2.7.5.4. High clean-up and maintenance costs*

There are high maintenance and clean-up costs associated with improper waste disposal (Simpson et al., 2013). All the waste that is unlawfully disposed of in woods or other areas must be removed at some point (Stretesky, 2016). These clean-up initiatives are often costly because they require many financial resources and a workforce to eliminate the contamination generated through improper waste disposal. Improper dumping often results in high clean-up costs, which the taxpayer must typically pay (Fortney, 2013).

## 2.8. *Perceptions of and attitudes towards illegal dumping*

### 2.8.1. *Introduction*

Community perceptions of waste management and illegal dumping are often complicated. Although the criminal act of dumping waste in non-designated areas is seen as a very straightforward act, there are usually several perceptions and attitudes influencing such behaviour. How a person or a community perceives something informs how that community or individual may act. The same can be applied to illegal dumping. When dumping waste in a specific spot in a neighbourhood is perceived as acceptable and permissible, it may lead to more people dumping waste illegally. Furthermore, people generally think it is a municipality's job to keep the community clean, but Kubanza (2012:94) states that there is often an attitude of apathy towards illegal waste dumping in many South African communities. These kinds of perceptions also speak to the persistence of illicit waste dumping in some communities. Community members may feel that it is acceptable to dump their household waste in an open field because they expect the municipality to remove the mess.

On the contrary, in the same study by Kubanza (2012), residents in Johannesburg noted that waste management issues such as illegal waste dumping were not the sole responsibility of the authority but also the responsibility of residents. Furthermore, residents indicated that these issues occurred due to people not respecting the proper regulations and laws already in place with regards to waste management. Molenaar (2010:8) emphasises that people are likely to behave more appropriately towards their surroundings if they perceive it as being clean. This is directly linked to perceptions behind illegal dumping. If a community feels or perceives their environment as dirty, they are likely to persist with unlawful waste disposal.

The community may be blamed for uncleanliness and persistence of issues such as illegal dumping; however, Pellow (2004:13) notes that the act of illegal dumping is often perpetrated by one or a small group of individuals within a community and is therefore not always the fault of the whole community. Investigating the underlying perceptions around issues such as illegal waste dumping may provide some valuable insight into the motivations behind illegal waste dumping and into underlying elements of social disorganisation within the community. (Brandt, 2017:32), for instance, believes that social disorganisation in a community may lead to an increase in undesirable behaviours such as crime and illegal waste dumping. The

prevalence of illegal dumping in a community may therefore indicate social disorganisation (Brandt, 2017). Brandt (2017:33) again notes that illegal dumping usually speaks to deeper underlying social issues within a community. Kubanza (2012:96) reiterates that illegal dumping may also make a piece of land undesirable and unwanted due to the land's unsanitary nature once it has been cleaned up. Furthermore, in the same study, respondents mentioned that illegal dumping often leads to the land being neglected by the community, which ultimately, in turn, leads to wastage of land (Kubanza, 2012).

### 2.8.2. *Convenience and distance*

González-Torre and Adenso-Díaz (2005) examined at least eight other regional research articles and conducted their analysis of the relationship between distance and reuse inspiration or intensity. A scientifically significant association was found between accessibility to recycling locations and either the option to reuse or the amount of reused waste generated; the lower the gap, the higher the reuse degree. If the distance to the recycle containers was too large, even individuals with environmental or ecological concerns were less inclined to isolate waste at the source and reuse it.

Gomez (2017) indicated that some 80% of participants claimed that they would dump refuse appropriately if disposal sites were strategically placed rather than if it was inexpensively priced. The same study found that just over half of the participants (57%) deemed 2-10 miles an appropriate distance for disposal sites; only 25% were willing to drive more than 10 miles for waste disposal.

### 2.8.3. *Cost*

There seems to be a general belief that it is the local authority's responsibility to clean up after citizens. A study by Cowee and Curtis (2009) found that while more than 70% of participants in South Africa would pay tax either to collect waste from public land or to improve law enforcement to prevent criminals, they would only pay up to \$4/year (approximately R40/year) – not even as a symbolic gesture of goodwill to the municipalities.

Nigerian research on the willingness and desire to spend money on waste disposal indicated a clear correlation between willingness and desire to spend and higher education standards (Rahji

and Oloruntoba, 2009). Rahji and Oloruntoba (2009) note that particular biological education could enhance perceptions towards safer and cleaner surroundings. Their research also showed that young individuals were more likely to pay for dumping services than older individuals due to the desire for a better future environment.

#### *2.8.4. Other perceptions*

Abel (2014) carried out a study on illegal dumping in South Africa and determined that several perceptions were associated with indiscriminate or illegal waste disposal. The main findings are described below.

1. In general, society seems to be unaware of the laws, policies and regulations of the land (despite such laws affecting citizens' lives daily and directly). Furthermore, some individuals may be aware of the laws and regulations, but a negative attitude may cause them to fail to observe these laws.
2. There seems to be a small link between conceptual awareness of environmental concerns and the actual, concrete effect of individuals' behaviour on that environment. However, there seems to be an utter disconnection between individuals' own 'landscape design' and the 'improper waste disposal' of neighbours in individuals' minds.
3. A typical mindset might be that proper waste disposal is 'problematic' in general, regardless of how near or open an authorised dumping site may be. It is crucial to assess society's sense of 'comfort' and see any ready improvements that local governments can make to promote or simplify the initiative and decrease opposition to appropriate disposal mechanisms.

#### *2.9. Studies done on solid waste management (African and global)*

Abel (2014) conducted a study to examine the perceptions of illegal dumping in the eThekweni Municipality. Abel determined that distance, education, cost and waste transportation issues were significantly associated with individuals' perceptions of illegal disposal. According to Abel, higher disposal costs, longer distances, and lack of means of transportation and low education levels were a key cause of negative perceptions of illegal dumping. The findings indicate that individuals who encountered fewer waste disposal challenges were more likely to embrace lawful disposal means due to positive perceptions. Individuals who experienced immense disposal challenges were likely to develop negative perceptions that caused them to

practice illegal dumping more easily.

Another study, conducted by Sotamenou, De Jaeger and Rousseau (2019) on municipal solid waste sanitation issues and livelihoods of urban populations in Yaoundé, Cameroon, found that the placement of infrastructure such as bins had an influence on waste collection. Additionally, the study found that increased recycling would be needed to combat the increase in waste being disposed of and the potential of waste being disposed of indiscriminately. The study also acknowledged that more waste infrastructure would be required in Yaoundé to improve waste management and prevent possible illegal dumping. Mbiba (2014:160) notes that sustainable solutions such as recycling can aid in waste reduction and prevent illegal disposal. Furthermore, Mbiba (2014:160) mentions that eastern and southern African cities (such as Mombasa, Lusaka and Bulawayo) have the potential to become leaders in waste minimisation and recycling given that many of the countries' governments provide legislative and policy support for the existing local recycling industry. Government institutions are the main providers of sanitation services such as waste collection in many African cities. However, a study by Tukahirwa, Mol and Oosterveer (2013) indicated that in some African cities such as Kampala and Nairobi, NGOs and CBOs play a significant role in the provision of sanitation services, especially for the poor. Tukahirwa, Mol and Oosterveer (2013) add that the privatisation of waste services has marginalised some of the poorest in these cities. NGOs and CBOs have therefore become increasingly important in the waste management systems of various African countries.

Several researchers have associated underdevelopment with illegal and indiscriminate dumping in Africa (Hambloch, 2014; González-Torre and Adenso-Díaz, 2005). Globally, several studies have associated illegal waste disposal with increased environmental pollution that has significantly contributed to global warming (Hansen and Panagiotakopoulos, 2015; Gomez, 2017). Research conducted by McGregor Tan (2018) in Australia argues that education is critical in promoting citizens' desirable perceptions of illegal dumping. Crofts et al. (2010) conducted research in Liverpool in the UK and determined that reduction in illegal waste disposal is essential to realising clean and safe environments for the survival of crops and animals, thus enhancing and ensuring food security.

### ***2.10. Solutions for illegal dumping***

Illegal dumping has a huge impact on society. There are several measures that governments as



well as citizens can take in order to mitigate illegal dumping. Various solutions may aid in reducing illegal dumping and ensuring a cleaner and healthier environment for future generations. One of the major challenges of illegal dumping is to identify when it will happen, where it will take place and how much will be dumped. There are several solutions that governments can implement to battle illegal dumping. Such solutions, as identified in the literature on waste management, include stricter government regulations, higher penalties and better control mechanisms. Other solutions, which can be applied at a societal level, include minimising consumption, increasing recycling and reuse and improving education. These solutions are explained in this section.

### *2.10.1. Government regulations*

Policymakers can create stringent rules to curb improper waste disposal (Ichinose and Yamamoto, 2011). Some developed countries have strict requirements in terms of waste management methods. These requirements, however, are either weak or poorly implemented in many developing countries. They have to be improved and their implementation should be enhanced to eliminate improper waste disposal issues. A study by Frantz (2006) points out that in some municipalities such as the Breede River District Council, there are adequate waste management policies for waste management in place at the municipality level, however there is poor implementation of the policies which ultimately affects to what degree and success the policies may work

### *2.10.2. Higher penalties*

The charges or punishments for the improper disposal of refuse are still very low in many nations (Watkins, 2015). Some researchers suggest that significantly increasing penalties for improper waste disposal is crucial in alleviating unlawful waste disposal (Sigman, 1998). Individuals and businesses have a greater incentive to abide by the law if there are significant penalties for improper waste disposal. Severer punishments will possibly lead to a decrease in unlawful waste disposal.

### *2.10.3. Control structures and mechanisms*

Sasao (2016) suggest that it is necessary to raise the fines for improper waste disposal and also to ensure that there are appropriate controls for regulating waste disposal. Suppose individuals

comprehend that there are high penalties for unlawful waste disposal, but are also aware that no one monitors them. In that case, these individuals will likely be inclined to continue dumping their refuse improperly because they know they will not be arrested or prosecuted. Better control systems are therefore important for mitigating the issue of indiscriminate dumping.

#### 2.10.4. Technology

Advances in technology may also be employed in waste management systems (Orlova et al., 2017). It is often economical to handle waste using these advances in technology. The disposal fees could also decrease through these methods, which are often inexpensive and which would allow individuals to avoid improper waste disposal and instead dispose of their waste in an acceptable way (Mihai and Taherzadeh, 2017). Technology is likely to increase surveillance, thus reducing instances of illegal waste disposal.

#### 2.10.5. Reduced dumping charges at legal dumping places

Dumping-site charges can also be subsidised by municipal, local or national governments to lower disposal costs (Matos, Oštir and Kranjc, 2012). Doing so would enhance the motivation for individuals and businesses to dump their waste legitimately, and the harmful impacts of illegal dumping could be minimised.

#### 2.10.6. Minimising consumption

If humans modify their consumption actions, they can significantly reduce improper waste disposal and the associated negative impacts (Jordá-Borrell, Ruiz-Rodríguez and Lucendo-Monedero, 2014). Humans' consumption levels have increased since industrialisation, as humans can use machinery to produce vast amounts of products at a reduced price per unit (Hanuman, 2019). However, this growth has also contributed to a considerable rise in the amount of waste generated. Furthermore, much of this waste is exported to developing nations in Africa, where it is recycled or burnt to eliminate it (Godfrey et al., 2019).

However, the waste section that does not have economic value is also unlawfully disposed of. Thus, the extent of unlawful waste dumping is also influenced by human consumption and



subsequent refuse production. Therefore, by minimising humans' daily consumption standards, we can reduce the problem to a certain degree.

#### 2.10.7. Education

Education is critical in mitigating challenges that face many sectors (Environmental Protection Agency, 2017). This is also relevant concerning the challenge of improper waste dumping. Agencies and government departments responsible for waste management should show citizens how the environmental system is impacted by improper waste disposal and what we can do to avoid it (Ciura, Łukasiewicz and Malinowski, 2017). This education should ideally commence at a very young age since young persons are typically more likely to improve their actions due to education. This may also transform their parents' and guardians' behaviour as their children will tell them about the harmful effects of illegal dumping. Furthermore, as these children become adults, they are much more likely to act in an environmentally friendly way. Additionally, Frantz (2006) suggests that the only way communities can achieve sustainable environmental change is to educate the youth and others about environmental management and consequences of our actions with regards to the environment.

#### 2.10.8. Reuse and recycle

The effective reuse and recycling of products is another way to minimise waste production and the resulting improper dumping (Charts, 2016). Instead of dumping used items into trash, for instance, individuals give things they no longer need to other persons. Separating waste during disposal is critical in ensuring efficient recycling and reuse (Fortney, 2013). The government can enhance recycling by establishing more recycling firms and enhancing private participation in recycling waste.

### **2.11. GIS and solid waste management**

#### 2.11.1. Concept of solid waste management

These days it is difficult to find instances of human development and growth that have not damaged or changed the ecosystem (Simpson et al., 2013). Without appropriate preparation, industrial, social and physical practices tend to generate solid waste, contributing to both financial and ecological misery (White, 2018). The traditional initiatives of waste management

(normally municipal solid waste is assembled and placed in sanitary landfills that attract insects, rats and other rodents, mites and birds and result in the release of greenhouse gases such as methane (CH<sub>4</sub>) and carbon dioxide (CO<sub>2</sub>), and other poisonous pollutants) continue to be inconvenient and costly, thus activating the requirement for a GIS. Monitoring vast areas regularly and procedurally for waste disposal sites has not been simple (Liddick, 2015). GIS technology that uses satellite algorithms and data to discover unknown and unlawful sites has proven to operate exceptionally efficiently, is cost-effective and can rapidly and proactively identify illegal sites over vast areas.

Currently, there is little or no monitoring or mapping of illegal waste disposal taking place in South Africa. Much like in South Africa, illegal dumpsite monitoring in other countries commonly includes voluntary reporting by residents and in situ surveillance of prevalent hot spots. This type of approach is not sufficient in some cases, especially when large areas have to be monitored (Mitchell, 2005). Remote sensing thus becomes particularly useful as you can monitor and surveil large areas remotely with precision and accuracy (Tenedório and Rocha, 2018). Glanville and Chang also conclude that 'remote sensing has the potential to address this knowledge gap through the use of existing analytical techniques to monitor and map illegal waste disposal sites comprehensively' (2015:8). Furthermore, the efficiency of clean-up programmes and in particular surveillance can be significantly improved through locating and mapping the distribution of illegal dumpsites. Importantly, residents and perpetrators of illegal dumping may be deterred from dumping through regular surveillance with remote sensing (Glanville and Chang, 2015).

### 2.11.2. Reasons for using GIS in solid waste management

GIS has been widely implemented alongside remote sensing in waste management research (Europol, 2013). Data collected from satellite imagery, photography and visual, microwave, LiDAR or thermal sensors are combined with necessary data attributes and levels, which could make it much easier to comprehend the nature and pattern of generated waste in the field (Webb et al., 2016). When organising waste management, these patterns are beneficial and offer remedies for coping with such severe environmental issues. This approach is regularly employed to establish optimal routes for solid waste collection (Dorn, Van Daele and Vander Beken, 2007). GIS is a technology that decreases site selection cost and time and offers investment management initiatives for the site's prospective monitoring procedures. Moreover, with excellent versatility, GIS data can be spectrally connected, shared, contrasted, analysed

and interpreted (Baird, Curry and Cruz, 2014).

Mobile applications have been developed and utilised in research and illegal dumping monitoring. One such application is a German-developed application called MÜLLweg! DE ('Trash Away'). It is a public participatory application which allows citizens to report illegal dumpsites (geolocations) directly to competent authorities, which allows authorities to locate and remove the illegal dumpsite. The application covers 10 000 municipalities or regional districts in Germany and has recorded over 2 000 manual entries. A similar mobile application called TrashOut was used in a study by Šedová (2016) in analysing the characteristics and causes of illegal dumping in Slovakia. The TrashOut mobile application has a larger database of reported illegal dumpsites globally and the database is accessible to anyone. Similar to MÜLLweg! DE, TrashOut allows citizens to report the location but also the size and waste composition of illegal dumpsites, depending on where you are located in the world. MÜLLweg! DE and TrashOut exhibit the potential of technology in waste management, specifically for monitoring illegal dumpsites, and in recruiting public participation in helping keep the environment clean and healthy.

## **2.12. Conclusion**

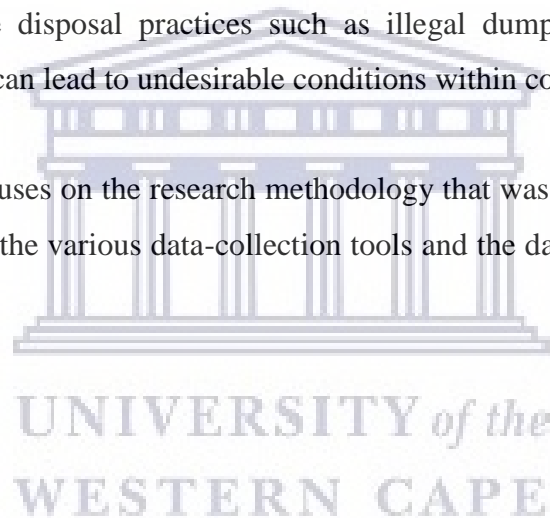
This chapter has reviewed the literature on issues of solid waste management at a local and national level in South Africa and the various theoretical concepts regarding illegal dumping and its impacts on society. The analysis and the discussion of various approaches with respect to waste management and waste mismanagement have demonstrated that while South Africa has strong legislative frameworks, the implementation and follow-through of said legislation still present a major challenge. The literature also revealed that while policy environments exist for moving up the waste hierarchy away from landfilling towards reuse, recycling and recovery, landfilling still remains the predominant method of waste management in South Africa. This is primarily because alternative methods of waste disposal are often perceived as being costlier than landfilling. This inadvertently leads to issues such as illegal dumping. The chapter has also shown that improper waste management which leads to illegal dumping can have serious environmental and social impacts such as environmental degradation, loss of biodiversity and high municipality cleaning costs.

As revealed in this chapter, achieving environmental sanitation is hindered by illegal dumping

in many countries globally, and the consequences of inadequate waste collection and disposal include land, air and water pollution, which cause further health hazards. Similarly, it was explicated in this chapter that conditions such as deteriorating human health and environmental degradation have severe consequences on the development of a country. It was also found that behaviour that leads to illegal dumping has harmful effects on society by imposing negative externalities.

Another connection between illegal waste disposal and public health was revealed. Illegal dumps often attract rodents and insects, which act as vectors of diseases and illnesses. In addition, illegal dumps situated close to homes cause offensive odour and visual displeasure, as well as placing citizens in close proximity to potentially harmful substances. Modern waste disposal practices are supposed to protect the health of communities and the environment; however, improper waste disposal practices such as illegal dumping continue to plague developing countries and can lead to undesirable conditions within communities.

The following chapter focuses on the research methodology that was applied in this research. The chapter also explains the various data-collection tools and the data analysis methods that were used.



## Chapter 3: Research Methodology

### 3.1. Introduction

This chapter provides an outline and description of the research process that was followed in the study. The chapter describes the research design that was used and the purpose of choosing it. It also describes the instruments that were used for the data-collection process and why they were chosen. Lastly, the chapter discusses the methods that were used to analyse the data.

A mixed-methods approach was used for this study. As explained in the objectives, the research includes the collection and assessment of spatial data and perceptions of residents in Mbekweni regarding illegal waste dumping. A mixed-method approach was chosen because, according to Hatzipapas, it allows for ‘conducting research that involves collecting, analysing and integrating quantitative and qualitative research’ (2013:26). Additionally, Tashakkori and Teddlie define the methodology of mixed methods as: ‘The broad inquiry logic that guides the selection of specific methods and that is informed by conceptual positions common to mixed-methods practitioners’ (2010:5). Johnson and Onwuegbuzie (2004:15) maintain that this approach is used when the combination of both strands of inquiry provides a better understanding of the research problem. Thus through the use of both quantitative data (spatial dynamics of illegal dumpsites) and qualitative data (interviews on perceptions), the study attempts to uncover and make sense of the spatial and perceptual dynamics of illegal waste dumping in Mbekweni. Data sets from both methods can be used to show and provide more substantial linkages and completeness (Topping and Timmins, 2019:56). As noted by Lieberman (2005:437), the mixed-method approach can be particularly useful in creating multi-angled arguments about research findings. In other words, through the use and integration of quantitative and qualitative methods, a researcher may be able to provide different views on problems that are often analysed deductively (Leech and Onwuegbuzie, 2009).

Byrne and Humble (2007:36) also explicate that the use of multiple methods within research is particularly useful in neutralising or cancelling some of the shortcomings of specific methods; hence the strength and advantages of each approach can enhance each other. Topping and Timmins (2019:56), however, note that a significant challenge of using both methods is that

the qualitative and quantitative elements of the data may be communicated and illustrated as if unconnected and sometimes as entirely different studies.

For a research methodology to be classified as mixed methods, it has to include different approaches at all levels of the study. According to Byrne and Humble (2007:36), a researcher may decide where to provide points of contact between the different methods. Social phenomena such as illegal waste dumping are inherently complex, and therefore varying methods and approaches are required in order 'to understand these complexities best' (Byrne and Humble, 2007:36). Mixed-methods research allows for the use of both exploratory ('whys') and confirmatory (hypothesis) inquiry (Byrne and Humble, 2007:36). A mixed-methods approach therefore gives researchers the advantage of answering exploratory and confirmatory inquiry simultaneously, thereby 'constructing and confirming theory in the same study' (Byrne and Humble, 2007:36). Certain detractors in academia believe that it is far-fetched to have compatibility between quantitative and qualitative forms of inquiry because of the incompatibility of paradigms intrinsically rooted in these different methods (Collins, Onwuegbuzie and Jiao, 2007). These paradigm purists therefore surmise that a researcher may only adhere to one or the other strand of inquiry. However, Tashakkori and Teddlie (2010) add that it is logical and advantageous from a mixed-methods point of view for researchers to make use of varying methods, but by only integrating them where necessary. In doing so, Maxcy states that a researcher may 'apply the findings to a reality that is at once plural and unknown' (2003 cited in Byrne and Humble, 2007:38).

According to Creswell (2013 cited in Mabila, 2017:138), there are six fundamental features of the mixed-methods research design. Most or all research that claims to have adhered to the mixed-methods research design generally have these core features as guiding principles. The features are: a data-collection process which consists of both qualitative and quantitative data; the analysis of both data sets; extensive and comprehensive procedures undertaken in both data sets; the combination and consolidation of the two data sources; a research design that entails a concurrent or sequential combination with an emphasis placed on both either equally or unequally; and an approach to research that is underpinned in a solid philosophical footing (Collins, Onwuegbuzie and Jiao, 2007). Therefore, for this research to wholly comply and subscribe to the mixed-methods research design, it has to incorporate these core features. Mixed-method research is rooted in a philosophical foundation that ascribes to the Deweyan stance in which nature is understood as a moving whole of interacting parts (Mabila, 2017:141).



The mixed-method research design rejects the mind-world scheme but views knowledge creation and experience from a holistic point of view (Brannen, 2005). Two main principles set apart mixed- method research design from other research approaches. These two principles, as highlighted by Tashakkori and Teddlie (2010:16), include dismissal of the either-or notion at any point of the research process, and a research approach that incorporates repetitive, cyclical and exhaustive procedures to achieve the desired outcome. Johnson and Onwuegbuzie further mention that:

We agree with others in that a mixed-methods research movement will be productive because it offers an immediate and useful middle position philosophically and methodologically; it offers a practical and outcome-orientated method of inquiry that is based on action and lends, iteratively, to further a method for selecting methodological mixes that can help researchers better answer many of their research questions. (2004:17)

This particular study employed a multilevel mixed-methods (with an exploratory sequential design) approach, and a multilevel mixed-method research design is defined by Headley and Plano Clark thus:

A multilevel mixed-methods research design is a MM design driven by a multilevel theory about a system for the purpose of better understanding three characteristics of that system: the holistic structure of the system; the individual components (levels) that emerge from, give rise to, or evolve in tandem with the structure; and the processes (mechanisms) at work between the components and the structure. (2020:9)

Relatedly, the system can be understood using three distinct characteristics, namely the integrated structure of the system; the individual levels that arise from structure; and the mechanisms that feed into the levels of the overarching system (Headley and Plano Clark, 2020:9). Traditionally, the multilevel mixed-methods approach has always been used in studies based on institutions such as hospitals; Teddlie and Tashakkori (2009 cited in Headley and Plano Clark, 2020:5) suggest that multilevel mixed-methods research designs are best suited in hierarchical organisations. This research, however, puts forward that a similar approach can be applied to waste management, which is inherently multifaceted and operates at various levels and components. The same kind of philosophy can be applied to environmental phenomena like illegal waste dumping, which is a recurrent and significant issue in waste management. Importantly, the overarching structure is the waste itself, with individual levels such as illegal waste dumping and waste administration. There are underlying mechanisms or processes that feed into these levels (or affect the levels), such as socio-economic drivers (poverty, crime),



inefficient waste services and lack of duty of care. Headley and Plano Clark (2020:14) emphasise that in such a multilevel system, the system may be composed of a top-down orientation or a bottom-up orientation. This implies that the overarching structure may cause the components below it to have specific characteristics. At the same time, the components at the very bottom of the system may also cause the levels and hence the structure or system to take on particular characteristics. In this sense, a unique mechanism in this system, such as unemployment, for example, may cause the levels above it to take on a specific characteristic, in this case in the form of an increased prevalence of illegal waste dumping. This may then influence the over-arching waste structure of a specific community or region, therefore affecting the entire waste 'system'. Due to this, multilevel mixed-methods research may produce data, evidence and conclusions about several facets of a multilevel occurrence, whether it is about the structure, at the levels below the structure or within the mechanisms feeding the various levels (Headley and Plano Clark, 2020). Headley and Plano Clark (2020:15) suggest that in such an approach to mixed-methods research, qualitative and quantitative inquiries would be well acquainted. They also mention that both the qualitative and quantitative strands of investigation may be used to investigate various aspects of the multilevel system at any component (structure, level or mechanism). It is essential to note, however, that the overarching structure of waste, and in this particular case waste in Mbekweni, is a constantly evolving thing. As the components of the waste structure in Mbekweni are not yet known, this research therefore attempts to uncover the various components at play when talking about a holistic structure of waste in Mbekweni.

### **3.2. Research design**

Headley and Plano Clark's (2020) definition of a multilevel mixed-methods research design shows that there are six design features to consider when using such a research design. These features are: theoretical grounding; mixed-methods research design; sampling strategy; data collection; data analysis; and integration phase.

The theoretical grounding of a multilevel mixed-methods research design should include a theoretical premise about the particular multilevel system which explains the system as a whole, the various components of the system (levels) and the specific processes that lead to the development of the system (mechanism). Both the qualitative and quantitative strands should help uncover and throw light on particular characteristics of the multilevel system (waste) being

studied. For example, through the use of both quantitative and qualitative approaches, it was possible to find out and explain how underlying mechanisms such as unemployment and social disorganisation contribute to waste administration issues and the continuation of illegal dumping in Mbekweni, which in turn affect the overarching structure of waste management in that community.

For the sampling strategies used within the multilevel mixed-methods research design to be justified, it has to go hand-in-hand with the research problem (Headley and Plano Clark, 2020). According to Headley and Plano Clark's (2020) view on multilevel mixed-methods research designs, the samples used in the research should effectively represent the studied population, and will therefore produce inferences that are justified, valid and trustworthy. Headley and Plano Clark add that 'Ultimately, the sampling strategies should be justified in terms of the underlying multilevel theory, the overarching multilevel purpose, and the unique purpose of each strand' (2020:10). This suggests that data-collection tools and techniques should be defensible, and it is therefore essential that the selected data-collection tools and techniques can generate multiple inferences about various levels of the system.

Therefore, results created from the analysis techniques should be able to be connected across levels and strands of the multilevel mixed-methods research design, in the integration process. As Yin puts it, there should be 'explicit connections or intentional redundancies between quantitative and qualitative strands' (2006 cited in Headley and Plano Clark, 2020:10) to promote seamless integration of data across levels. The integration process of a multilevel mixed-methods research design should facilitate the development of reasoning or the overall explanation of the system (Headley and Plano Clark, 2020). Moreover, these explanations should shed light on the structure, levels and mechanisms of the system. Headley and Plano Clark conclude that, in order to distinguish a multilevel mixed-methods research design from a single-level mixed-methods research design, integration of data and results is crucial to 'yield across level meta inferences that explain more than one aspect (e.g., structure, component, or processes) of the system' (2020:10).

### **3.3. *Pragmatism in mixed-methods research***

Pragmatism advocates for a practical approach to a problem and has particularly strong connections with mixed-method research. Logical reasoning in pragmatism is based on an

abductive approach. In other words, researching a problem starts with an observation, and then seeks to find the best and most likely explanation for the observation (Parvaiz, Mafti and Wahab, 2016). If the same thinking were applied to the issue of illegal waste dumping, for instance, a researcher would start by acknowledging the problem, observing it and investigating it before a logical conclusion or set of inferences can be made about why the illegal waste dumping occurs. This is different from inductive reasoning, as inductive reasoning seeks to prove or disprove a preconceived idea or hypothesis about an issue. Morgan (2014:8) states that pragmatism recognises that qualitative and quantitative methods have their limitations and that combining the different approaches in the same study can be complementary. Pragmatists also contend against the perceived polarity of quantitative and qualitative research paradigms and instead favours the substantial use of both approaches. In this respect, pragmatism is particularly suited for a study of this nature as it supports using two strands of inquiry such as qualitative and quantitative strands in one research study (Teddlie and Tashakkori, 2003). Pragmatism thus provides a linkage between paradigms and methodology (Cameron, 2011). Venkatesh, Brown and Sullivan (2016:442) hold that pragmatism's 'dialectic' quality allows a researcher to view and understand a research problem through several different perspectives and lenses. Therefore, it is appropriate for a study like this that draws on different perspectives originating from both quantitative and qualitative data.

Pragmatism is considered to have a robust theoretical position in mixed-methods or methodology; however, Cameron (2011:106) reveals that pragmatism is often criticised as too general and broad an approach for mixed-methods researchers. Cameron (2011:105) suggests that it is therefore essential for mixed-methods researchers to acknowledge these criticisms. Furthermore, Cameron (2011:105) notes that there are two issues that a researcher has to acknowledge when pragmatism is applied to the mixed-methods approach. Firstly, pragmatism as a theoretical framework does not place enough focus on theoretical ideas and beliefs; thus, mixed-methods researchers will not be thoughtful enough throughout their research about the various tools and methods used, and their application thereof will not be able to rationalise and simplify the phenomenon being researched. The application of philosophical ideas and beliefs should therefore be included in mixed-methods research (Cameron, 2011). Secondly, Cameron (2011) asserts that theorists within the pragmatism paradigm tend to focus predominantly on the role of paradigms in mixed-methods research, and not enough on the validity of practical inquiry decisions. Additionally, Biesta (2010:114) argues that even though pragmatism does not necessarily provide a theoretical basis for mixed-methods research, it assists mixed-

methods researchers to pose more clear-cut questions about the theoretical implications of their research designs.

The following sections deal with methods that were employed in the study for: the mapping of the locations of illegal dumpsites; the observations and recording of the spatial variables of illegal dumpsites; conducting interviews with affected people and officials; and integrating the spatial and survey data through a GIS application.

### **3.4. *Sampling methods***

The data-gathering process is a crucial element of research because the data collected contributes to a better understanding of the applicability of a theoretical framework (Mason, 2010). It is therefore imperative that the way in which the data is collected and from whom is done in a proper way and with sound judgement. This is particularly important when one considers that no amount of data analysis can compensate for incorrectly collected data. In research parlance, the technique of selecting a representative subset of a larger population is called sampling (Onwuegbuzie and Collins, 2007).

Sampling can also be defined as the ‘process of selecting units (e.g., people, organizations) from a population of interest so that by studying the sample we may fairly generalize our results back to the population from which they were selected’ (Trochim, 2006). It is therefore vital for a researcher to make the research design more plausible by developing criteria or parameters for selecting sites and subjects to be used in the research. Also, the sampling methods need to be systematic to get the right data and information from the sample (Acharya et al., 2013). Sampling methods are divided into probability sampling and non-probability sampling. According to Etikan, Musa and Alkassim (2016:5), when using a non-probability sampling technique, members of a population within the area of interest do not have an equal chance of being selected for the study sample, which they would when using a probability sampling technique. This makes non-probability sampling cheaper, less time consuming and able to be applied quickly (Etikan, Musa and Alkassim, 2016).

A multi-sampling method was used for this research. Specifically, the study incorporated non-probability sampling techniques: purposive sampling and convenience sampling.

### 3.4.1. *Purposive sampling*

Purposive sampling (also called 'subjective' or 'selective' sampling) investigates subjects based on a predetermined set of criteria (in this case, homes and residents situated closest to illegal dumpsites). As stated by Etikan, Musa and Alkassim, 'The researcher decides what needs to be known and sets out to find people who can and are willing to provide the information by virtue of their knowledge or experience' (2016:6). Patton (2007:1) surmises that purposive samples may vary but must share common or similar characteristics or meet a particular criterion which helps contribute to the specific research objective. Therefore, for this study, purposive sampling was used to select sites where homes were situated in proximity to an illegal dumpsite. The study did not include everyone in Mbekweni, but rather those households that were closest to illegal dumpsites and therefore more likely to be affected by illegal dumping than residents and homes further away. The implication of using purposive sampling is that the answers and insights recorded are coming from the specific perspective of individuals and families who at the time of conducting this research were the people closest to the problem (illegal dumping) and most affected by it, and therefore arguably the people who have the most significant insight into the issue of illegal dumping in Mbekweni. As explained by Alvi (2016:32), the sample in this case will be much smaller than when using probability sampling, for instance, where sweeping generalisations are made about a population.

This research sought to understand the perceptions of illegal dumping by individuals or groups in Mbekweni, hence allowing for the development of theories and descriptions of residents' experiences. Purposive sampling was therefore chosen as the best-suited sampling strategy to achieve this goal. Devers and Frankel (2000:264) assert that purposive sampling allows for the selection of 'information-rich' cases, which further enhances and provides better insight into the research questions by shedding light on individuals' and groups' behaviours and experiences. In addition, Miles and Huberman (1994 cited in Devers and Frankel, 2000:264) mention that three particular types of cases allow for purposive sampling to have the best outcome. These are: typical cases (samples which are identified as regular or average for the population being studied); deviant cases (samples which exhibit elements of the particular phenomenon being studied); and negative cases (samples where individuals or groups are the exceptions to the rule) (Miles and Huberman, 1994 cited in Devers and Frankel, 2000).

This research studied the deviant cases, since it looked at the lived experiences and perceptions of individuals who may be significantly affected by illegal dumpsites and potentially have the best insight into the problem, based on their proximity to the dumpsites. This particular type of purposive sampling is called homogeneous sampling (Tuckett, 2004), as the focus was placed on candidates who shared similar traits or specific characteristics or experiences. As discussed above, the characteristic shared by candidates was their proximity to illegal dumpsites. By focusing on this distinct similarity, we were better able to select candidates who had a good understanding or relevant experience of illegal dumping in Mbewkeni. It is emphasised by both Tongco (2007) and Palys (2008) that this is more of a conscious choice than a weakness in the sampling method, provided the judgment call is based on clear, defensible criteria and not merely blatant prejudice.

#### 3.4.2. *Convenient sampling*

After the specific sites have been selected through the use of purposive sampling, convenient sampling was employed to select residents from those homes that were situated in proximity to illegal dumpsites. Etikan, Musa and Alkassim (2016) further mention that convenient sampling is particularly useful in targeting population groups that meet criteria such as accessibility and availability.

After identifying households that were located in proximity to the largest recorded illegal dumpsites in Mbekweni, all the other households and subjects could not be randomly selected for the research. Therefore, a convenience-based sampling method, in which residents or participants were chosen for interviewing based on their availability and accessibility, was then used. This type of sampling is called convenience sampling (Tuckett, 2004). Convenience sampling can also be thought of as accidental sampling (Collins, Onwuegbuzie and Jiao, 2007). The primary assumption made during this process was that the subjects of the target population in Mbekweni were homogeneous. Their homogeneity was based on the fact that all the households were situated close to one of the biggest illegal dumpsites in Mbekweni. At this stage, whoever among that group was available and willing to participate in the interview was selected for the sample. Therefore, the sampling criteria that was used for selecting the participants for this study included: the household's proximity to an illegal dumpsite (approximately 20-30 metres); adults or homeowners of the household (in adhering to ethical considerations no children were interviewed); the willingness of residents to participate;



availability of residents; and accessibility to the residents. By using a multi-sampling method of purposive and convenience sampling, the aim of data collection remains the same, and both sampling assumptions are achieved with both methods (Khedive, 2013).

### **3.5. *Geo-locating using GPS in the field and web-based systems***

The quantitative data-collection process was conducted during September and October 2019. The process included the recording of the locational coordinates of illegal dumpsites, taking note of the waste compositions and taking additional field notes and photographs. A systematic approach was used to locate and map all the illegal dumpsites in Mbekweni. Mbekweni is a relatively small township, so the geolocation of illegal dumpsites was not too strenuous. However, to ensure that the entire area of Mbekweni was covered, we used the main roads in Mbekweni as boundaries. These roads included Drommedaris Road along the western border, Sand Street at the northern border of the township, separating Mbekweni from Newton, and Jan Van Riebeeck Drive on the eastern border (see Appendix C for a reference map of the area).

Furthermore, Drommedaris Road was used as the main access road in and out of Mbekweni; most of the streets in Mbekweni run perpendicular to it, making it a useful reference point. This allowed us to progress through Mbekweni in an eastward direction, from west to east, until we reached Jan Van Riebeeck Drive on the eastern extent of Mbekweni. I drove, with an assisting researcher, through every street, going through each until we got to Sand Street on the northern edge of Mbekweni. A total of 62 illegal dumpsites were located, all varying in size and waste composition. This process was significantly aided by the use of two mobile apps which were integral tools during this phase. These two mobile applications were Fields Area Measure and TrashOut. The specifics and usage of these mobile applications are discussed in sections 3.5.1 and 3.5.2.

#### **3.5.1. *TrashOut***

TrashOut is a mobile application which helps in the location and monitoring of illegal dumpsites all over the world. Specifically, it is a participative application which can be used by experts and ordinary people to help locate, keep track and alert governments or authorities of illegal dumping. People can report local illegal dumpsites through the use of a smartphone. Through the use of the reported information, a global database is created consisting of the



locations, composition, and size of the illegal dumpsites. This information is also available at [www.trashout.me](http://www.trashout.me), which is owned by an NGO. This mobile application was incredibly useful as it allowed for the recording of the location data and waste composition on a single platform. TrashOut made the mapping process of dumpsites easy and simple, as everything I needed was only a push of a button away on my smartphone. TrashOut provided a precise location in decimal degree format with an accuracy of about 4 metres. The waste composition options available were quite generic, though, and additional field notes were made to ensure more precise information of the morphological composition of all 62 illegal dumpsites was recorded. Figure 1 is a snapshot of the main TrashOut interface showing how the database is recorded.



Figure 1: TrashOut mobile application

Figure 1 is an actual snapshot of the mobile application as it appeared on my phone. The image on the left is the main interface of the application. It provides several options such as viewing any illegal dumps reported near you, current news in the illegal dumping world and the nearest recycling collection points based on your location. The image on the right displays how the reported dumpsites appear on the map where they were reported. This image shows the dumpsites that were reported during the data-collection process in Mbekweni. The closer you zoom in on the map, the more illegal dumpsites appear on the map and the more they are distributed. The red dots represent the current illegal dumpsites, while the green dots represent

the illegal dumpsites that were reported as being cleaned up. During the fieldwork period in Mbekweni, four dumpsites were reported as cleaned up during the fieldwork.

In addition, TrashOut is a unique mobile application (in fact, it is the first of its kind). There are no other applications available with the same features and applicability in waste management, and TrashOut is the first application that allows people to locate and report illegal dumping globally. Its uniqueness and applicability, especially with regards to illegal dumping and waste management, were two of the reasons that TrashOut was chosen for this study. Some of the features that make TrashOut useful include a trash map that displays all the reported illegal dumpsites in the region, being able to report illegal dumps anonymously, the ability to update previously reported illegal dumpsites and making all reported data available to anyone from anywhere in the world. Another reason for using this application was to demonstrate its applicability in South Africa. The motivation is that, by demonstrating through this research how TrashOut can be used as a research tool by citizens and authorities, it may be adopted at some point as a tool for monitoring illegal dumping and improving waste management.

However, like any other technologies or applications, TrashOut has some limitations. The first limitation relates to the reliability of using the large datasets gathered from the platform. Šedová (2016) points out that the data is usually reported by ordinary citizens and is not systematically collected. Therefore the reported data may not always be reliable. The second limitation is that in order to use the application the user needs a smartphone and mobile data to report illegal dumps. TrashOut is inherently resource-reliant and is not necessarily available to everyone. Its third limitation is that the reported illegal dumps may not necessarily represent the true scale of illegal dumping but rather the reported illegal dumps (Šedová, 2016).

### 3.5.2. GPS Fields Area Measure

The second aspect of illegal dumpsites that this study investigated is the size of illegal dumpsites in Mbekweni. This was made possible by the use of the area-measuring mobile application called GPS Fields Area Measure. This mobile application allows you to measure the sizes of plots of land – in this case, the size of illegal dumpsites. The dimensions of illegal dumpsites were measured in square metres. GPS Fields Area Measure uses a GPS-tracking auto-measuring tool for walking or driving around specific boundaries. This ensured the most accurate size measure possible.

However, not all illegal dumpsites were accessible to walk around, so GPS Fields Area Measure allowed me to manually draw and plot the area of the illegal dumpsite in real time when standing near it. I was able to measure the area and perimeter sizes of all 62 illegal dumpsites. This information was recorded and saved on a database that is accessible when needed. Furthermore, based on the GPS functionality, it was possible to correlate the specific area measurements with the exact dumpsite reported on TrashOut. Figure 2 is a snapshot of the main interface of the GPS Fields Area Measure application.



Figure 2: GPS Fields Area Measure mobile application

On the left, Figure 2 shows the Google Earth satellite view of Mbekweni and all the illegal dumpsites highlighted in green. On the right is the database created from all the saved measures with their specific numerical notations and area of the plots measured.

The reason for choosing GPS Fields Area Measure was twofold. Firstly, it is an industry-standard area-, distance- and perimeter-measuring tool that is used in a variety of industry applications such as farm management, construction surveys and landscape design. This also means that the application tool has a high level of credibility due to the fact that it is

used in activities and industries that require the best possible accuracy. The application was developed by Farnis, a digital agriculture tech company that develops similar mobile applications for agricultural ICT solutions, thus making GPS Fields Area Measure application a reliable tool.

Secondly, the application was chosen because of the unique features that it offered compared to its competitors. Features include GPS auto-tracking, which helped the researcher to measure the walking distance around a specific boundary of an illegal dumpsite. Additionally, the KML (Keyhole Markup Language) exporting feature allowed various illegal dumpsites to be measured and the data to be exported to another programme such as Google Earth or GIS for further analysis.

### **3.6. *Qualitative interviews***

Interview data was collected between 10 and 19 February 2020. 25 interviews were conducted, of which 19 were conducted in English and six in isiXhosa. A translator was present and therefore translated the questions into isiXhosa as the interviews took place, and vice versa. Ethical considerations were adhered to and permission was granted by the respondents to have the interviews recorded. It is important to note that the interview questions were not piloted in the field and that this process could have aided in a more seamless interview process. All interviews were tape recorded, and the verbatim responses were transcribed using a standardised transcription protocol. The sample unit used for the interview process was selected based on their proximity to illegal dumpsites. The sample group was further split into different size categories of dumpsites they were situated close to; of the 25 interviews conducted, 10 of the participants lived within 20-30 metres of illegal dumpsites categorised as large. 7 of the participants interviewed lived close to a medium-sized illegal dumpsite, and 8 participants interviewed lived close to a small-sized illegal dumpsite. The sizes of the illegal dumpsites were identified in the previous mapping phase using the GPS Fields Area Measure mobile application.

The rationale behind such an approach was to determine if there were differences in perceptions with regards to the presence of vermin or annoyances based on the size of the illegal dumpsites. The interview was based on 11 closed-ended questions and 14 semi-structured open-ended questions. The 11 closed-ended questions allowed the interviews to be participatory, as



participants were asked questions regarding awareness, hygiene, aesthetics, annoyance and solutions to illegal dumping in Mbekweni. The semi-structured questions focused on understanding the attitudes of residents in Mbekweni with regards to illegal dumping and their concerns thereof. This also provided an opportunity for individual narratives and discourses to emerge. The questions that explored the experiential aspects of respondents were also quite important. See Appendix B for more information on the questions posed to the respondents.

### **3.7. Data analysis**

#### ***3.7.1. Mapping and analysis of illegal dumping***

A GIS is a multi-component program that is used to visualise, analyse and manage geographic data and its correlative spatial elements (Goodchild, 2005). In one way or another, the majority of data collected on earth can be allocated a spatial location (either on earth's surface or in a coordinate system); therefore, any kind of data can be represented in a GIS (Longley et al., 2006). The purpose of the analysis largely determines how effectively a dataset can be presented in a GIS. For instance, if one is interested in identifying the African countries with the most malaria cases, a table listing the nations and the corresponding figures will suffice. However, if you are interested in knowing whether the African countries with the highest number of malaria cases are geographically clustered, a GIS would be suitable for that type of analysis. You will need additional data on the locations and shape of each country (Mitchell, 2005).

Additionally, a common type of analysis carried out on a GIS is spatial analysis. Within the context of a GIS program, spatial analysis involves the manipulation and querying of data (Wagner, Gresham and Dato, 2006). This type of analysis is primarily based on identifying patterns and underlying processes based on statistical data (Tenedório and Rocha, 2018). Relatedly, a spatial analysis may be used to identify the source of a particular type of spatial pattern that can be observed from the spatial data (Fischer, 2006). Using the same analogy of malaria cases in African countries, spatial analysis can be used to determine whether the distribution of malaria cases in a particular country or across multiple countries is dispersed, clustered or random, and what the source of the distribution of malaria could be. Fischer and Getis (2009) state that spatial analysis is in essence an analytical or investigative process which attempts to quantify an identified spatial pattern and tries to figure out what may have caused

the pattern to occur. O'Sullivan and Unwin (2010:3) note that spatial analysis can also be employed as a quantitative and statistical technique in research. GIS has untapped potential to be used as a useful tool for mapping and monitoring illegal waste disposal. Glanville and Chang (2015:7) believe that, in the last 15 years, there has been limited research conducted globally on the development and training methods of monitoring and mapping illegal waste disposal.

Globally, illegal waste disposal has led to a wide variety of environmental and social problems which in turn have created a demand for cost-effective and efficient ways of monitoring and mapping solutions to assist with better waste management efforts (Glanville and Chang, 2015). GIS techniques such as remote sensing can be useful in this regard as it has the potential to provide important information about illegal dumpsites such as location, waste composition and land use type to aid surveillance operations (Tomlin, 1990). Maantay and Ziegler (2006:4) likewise emphasise that GIS, and particularly remote sensing, helps provide an understanding of the spatial distribution of illegal dumping sites, which helps make waste management efforts more cost-effective and efficient, therefore adding to local authorities' effectiveness in responding to issues such as illegal waste disposal (Getis, 2005).

In a study by Biotto et al. (2009), GIS mixed with a multi-criteria analysis method was used to locate illegal dumping sites in Italy, and four factors were found to be associated with illegal dumping sites. These factors are: high population density; locations near industrial zones; locations within 6 kilometres of formal waste sites; and abandoned former quarries. In another study, De Feo et al. (2014) used a web-based GIS method which included providing the location and hazard level of each illegal dumpsite, therefore systematically organising each dumpsite according to importance. This made the process of cleaning up illegal dumpsites more efficient and cost-effective. A study by Silvestri and Omri (2008) also used GIS tools to pinpoint locations of illegal waste deposits, and, through the use of several data layers such as size, shape and location of illegal landfills, it was uncovered that illegal waste sites were predominantly situated in areas with dense vegetation cover. In the South African context, Eberhard (2018) has discovered that the eThekweni municipality plan to incorporate GPS and GIS specifically into their targeted waste management strategy to help them quantify and identify areas most impacted by illegal dumping. This targeted approach will assist in curbing illegal dumping in certain areas and help authorities stay ahead of the problem in eThekweni.

### 3.7.2. *GIS application and spatial data layering*

GIS analysis was an essential method used to create the maps. Essentially, different sets of data layers were used to represent various aspects and spatial dimensions of illegal dumpsites in Mbekweni. All GIS functions were carried out using the GIS software, ArcMap 10.6. The first set of spatial data that was recorded was the geolocation coordinates of illegal dumpsites. This coordinate data was initially collected in the DMS (degrees, minutes and seconds) format. However, ArcMap 10.6 can only take coordinate data in the DD (degree decimals) format. In order to convert all 62 sets of coordinates, the data was compiled into an Excel sheet. After that, various functions were used to convert the DMS coordinates into DD coordinates. Once this was done, additional attribute data such as the area size, waste composition and size categories of the illegal dumpsites were added to the Excel sheet, in essence creating a database of illegal dumpsites. The attribute data was necessary in this case, as it allowed me to execute spatial queries and analyses in ArcMap. The Excel sheet was then converted into a text file which was imported into ArcMap.

The benefit of having a geodatabase of tabular information in one place is that I can visualise, query and efficiently analyse the data without adding different data sets each time. Likewise, the tables in the geodatabase allowed me to map and visualise certain aspects of the data linked to illegal dumpsites. Other features such as classifying and categorising attributes were used to symbolise various layers such as the different illegal dumpsite size categories and the additional waste characteristics of these illegal dumpsites. Figure 3 shows the geodatabase of illegal dumpsites and the correlating attribute tables.

FID	Shape *	Point	D lat	D Long	Area sqm	Perimeter	Size	Waste Comp
0	Point	1	-33,684167	18,99	319	80,9	Large	Mixed
1	Point	2	-33,686944	18,990278	40,451	35,665	Small	Glass
2	Point	3	-33,684444	18,989167	85,7	46,6	Medium	Builders Rubble
3	Point	4	-33,685	18,988889	34,335	22,296	Small	Mixed
4	Point	5	-33,685	18,987778	27,784	21,586	Small	Mixed
5	Point	6	-33,684722	18,989722	80,207	37,82	Medium	Garden
6	Point	7	-33,684722	18,988333	94,404	43,447	Medium	Builders Rubble
7	Point	8	-33,675556	18,985833	64,004	30,454	Medium	Household
8	Point	9	-33,688889	18,984722	151	66,4	Large	Demolition
9	Point	10	-33,6825	18,988056	135	44,126	Large	Demolition
10	Point	11	-33,681944	18,987778	60,777	30,964	Medium	Garden
11	Point	12	-33,681389	18,9875	33,147	22,991	Small	Garden
12	Point	13	-33,681667	18,987222	22,761	20,691	Small	Plastic
13	Point	14	-33,680556	18,9875	76,307	36,32	Medium	Household
14	Point	15	-33,676667	18,989722	50,39	28,288	Medium	Builders Rubble
15	Point	16	-33,675833	18,989722	31,629	27,585	Small	Builders Rubble
16	Point	17	-33,673056	18,991389	5,476	9,871	Small	Mixed
17	Point	18	-33,678056	18,995278	98,892	43,032	Medium	Mixed
18	Point	19	-33,678611	18,994722	78,014	68,489	Medium	Garden
19	Point	20	-33,682778	18,993056	3,994	55,513	Small	Mixed
20	Point	21	-33,680556	18,989167	31,075	25,219	Small	Demolition
21	Point	22	-33,687778	18,991111	142	70,971	Large	Builders Rubble
22	Point	23	-33,685556	18,995278	258	62,475	Large	Builders Rubble
23	Point	24	-33,685556	18,995278	182	55,696	Large	Builders Rubble
24	Point	25	-33,690278	18,989444	7,558	22,121	Small	Mixed

Figure 3: Attribute table



In order to map the illegal dumpsites in ArcMap, a base layer was needed. For this function, the web-based geographical system Google Earth was used. In Google Earth, the map of Mbekweni was located. On this area map, four control points (one in each corner) were added using the Google Earth editing tools. These control points contained the geographic coordinates of the maximum extent of the area of the map that would be used in ArcMap. The satellite image of Mbekweni was then exported as a jpeg file. In ArcMap, the Google Earth image was imported. The four control points created previously in Google Earth were georeferenced (using georeferencing tools) based on the correlating latitude and longitude values recorded in Google Earth.

In this context, georeferencing is the process of aligning the Google Earth image to a map coordinate system – WGS 1984. This allows you to view and query GIS data according to the location of the map. Additional base layers were downloaded from [extract.bbbike.org](http://extract.bbbike.org). These base layers contained the road/rail, building and watercourse features of Mbekweni. It is important to note that GIS is utilised in this study as a means to an end and not an end in itself. ‘Technicist’ aspects thereof are used as they are relevant to the study, contextualised by other data-gathering tools. It is also not a study in the application of a typical community GIS project.

### 3.7.3. Spatial statistics tools: spatial autocorrelation (Global Moran's I)

The variability of the distribution of a specific feature can be evaluated using cluster analysis, which divides the data into groups containing similar variables while considering the geographical location of features and their spatial relationships (Getis and Ord, 2010). Peeters et al. (2015:140) state that spatial clustering methods evaluate the extent of spatial autocorrelation between features and quantify the statistical significance of the identified clusters. Therefore, illegal dumping is inherently a spatial phenomenon. Scott and Warmerdam (2005:16) report that spatial autocorrelation is a useful tool for identifying possible relationships from the spatial distributions of illegal dumpsite points. Peeters et al. (2015) note that the method gained prominence in the late 1980s as a spatial analytical approach. Spatial autocorrelation simply means a spatial statistics tool that is used to measure feature locations and attribute values using the Global Moran's I calculation. The tool assesses whether the pattern of a specific feature (in this case illegal dumpsites) manifests in a clustered, random or dispersed way (Tomlin, 1990). Spatial autocorrelation equally allows us to identify the strengths of associations or relationships among realisations of a variable (attribute) between

spatial features such as illegal dumpsites (Scott and Janikas, 2009). The tool integrates the geographical location of the features and the spatial relationship between the features directly. Furthermore, in some studies, spatial autocorrelation may be useful in testing a hypothesis about spatial relationships. Peeters et al. (2015:141) reiterate that the goal of the spatial autocorrelation tool is to analyse the spatial data and determine whether the features within the dataset are spatially dependent or independent. The authors maintain that if features within a dataset are spatially dependent, the features closer to each other tend to be more similar than features located farther apart; they often form clusters.

Three main values are derived from the calculation: the Global Moran's Index (Global Moran's I) value, the z-score and the p-value. These values indicate the statistical significance of the results. The z-score and the p-value will also indicate whether you can reject the null hypothesis. The null hypothesis states that the value associated with the features are spatially uncorrelated, and thus randomly distributed. According to Wheeler and Páez (2009:468), spatial randomness indicates that the values are randomly distributed among the features in a dataset, reflecting random spatial processes at work. The Global Moran's I value will indicate whether the pattern leans towards a clustered distribution (positive value) or whether it leans towards a dispersed distribution (negative value). The math for the Global Moran's I statistic requires some variation in the specific attributes being analysed (Wheeler, 2007). In other words, the input field that is intended to be analysed needs to contain a variety of values, i.e., input values cannot all be 1. The specific math equation for Global Moran's I is shown in Figure 4.

The Moran's  $I$  statistic for spatial autocorrelation is given as:

$$I = \frac{n \sum_{i=1}^n \sum_{j=1}^n w_{i,j} z_i z_j}{S_0 \sum_{i=1}^n z_i^2} \quad (1)$$

where  $z_i$  is the deviation of an attribute for feature  $i$  from its mean ( $x_i - \bar{X}$ ),  $w_{i,j}$  is the spatial weight between feature  $i$  and  $j$ ,  $n$  is equal to the total number of features, and  $S_0$  is the aggregate of all the spatial weights:

$$S_0 = \sum_{i=1}^n \sum_{j=1}^n w_{i,j} \quad (2)$$

The  $z_I$ -score for the statistic is computed as:

$$z_I = \frac{I - E[I]}{\sqrt{V[I]}} \quad (3)$$

where:

$$E[I] = -1/(n - 1) \quad (4)$$

$$V[I] = E[I^2] - E[I]^2 \quad (5)$$

Figure 4: Mathematic equation of the Global Moran's  $I$  statistic. Source: ESRI ArcGIS Pro.

The Global Moran's  $I$  statistic tool calculates the average and the variance for the attribute being evaluated. Then for each feature value, it subtracts the average value, creating a deviation from the mean (Baron and Aldstadt, 2002). The deviation values for all the neighbouring features are then multiplied together to create a cross-product. The numerator for the Global Moran's  $I$  statistic includes these summed cross products. For instance, if features A and B are neighbours, and the average for all feature values is 10. Table 1 shows the wide variety of possible cross-product results from a hypothetical scenario.

Feature values		Deviation		Cross-product
A= 50	B= 40	40	30	1200
A= 8	B= 6	-2	-4	8
A= 20	B= 2	10	-8	-80

*Table 1: Cross-products derived from hypothetical Global Moran's I statistic calculation*

When values for neighbouring features are either both larger than the average (mean) or both smaller than the average, the cross-product will be positive. When one value is smaller than the average and the other is larger than the average, the cross-product will be negative. With the Global Moran's I statistic, the larger the deviation from the mean, the larger the cross-product result. With regards to the spatial distribution of features within a dataset, if the values cluster spatially (high values cluster near other high values; low values cluster near other low values), the Global Moran's Index will be positive (Baron and Aldstadt, 2002). When high values are sparsely distributed from other high values and tend to be closer to low values, the index will be negative. Therefore, by accounting for both the difference in attribute values between features as well as for spatial location and relationships, the Global Moran's I statistic models the spatial variability by quantifying the statistical significance of the recognised patterns and evaluates the degree of clustering of observed spatial patterns (Levine, 1996).

Wheeler and Páez (2009:468) conclude that spatial autocorrelation is essentially an inferential statistics procedure in which the results are always interpreted within the context of its null hypothesis. Within the context of spatial autocorrelation, the null hypothesis refers to a scenario in which the attribute values being calculated are randomly distributed within the study area. This also reveals that there is a random chance of spatial processes within the dataset or features being analysed. It is equivalent to picking up a bunch of features and throwing them down on a surface, letting them land where they may. This is what a random distribution or the null hypothesis is. For this tool to be of any significance, more than 30 features are required in the dataset being analysed.

#### *3.7.4. Data management*

Forman and Damschroder (2007:44) state it is essential to create a labelling system for the data

before starting the data collection process. Qualitative data is inherently more complex, and it comes in many different forms such as interviews, observations and recordings. Therefore, the information needs to be categorised and classified to make data analysis seamless and efficient. In this respect, all the interview recordings were labelled with the participants' ID. The ID was comprised of the time, date and an assigned number from 1-25 given to every participant (e.g., 12:15\_11th\_N6).

All copies of the recordings were backed up on an external memory device. As per the transcription process of content analysis, all the recordings were transcribed verbatim so that the recordings appeared as the written text. Devices such as exclamation marks were also noted to show indications of emotions. After the transcription process was completed, all the transcript documents were compared to the audio recording, and any gaps that were left during the transcription process were added. This process ensured that transcripts were as accurate as possible. Also, additional comments noted during the interview process were also added to the transcripts. Finally, no personal information was captured in keeping with research ethics (Forman and Damschroder, 2007).

### 3.7.5. *Content analysis*

Qualitative content analysis was used to analyse the interview data collected from residents in Mbekweni. Qualitative content analysis refers to a qualitative method of analysing information in which the text is examined (Downe-Wamboldt, 1992). Morgan (1993, cited in Forman and Damschroder, 2007:40) notes that qualitative content analysis deals with placing data into specific categories which have been partly developed from data based on reported observations and experiences in the field (Vaismoradi, Turunen and Bondas, 2013). It varies from other types of analysis such as discourse analysis in that content analysis examines the text of the interview data or information as opposed to analysing how language is used, like in discourse analysis (Duriau, Reger and Pfarrer, 2007). Qualitative content analysis also differs from other analysis techniques based on the fact that qualitative content analysis is atheoretical (not concerned with a theoretical basis) while other methods involve a theoretical perspective such as grounded theory and narrative analysis (Forman and Damschroder, 2007). Qualitative content analysis was used to examine the data collected in the field based on open-ended questions aimed at capturing the detail and depth of perceptions of illegal dumping in Mbekweni. The qualitative content analysis was carried out in three phases, namely immersion

phase, reduction phase and interpretation phase.

The immersion phase consisted of making notes of comments, first impressions and initial thoughts based on the interview data. Through this, it was possible to develop new topics, general statements and get a sense of the whole. The transcripts were read multiple times, and early hunches were noted. This was a helpful phase as it assisted in fine-tuning the initial categories that were developed. It also helped with retaining ideas, as the transcripts were read multiple times.

The reduction phase, in essence, entails reducing the raw data to its simplest and most necessary form. In this phase, the idea was to categorise the data into themes and categories that spoke to specific aspects of the research questions and topic of this study. To do this, codes were developed, and these codes were based on themes identified in the data. The relevant data or text was separated into various codes such as 'children and waste' or 'illegal dumping vs unemployment'. The reorganisation of the data helped facilitate interpretation in further phases. This was the most crucial phase of the content analysis as it allowed for the research to take shape and substance.

The last stage of the qualitative content analysis was the interpretation phase. This phase constituted coming up with preliminary conclusions based on specific themes. The categories developed in the previous step were synthesised and analysed to draw up results. Likewise, the descriptive and interpretive themes were organised in a way that facilitates a logical explanation of the results as they pertain to the research questions.

While qualitative content analysis was used for analysing qualitative data, quantitative content analysis was used to analyse the closed-ended interview questions. Quantitative content analysis was especially suited for this study as it allowed for the extraction of quantitative data about questions around accessibility, temporality and annoyances of illegal dumpsites as perceived by residents. This was incredibly valuable input data in ArcMap as it provided an aspect of PGIS, thereby making the study iterative. Allen and Frisby (2017:3) contend that one of the significant strengths of content analysis is that it can be used for data of a qualitative and quantitative nature.

### 3.8. *Conclusion*

This chapter focused on the research methodology utilised in this study. An outline and explanation of the various methods and tools used in the research was provided. The chapter also looked at the methods used to analyse the data and provided the rationale for the selection of those specific methods. The following chapter provides the research data collected during the data-collection process. An analysis of the data is provided as well.





## **Chapter 4: Research Results and Analysis**

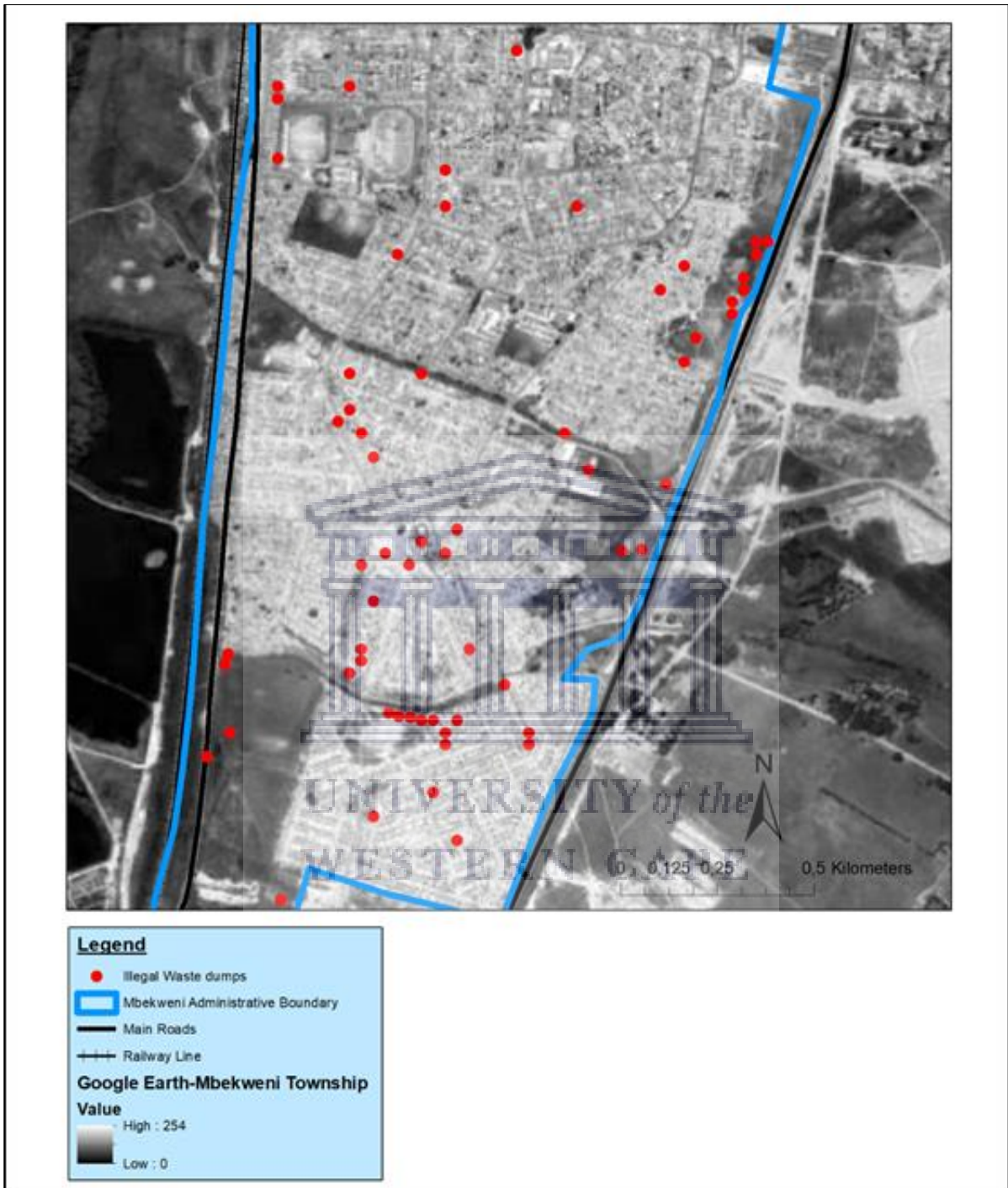
### ***4.1. Introduction***

This chapter focuses on the research results obtained from the data-collection process. It explores the different GIS analyses that were produced from the data obtained from illegal dumpsites in Mbekweni. This section examines the analysis of various spatial characteristics associated with illegal dumpsites such as their proximity to waste facilities and river streams, the areas with the highest density of dumpsites and the waste composition types related to the dumpsites. The potential impacts of illegal dumping are illustrated through the use of photographs and additional maps. Maps were created to represent and visualise the various spatial characteristics of dumpsites in Mbekweni.

In relation to GIS, the chapter also explores various spatial associations amongst illegal dumpsites by looking at the spatial autocorrelation of attributes associated with illegal dumpsites. The last two sections of this chapter focus on the results from the data obtained from residents in Mbekweni. The first section focuses on the questionnaire results based on residents' perceptions of illegal dumping, such as the temporality and perceived frequency of dumping and other experiences. Lastly, the chapter concludes with a review of various perceptions and aspects of illegal dumping such as the perceived reasons for dumping, perceptions of the municipality and general attitudes towards waste management issues in Mbekweni.

### ***4.2. GIS map visualisation***

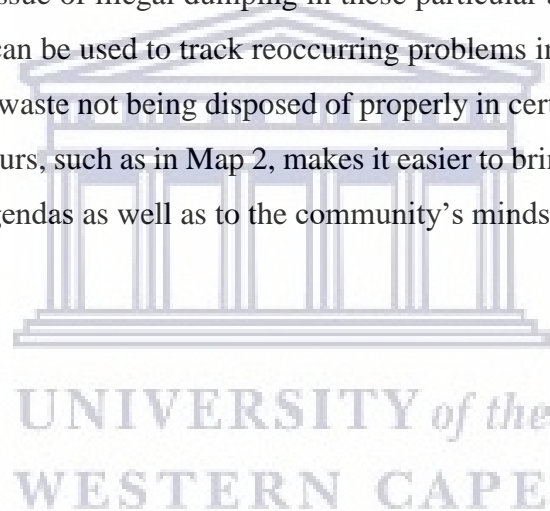
In this section, the GIS data that was collected through the TrashOut and the GPS Fields Area Measure applications are analysed. Maps were created using the ArcMap 10.6 GIS software to illustrate and represent various spatial data related to illegal dumpsites in Mbekweni. Also included is a section on spatial analysis and the use of specific spatial analysis methods to draw inferences from the data relating to the distribution of illegal dumpsites and the reasons for their distribution. Additionally, other types of data such as photographs and graphs were used to illustrate and corroborate the GIS data and maps that were produced.

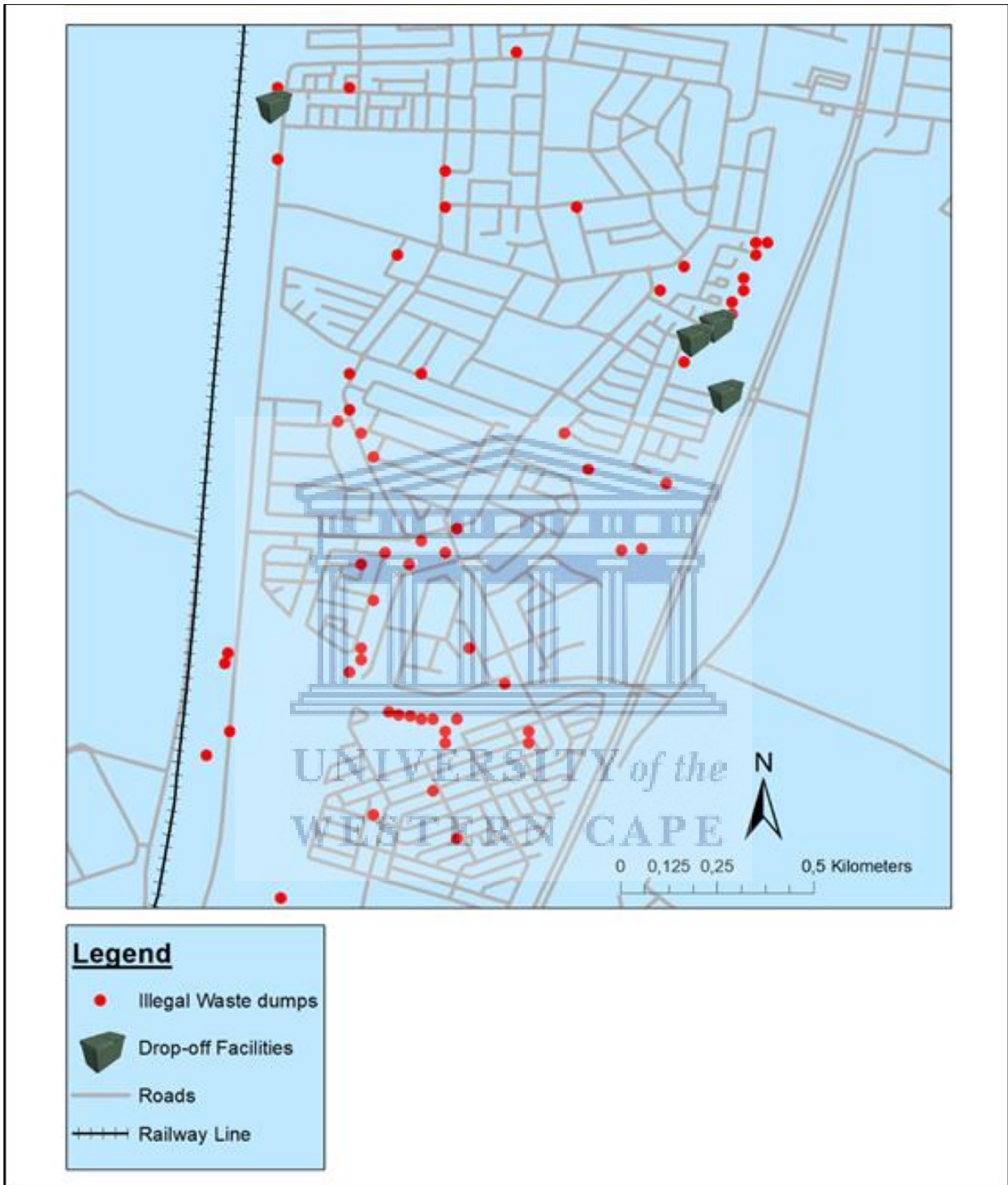


Map 2: Location map of illegal dumpsites in Mbekweni

#### 4.2.1. Location map

Map 2 represents all the illegal dumpsites in Mbekweni Township. This map is meant to serve as a visual and graphical representation of a real-world phenomenon such as illegal dumping. A total of 62 dumpsites were recorded and are represented in Map 2. The locations of the illegal dumpsites are represented by the red dots. A greyscale colour scheme was used to reduce the background noise and enhance the visibility of the illegal dumpsite points (the high-low value in the legend serves no purpose). A map such as this serves two purposes. The first is to illustrate the spatial extent of illegal dumping in Mbekweni, and the second is to show the distribution of illegal dumpsites. Map 2 also helps to illustrate the visible environmental changes taking place in Mbekweni; as can be seen on Map 2, some areas have more illegal dumpsites than other regions. Furthermore, there is a clustering of illegal dumpsites in certain parts, representing a real issue of illegal dumping in these particular areas over others. Map 2 is also useful as this data can be used to track reoccurring problems in certain areas. It can aid in analysing the causes of waste not being disposed of properly in certain areas. Mapping sites where illegal dumping occurs, such as in Map 2, makes it easier to bring illegal dumping to the forefront of authorities' agendas as well as to the community's minds.





Map 3: Illegal dumpsites in relation to formal waste facilities

#### 4.2.2. Illegal dumpsites in relation to disposal facilities

Map 3 represents the illegal dumpsites in Mbekweni in relation to the formal waste facilities. During the mapping process, a total of four drop-off facilities were identified throughout Mbekweni. Map 3 provides a good visual representation of the spatiality of waste facilities in Mbekweni and how they relate to illegal dumpsites. Three of the mini drop-off facilities on the eastern extent of Mbekweni were built recently. A skip was located on the western extent of Mbekweni opposite the railway line. This skip was being used for household waste disposal by the residents of the OR Thambo Informal Settlement. It was interesting to see that the three mini drop-off facilities were all near each other. Municipality officials indicated that the mini drop-off facilities were built in that specific area of Mbekweni to combat a serious issue of illegal dumping. From the spatial distribution of illegal dumpsites in relation to the drop-off facilities and the waste skip, it is clear that there is an obvious need for additional waste facilities in Mbekweni. As such, linking this to the interviews conducted during the study, an issue brought up by several residents was that the newly built mini drop-off facilities were situated too far from their homes and only served and benefited people residing in the immediate surroundings of the drop-off facilities.

As Map 3 shows, several illegal dumpsites were situated in close proximity to the drop-off facilities, in some cases even directly outside of the drop-off facilities. This is noteworthy, especially considering that the drop-off facilities were specifically built in those locations to curb illegal dumping. It therefore appears as if the drop-off facilities have not been as effective as expected in mitigating illegal dumping in those immediate areas. It appeared as if waste was frequently being dumped outside of the drop-off facility as opposed to inside. These dumps had eventually expanded into large waste dumps. Figure 5 and 6 below provide an example of the situation found at two different drop-off facilities. These facilities were located adjacent to each other. In Figure 5 and 6, the large amount of waste being dumped outside of the facilities is visible, despite a clear sign on the drop-off facilities indicating where to drop off the waste. This dumping defeats the purpose of the mini drop-off facilities, degrades the surrounding areas and distorts the public perception of what drop-off facilities are used for. Once it becomes a common practice to dump waste outside and around the facilities, it becomes a norm and a whole new issue (usually an ugly one) is created. If a community individual starts dropping waste outside the facility, the next person may come and view it as permissible to dispose of their waste in a similar fashion. If left unchecked over time, the common practice becomes



dropping the waste outside because it is widely viewed as permissible. (See also Appendix E.)



Figure 5: Mini drop-off facility 1

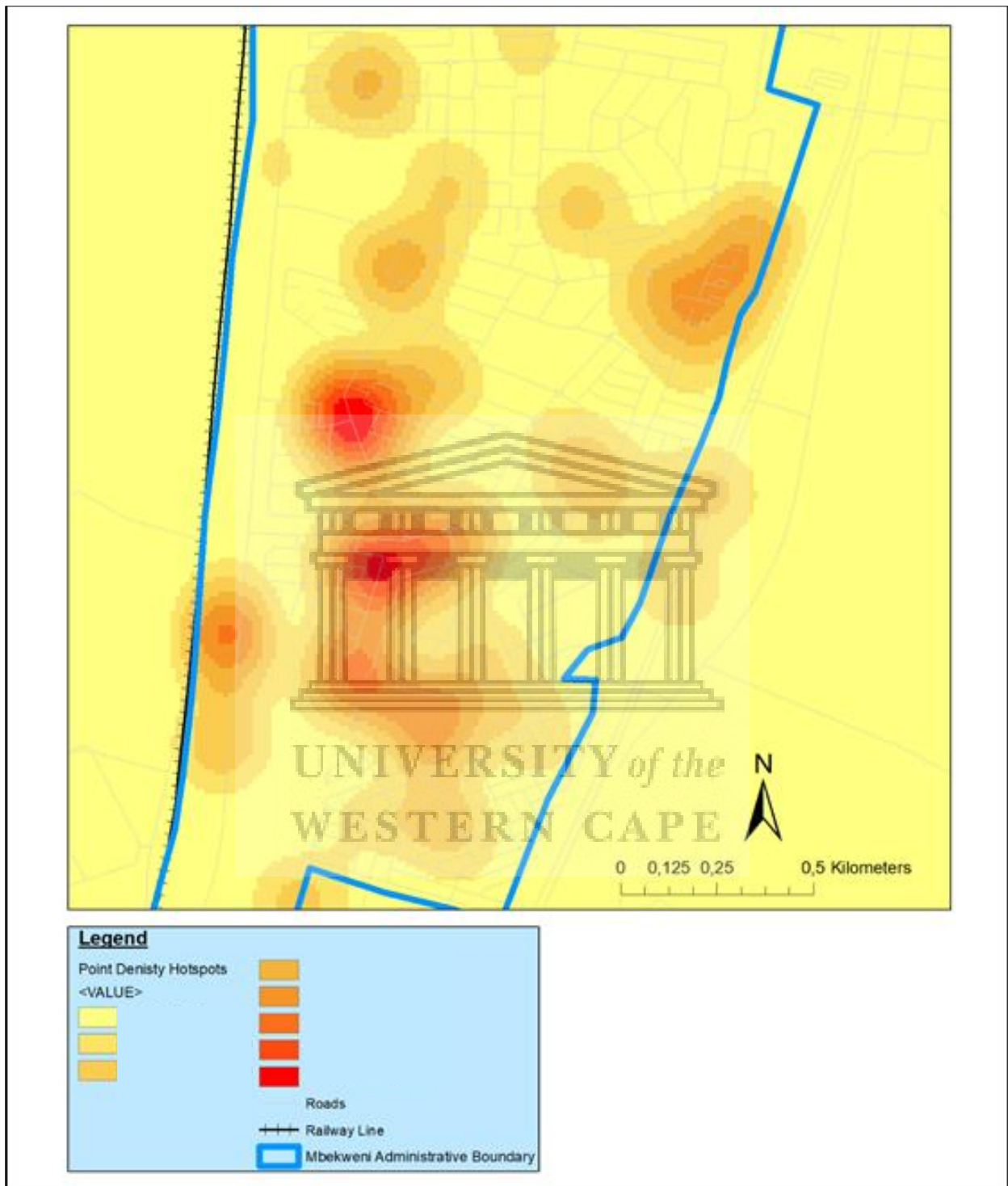
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*Figure 6: Mini drop-off facility 2*





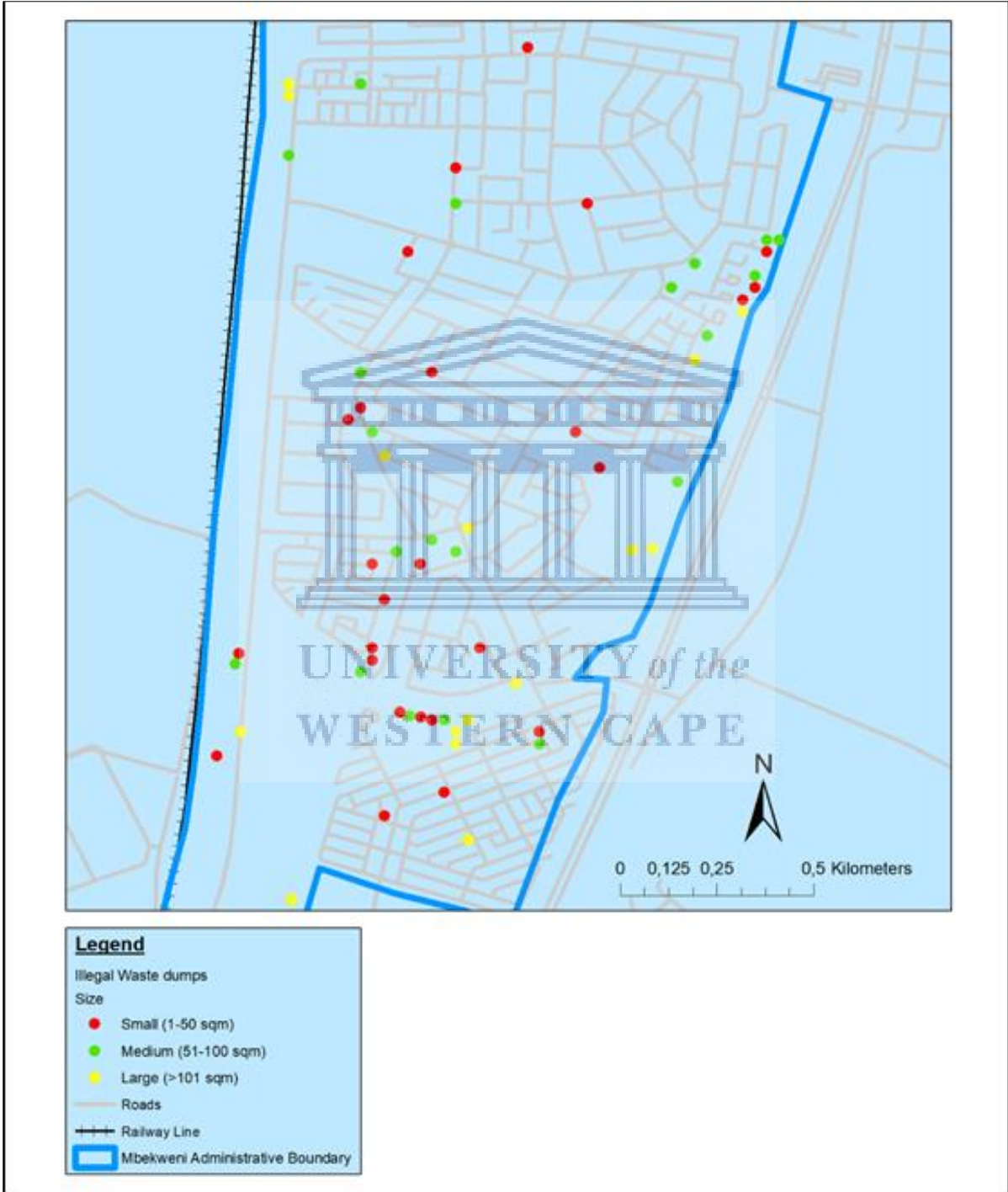


Map 4: Hotspot analysis- Heat map of illegal dumpsites

#### 4.2.3. Heat map of illegal dumpsites

Map 4 represents a heat map of illegal dumpsites in Mbekweni Township. The point density tool in ArcMap was used to create this heat map. The tool essentially calculated the amount per unit area from point features (illegal dumpsite points) within a neighbourhood. In this particular case, the sum values of the illegal dumpsite points within the study area were divided by the study area size to get each cell's density value. Map 4 thus represents the varying cell density value of illegal dumpsites in Mbekweni. A heat map takes the values of location or point data and represents these values in a two-dimensional format. The values are additionally represented in colour which provides a visual analysis of the extent of an issue or theme. Point data such as the coordinate data is analysed to show an estimated surface showing the density of the point data occurrences – in this case, the occurrences of illegal dumpsites. The red-yellow colour gradient indicates areas of increasingly higher illegal dumpsite density. Map 4 is closely related to Map 2, and they are useful when identifying problem areas that need more attention in terms of service delivery or regular clean-ups.

Map 4 may also help in understanding the behaviour of residents in Mbekweni with regards to illegal dumping and whether there is a particular tendency to dump waste in a specific area based on the density of illegal dumpsites in that specific area. Where you might see a high density of illegal dumpsites in Figure 1, that same data is represented in Map 4 using colour as a visual tool. Map 4 also helps to answer questions related to where illegal dumping occurs in Mbekweni and how the dumpsites are distributed spatially. On Map 4, the colour is darkest in the areas where the highest density and occurrence of illegal dumpsites are located. Meanwhile, the lighter the colour gradient, the lower the density of illegal dumpsites in that particular area. It is important to note that heat maps are surface interpolation maps, and they are therefore not always statistically accurate and are a visual representation of data as opposed to a statistically significant representation. Such a visual representation can still be useful, however. Therefore, Map 4 is used to visualise the intensity of the spatial occurrence of illegal dumpsites in Mbekweni.



Map 5: Size categories of illegal dumpsites

#### 4.2.4. Size categories of illegal dumpsites

Map 5 represents the three different size categories of illegal dumpsites in Mbekweni. The size of all 62 illegal dumpsites were recorded in square metres and placed into various size categories. The categories are: small (1 m<sup>2</sup>-50 m<sup>2</sup>), medium (51 m<sup>2</sup>-100 m<sup>2</sup>) and large (> 101 m<sup>2</sup>). The size categories were created to show the different sizes of illegal dumpsites within Mbekweni. Different colour symbology was also used to distinguish between the different types (i.e., red = small, green = medium and yellow = large). All 62 dumpsites represented in Map 5 covered a total area of 6 639 m<sup>2</sup> or 1.64 acres. The majority of illegal dumpsites recorded fell within the 'small' category. Also, the two largest illegal dumpsites in Mbekweni were recorded at 1 165 m<sup>2</sup> and 626 m<sup>2</sup> respectively. Coincidentally, these dumpsites were located next to each other and had essentially morphed into informal communal waste disposal sites. These two large dumpsites were not so much viewed as illegal dumpsites as informal drop-off sites which were being used by residents in the vicinity as an alternative form or site for waste disposal. This is probably also because one of these dumpsites was situated near a skip.

The varying sizes of illegal dumpsites provide a clue into the problem areas in Mbekweni, and the size of the illegal dumpsite typically indicates the extent of illegal dumping and how much of it is occurring. The biggest dumpsites likewise show evidence of a reoccurring problem and thus need urgent attention. At the same time, the medium-sized dumpsites very much have the potential to grow into large-sized dumpsites if left unchecked and untreated. In this sense, the largest dumpsites in Mbekweni pose the highest risk to the environment, health and general well-being of community members. Map 5 identifies the locations of the biggest illegal dumpsites. It would probably make sense to focus on these areas first before they grow even bigger.

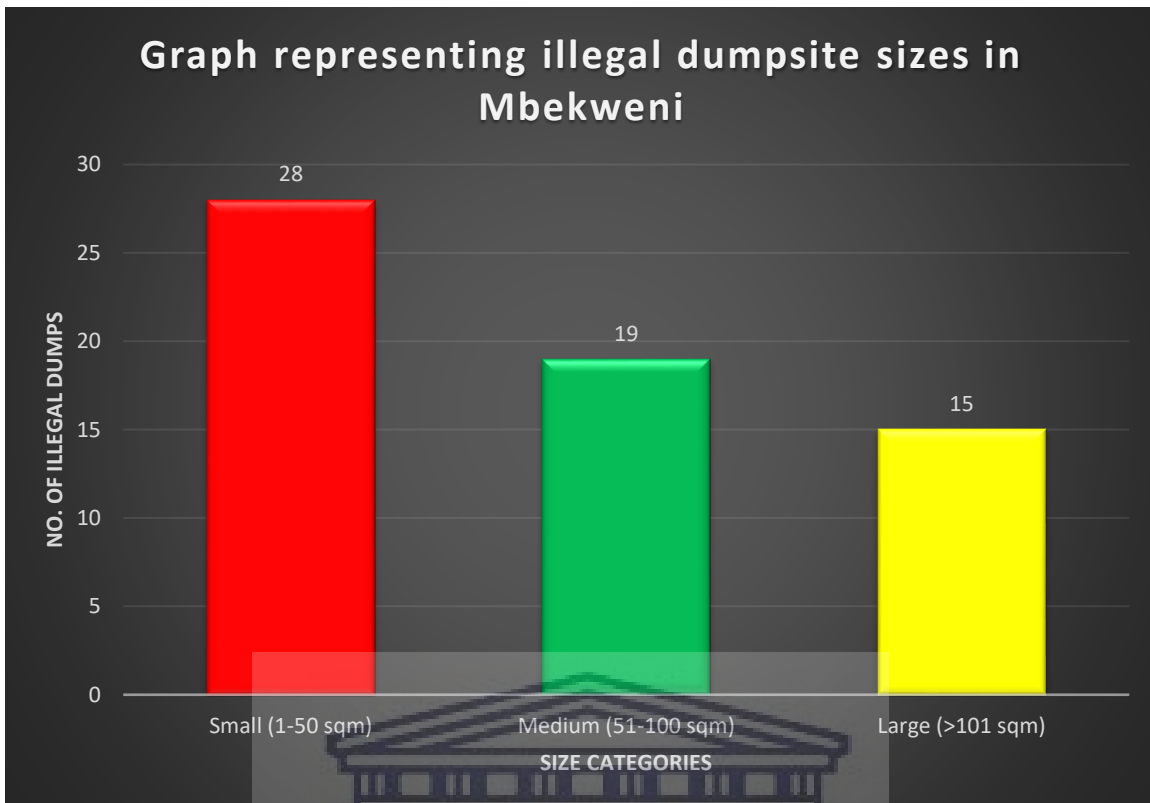


Figure 7: Size categories of illegal dumpsites

The empirical data based on Map 5 is summarised in Figure 7 above. As previously pointed out, the majority of the illegal dumpsites recorded were categorised as small (28, or 45%). This was followed by medium-sized and large-sized dumpsites at 19 and 15 respectively. Importantly, though, 15 (24%) of the illegal dumpsites were equal to or bigger than 101 m<sup>2</sup>, which is quite large.

To provide a bit of context to their sheer size, 100 m<sup>2</sup> is equivalent to approximately a quarter acre, or, in other words, it is bigger than most of the house plot sizes in Mbekweni. A total of 15 illegal dumpsites were therefore bigger than most house plots. As highlighted previously, these 15 large illegal dumpsites had essentially become informal waste disposal sites in the sense that their sheer size and area coverage indicated that dumping waste on these dumpsites had become a common and reoccurring practice or incidence. These were also the illegal dumpsites that were serviced or cleaned the most, due to the health hazard they posed (See Appendix D for before and after pics). In some cases, however, large illegal dumpsites had remained uncleaned and had accumulated waste over a long period, probably due to their presence not being known by the authorities. These illegal dumpsites also posed the greatest health and environmental risk because, based on the opinions of most respondents living in



proximity to them, they were not cleared regularly. Figure 8 and Figure 9 provide a visual scale of some of the larger illegal dumpsites.



*Figure 8: Illegal communal dumpsite 1*



*Figure 9: Illegal communal dumpsite 2*

The two images above represent the largest recorded illegal dumpsites in Mbekweni. The dumpsite in Figure 8 was measured at 1 150 m<sup>2</sup>, while the dumpsite in Figure 9 was measured at 626 m<sup>2</sup>. From these images, you can get an idea of the sheer scale of some of the biggest illegal dumpsites in Mbekweni. These particular dumpsites were situated adjacent to each other and were located just outside the Mbekweni railway station. Furthermore, across the street from these dumpsites is an informal settlement, the OR Thambo Informal Settlement, which represents the informal section of Mbekweni (see Figure 10). The two dumpsites were distinguishable from each other as there was a clear boundary between the two dumpsites. It appeared as if there was a clear delineation of the two sites.

This whole area is in fact the Metrorail railway reserve land, which also falls under the control of Eskom. Some of these informal dwellings are visible in Figure 8. In these particular images, a juxtaposed scene is created by the vast amounts of waste situated adjacent to the railway station and the OR Thambo Informal Settlement dwellings creeping up in the background. In Figure 9, we can see a type of formal waste disposal facility known as a skip. The skip was placed here to provide the OR Thambo Informal Settlement residents with a household waste disposal point. However, it appeared as if the whole area has become a waste drop-off site. It is quite possible that at one point the skip was being used for its intended purpose by the community, but, over time, the entire area became a site for waste disposal as people started to

dump their waste next to the skip instead of dumping it inside the skip. This could have been as a result of the lack of service delivery and lack of resources reported by the community members in this part of Mbekweni. Succinctly, this entire area has been transformed into a massive communal dumping site. It is also important to note that these two illegal dumpsites are some of the most serviced in Mbekweni, mainly due to their size and scale. Ironically, it could be for this exact reason that this area has turned into what it is today. People might notice that the area gets cleaned regularly and might therefore misinterpret it as consent for continually dumping their household waste there.





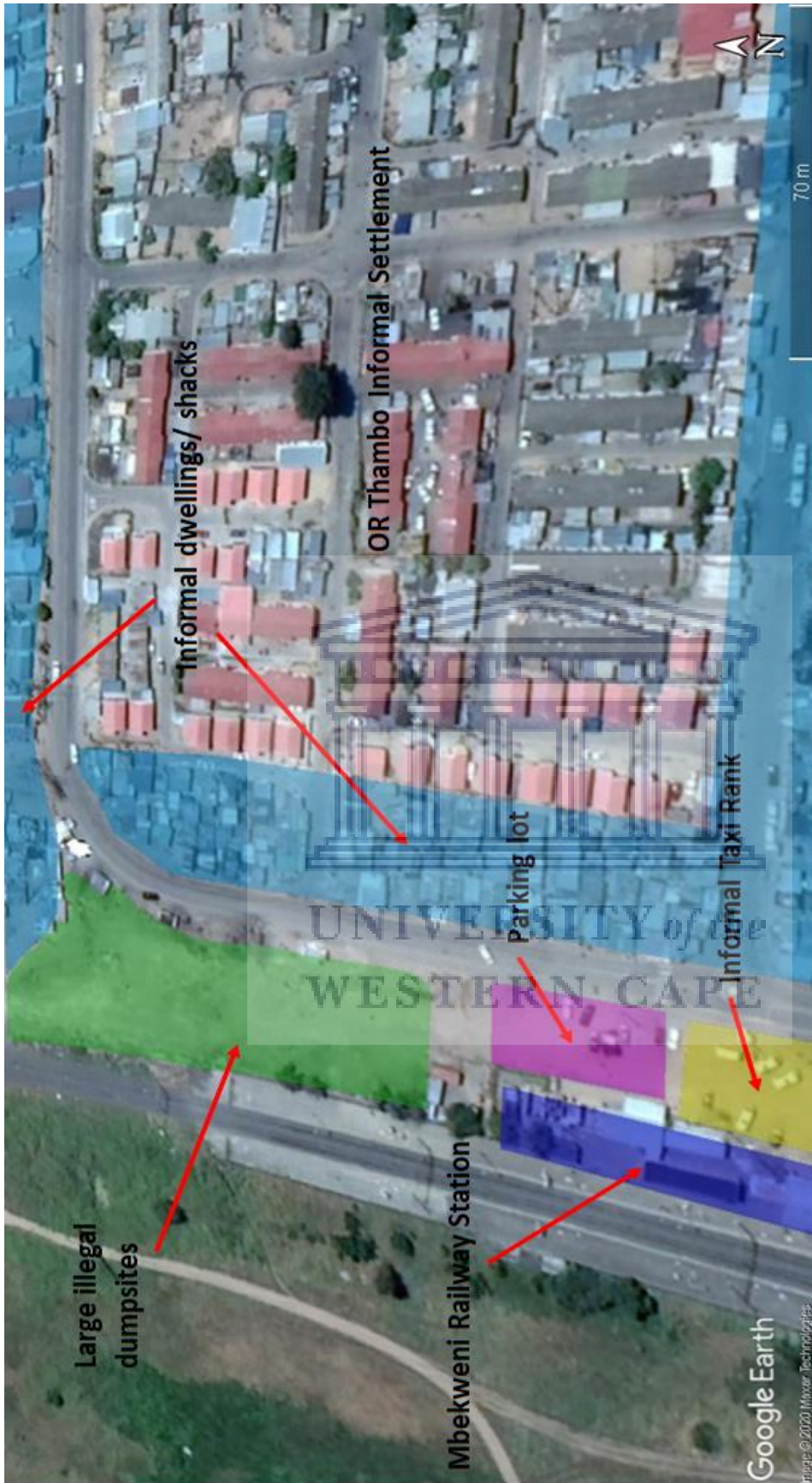
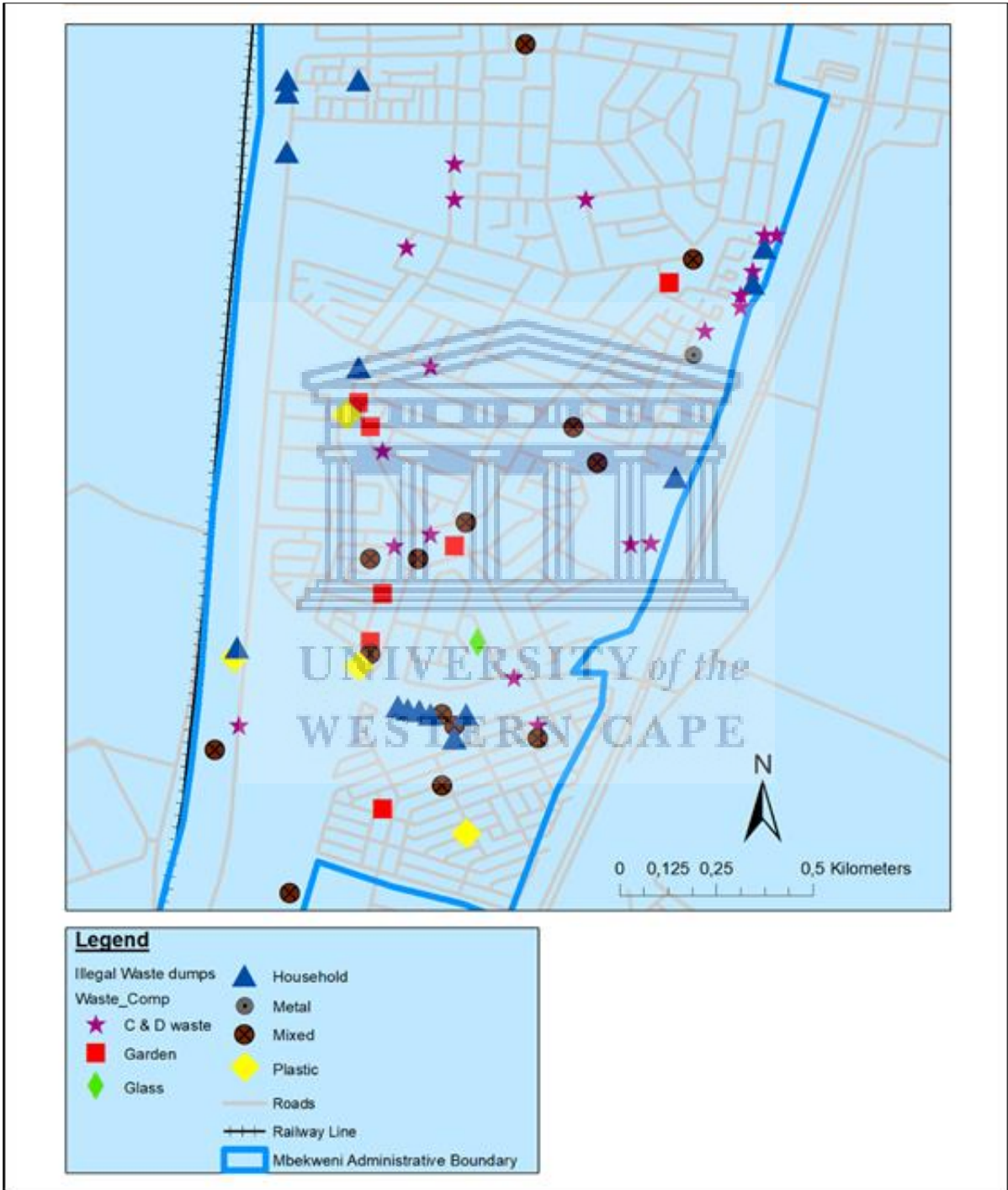


Figure 10: Communal dumpsites in relation to the surroundings



Map 6: Waste composition of illegal dumpsites

#### 4.2.5. Waste composition

Map 6 represents the waste composition of illegal dumpsites surveyed in Mbekweni. The waste composition of the dumpsites was based on identifying the most visible and prominent type of waste found at each illegal dumpsite. In some cases, the waste type was so diverse that the illegal dumpsite was classified as having a mixed-waste composition. From Map 6, it is evident that there was a wide variety of waste compositions of illegal dumps. A total of 7 waste composition types were identified, all of which are presented in Figure 8. Waste composition analysis is essential because certain kinds of waste can possibly be linked with specific problem areas. This may also help to inform the type of intervention measures that are needed in certain areas, based on the most dominant kind of waste being dumped. This could likewise be useful in cases where a specific type of waste is being illegally dumped due to a lack of knowledge on how to dispose that waste type properly but also a lack of facilities to do so. For instance, residents in general expressed their lack of knowledge of how to deal with C&D waste. The fact that a large number of illegal dumpsites were indeed composed predominantly of C&D waste speaks to a specific issue of C&D waste disposal in Mbekweni.

The waste composition numbers from Map 6 are summarised in Figure 11. The chart shows that C&D waste, household waste and mixed waste were the most common types of waste at 32%, 24% and 23% respectively, while the least common types were glass and metal. It is quite peculiar and unexpected that C&D waste was amongst the most common waste types. This could be attributed to the constantly changing nature of infrastructure in Mbekweni from which large amounts of C&D waste are being generated. From the interview process, it was learned that residents who were either building extensions onto their houses, building new homes or shifting from shacks to formal housing would often illegally dump the residual C&D waste as there were no other disposal alternatives available.

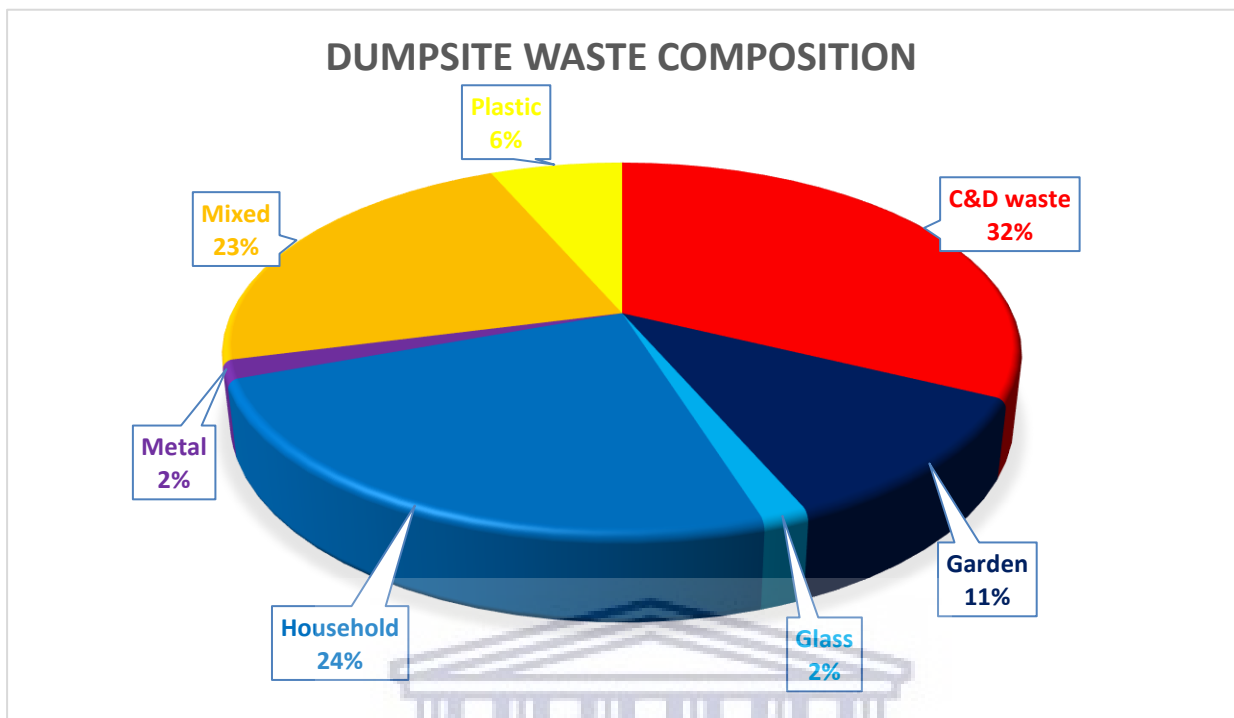
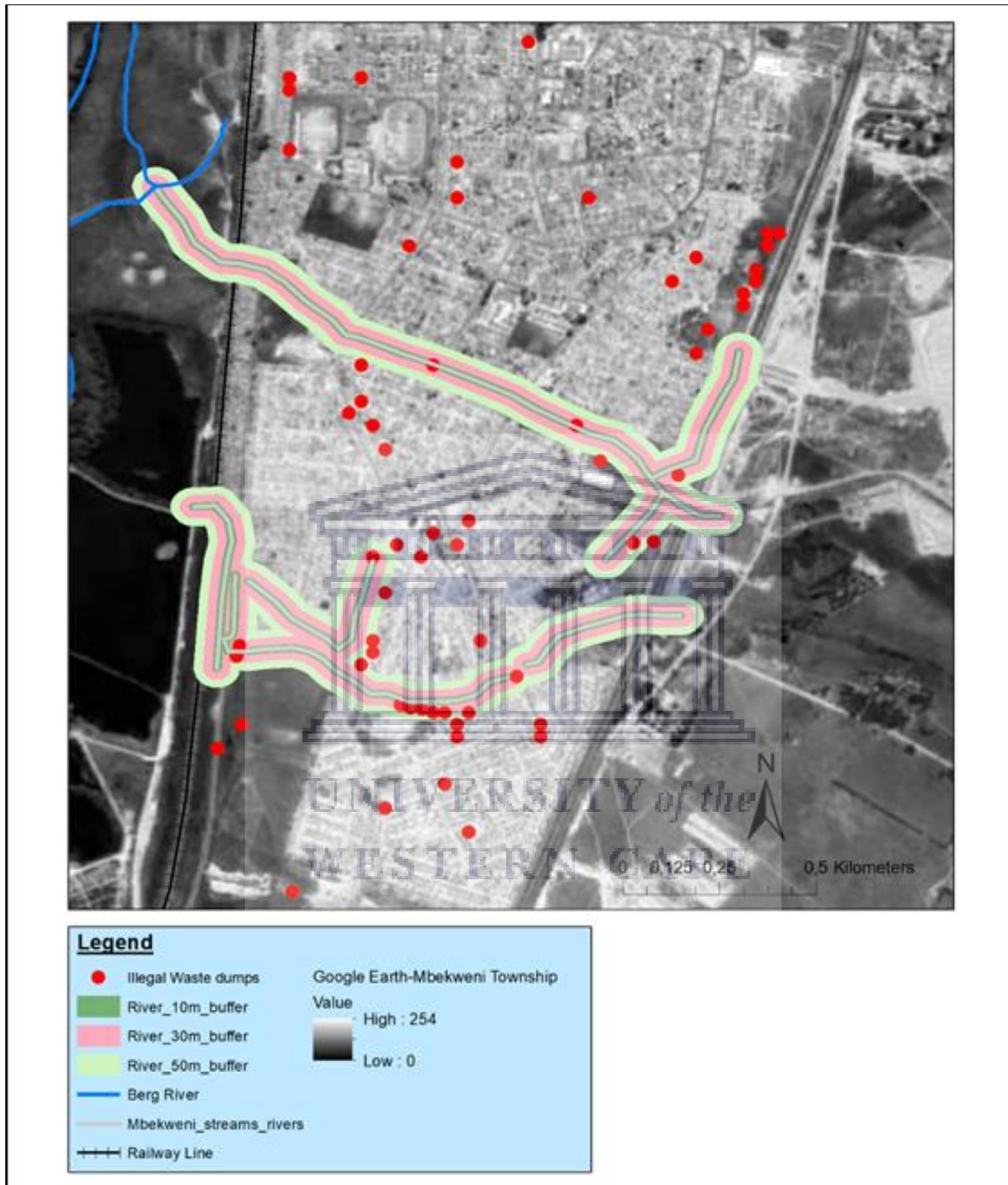


Figure 11: Pie chart showing the various dumpsite waste compositions

Furthermore, residents pointed out that in order to dispose of C&D waste, they were required to transport it to the landfill site in Wellington and pay an additional gate fee. It could thus be deduced that monetary incentives play a big part in the prevalence of C&D dumps. Typically, household waste was one of the most common waste types since the disposal of household waste is a general issue in Mbekweni. Additionally, illegal dumps that were composed of household waste in most cases consisted mainly of black bags or plastic bags with household waste in them. This was usually an indication either that household waste was not being collected or of excess household waste. This is also based on the fact that some residents admitted to putting excess waste in a plastic bag and disposing of it at an illegal dumpsite. Particularly at large illegal dumps, household waste such as old food and other organic waste was found. Specifically with regards to disposable nappies which were an issue, Mbiba (2014) points out that they are a problematic waste type that has recently emerged in Zimbabwean cities. These types of illegal dumpsites created unsanitary conditions and posed a real health hazard and odour as well as annoyance to any surrounding areas.





Map 7: Proximity of illegal dumpsites to river streams

#### 4.2.6. Riverine waste

Map 7 represents a proximity buffer analysis of illegal dumpsites from waterways in

Mbekweni. The purpose of Map 7 is to show the illegal dumpsites and their proximity to streams and waterways in Mbekweni. Three different distance buffers were used to represent the distance from the streams and watercourses in Mbekweni. The buffers were measured at 10 m, 30 m, and 50 m from the streams; therefore, the map represents illegal dumpsites that are situated within a certain distance from the watercourses and streams. These distances were chosen in order to best visualise graphically the various distances from streams that illegal dumpsites may occur. In other words 10 m was chosen as the smallest possible distance that could still be visualised on the map, and 50 m was chosen as the furthest possible hypothetical distance from the streams that illegal dumpsites may occur. 30 m was chosen as an intermediate distance, to show and visualise the different levels of distance from streams in Mbekweni. For this particular type of analysis, only watercourses and streams located within Mbekweni were focused on. All the water systems are, however, connected (see Figure 12). This provides an indication of the potential environmental effects that these illegal dumpsites might have on the wetland and the environment as a whole. Map 7 shows that illegal dumpsites represent a clear environmental risk due to their proximity to streams.

Illegal dumpsites that are situated within the 10-metre buffer present the most significant threat. In some cases, some of the illegal dumpsites were located in the actual streams, therefore posing a direct and immediate environmental risk due to the potential point source pollution that may enter the stream. These illegal dumpsites become a bigger problem in winter months when the area receives the majority of its annual rainfall. As the flood line of these streams increases, so does the potential for illegal dumpsites located within the 50-metre buffer of any watercourse to get washed up onto the river streams, therefore becoming a point source pollutant. The environmental effects of illegal dumping are often hard to picture or comprehend. Map 7 is useful in this regard as it illustrates the direct impact that illegal dumpsites could have at varying distances on aquatic biodiversity. The environmental impact of illegal dumping is thus brought to the forefront.





Figure 12: Fluvial system in Mbekweni.

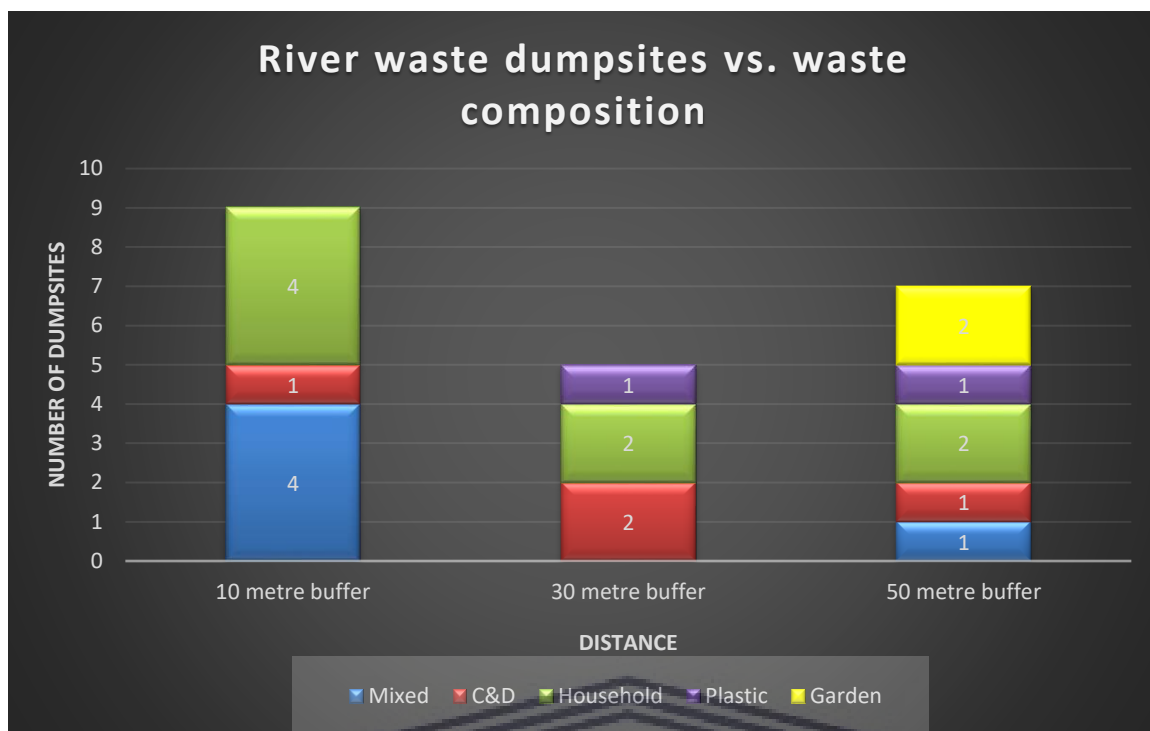


Figure 13: Waste composition of dumpsites found near streams

The waste compositions of illegal dumpsites located at the various distance buffers are summarised in Figure 13. In other words, the graph shows the waste composition of the different illegal dumpsites that were located at different proximity buffers from any stream or watercourse in Mbekweni. The chart also shows the number of illegal dumpsites located at various distance buffers from the streams. The majority of illegal dumpsites located close to streams were located within the 10-metre buffer. A total of 9, 5, and 7 illegal dumpsites were situated within the 10-metre, 30-metre and 50-metre proximity buffers respectively. Based on the waste composition, household waste was the most prominent waste type found in illegal dumpsites located within the various proximity buffers. This was followed by mixed waste and builders' rubble. In all, a total of 21 illegal dumpsites were located close to streams and watercourses in Mbekweni. This is 36% of all illegal dumpsites recorded in Mbekweni.

Figure 13 also illustrates the relationship between illegal dumping and streams in Mbekweni, and the potential environmental impact it may cause. Showing the different waste compositions provides an indication of the possible types of waste that are being dumped near streams and at what distances from the streams. This information might help inform authorities on the types of mitigation measures they can employ or could help them determine where hot spots presenting the most significant environmental risk from illegal dumping are located. The

authorities may not be aware of the presence of these dumpsites situated in river streams as they are at times well-hidden due to the tall vegetation and slope of the landscape, which would require somebody to stand on the bank of the stream in order to notice them.



*Figure 14: Dumpsite alongside a river bank*

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*Figure 15: Dumpsite situated in stream water*



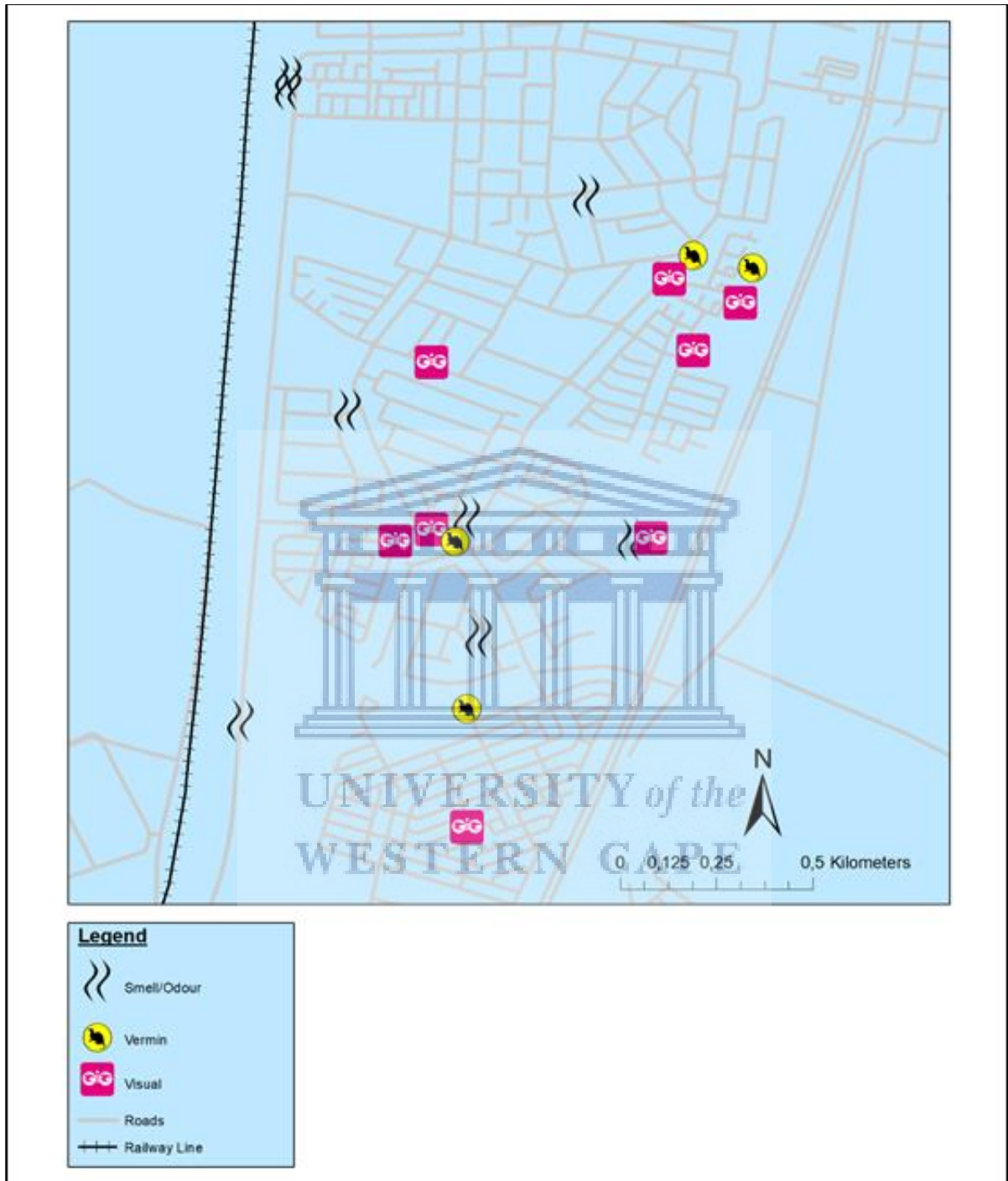
*Figure 16: Waste spilling over into stream*



*Figure 17: Another dumpsite alongside a river bank*

The images above provide useful visual representations of the illegal dumping issue in Mbekweni, especially with regards to waterways and streams. The waste is clearly evident in all four photos, and almost appears juxtaposed with the natural vegetation and river streams. In Figure 14 in particular, there is a large amount of mixed waste situated alongside the bank of the watercourse. There is also bulky waste such as old couches and a bit of C&D waste visible. In Figure 15, household waste (evident from the black plastic bags) has spilled over into the stream, and, in Figures 15 and 16, the waste is spread all over the stream, thus indicating that it may have been carried into the stream by a water run-off. In Figure 16, several old tyres are located in the middle of the stream. Most of these streams are perennial, and water only really starts to flow during the rainy season when there is an abundance of run-off. However, when it is not cleaned up, especially during the rest of the year, the waste remains in the stagnant water of the river banks and streams, slowly contaminating the water and creating particularly unsanitary and undesirable conditions which may attract vermin and pests associated with such situations. Contaminants from this waste could potentially leach into the soil and aquatic vegetation as well as running off into the stream and eventually ending up further down the fluvial course, therefore further polluting the water, agricultural fields and food chains.





Map 8: Annoyances related to illegal dumpsites



#### 4.2.7. *Annoyances emanating from illegal dumps*

Map 8 represents the annoyances that were recorded by the residents at 20 different illegal dumpsites in Mbekweni. The 20 illegal dumpsites represent the largest illegal dumpsites within their respective categories, i.e., 10 large dumpsites, 6 medium dumpsites and 4 small dumpsites. The data presented was captured from participants who resided in proximity (approximately 20 m-30 m) to the 20 illegal dumpsites. This was done in an attempt to capture qualitative data such as annoyances experienced and perceived by residents and represent this data in a quantitative format such as GIS maps, making this, in essence, a form of participatory and qualitative GIS application.

Three main annoyances were identified by the residents: visual annoyance, vermin or pests and smell or odour. Map 8 therefore represents the types of problems that residents/participants identified from their experiences of illegal dumpsites located near their homes. Map 8 illustrates this data by showing which annoyances were related to which illegal dumpsites. The most common nuisance identified by residents was smell or odour, which means that the smells and odours emanating from the illegal dumpsites affected these residents the most. Likewise, smell/odour was the most common annoyance linked to large-sized illegal dumpsites.

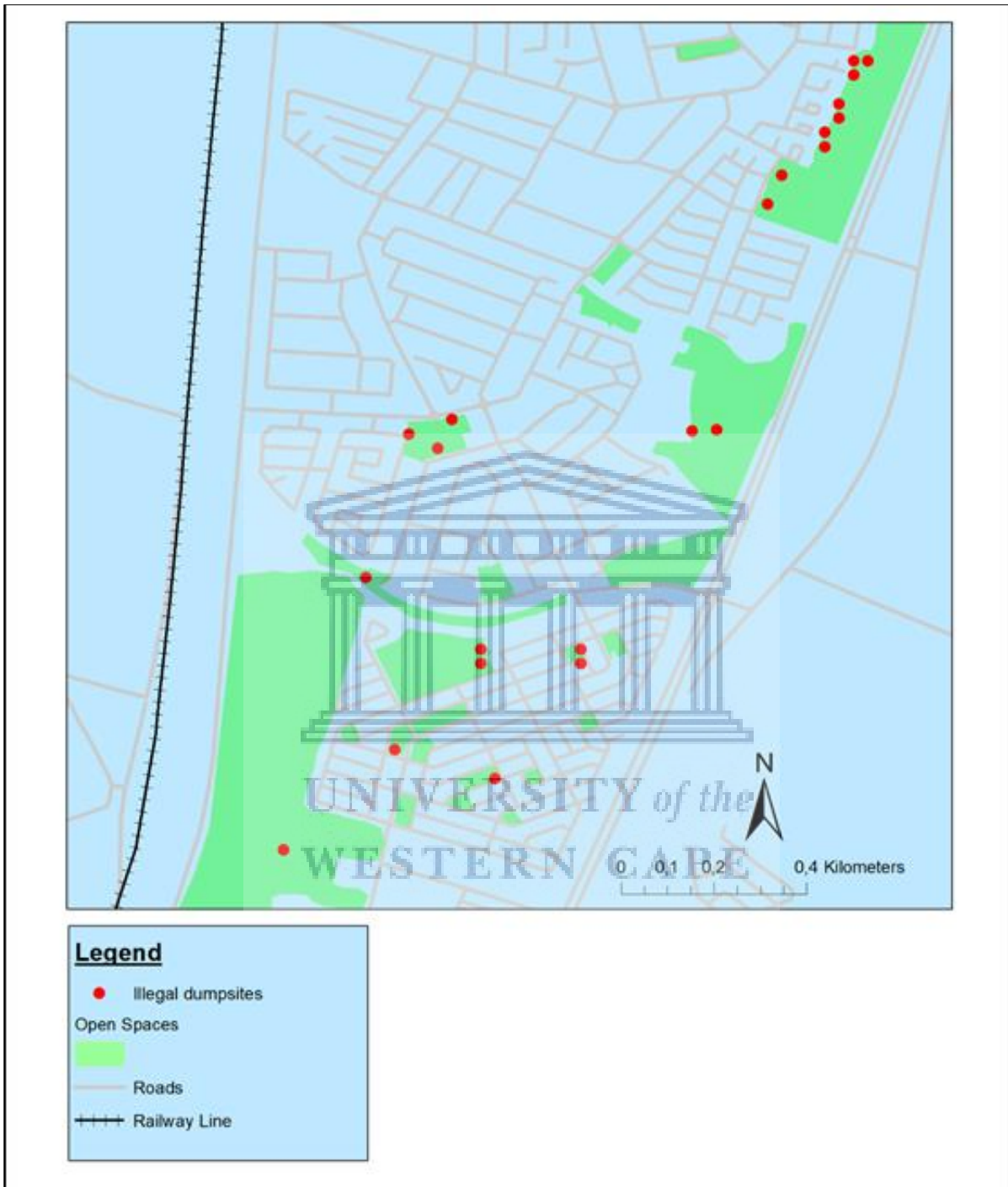
The visual impact of illegal dumpsites was also a commonly reported annoyance. This explicitly related to the visual effects that illegal dumpsites had on the residents in terms of a dirty and degraded landscape. In addition, the visual impact of illegal dumpsites also affected the residents' perception of their community and its cleanliness. Relating to this was the discovery during the interview process that most residents reported seeing or perceiving Mbekweni as a generally dirty place. This implies that the visual impact of illegal dumpsites certainly plays a negative role towards residents having negative perceptions of the environment and community spaces.

In the case of vermin or pests being reported as an annoyance, the residents reported seeing or even being affected directly by vermin and pests that emanate from illegal dumpsites near their homes. Additionally, residents reported that illegal dumpsites were massive breeding grounds for mosquitoes, especially during the summer months when it is hot. This was a particular concern as such situations can easily lead to diseases that

could be spread, particularly to children, who were the most vulnerable as many of them often interacted with illegal dumpsites, such as when playing outside.



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Map 9: Illegal dumpsites in relation to open unused spaces

#### *4.2.8. Illegal dumping and open spaces*

An interesting inference that can be drawn from the distribution of illegal dumpsites in Mbekweni is how many of these dumpsites were situated on open communal spaces that community members interact with on a daily basis. Map 9 represents the highlighted open (communal) areas in Mbekweni in relation to the locations of illegal dumpsites. A total of 22 illegal dumpsites were identified that were located on open communal spaces and large areas on the periphery of Mbekweni. The purpose of this analysis is also to illustrate the role that open spaces play in illegal dumping and to show that they are often targeted as sites for illicit waste disposal. In most cases, these open public spaces are easily accessible and often uncared for due to lack of 'ownership' by the residents. When open communal spaces are uncared for and there is lack of a sense of general ownership of this space amongst the residents, the spaces become susceptible to illegal waste disposal. Likewise, when these spaces are also easily accessible via roads and pathways, it makes it easier for perpetrators to access these spaces via foot or vehicle to illegally dump waste. The large open spaces are of particular importance because there is often tall and thick vegetation that makes it easier for waste disposal sites to remain hidden and undetectable.

This type of analysis brings to the fore the concept of environmental design and opportunity reduction. Through the environmental design of open spaces (such as creating flowerbeds and vegetable gardens), the opportunity for illegal waste disposal can be reduced. It is clear from Map 9 that open communal spaces that are left unused provide an opportunity for illegal waste disposal due to an absence of perceived ownership of these spaces. Meanwhile, creating new land uses for these spaces could assist in preventing illegal dumping in Mbekweni, particularly in the open spaces on the periphery of Mbekweni that remain largely unused and are especially susceptible to illegal waste disposal because they appear uncared for.

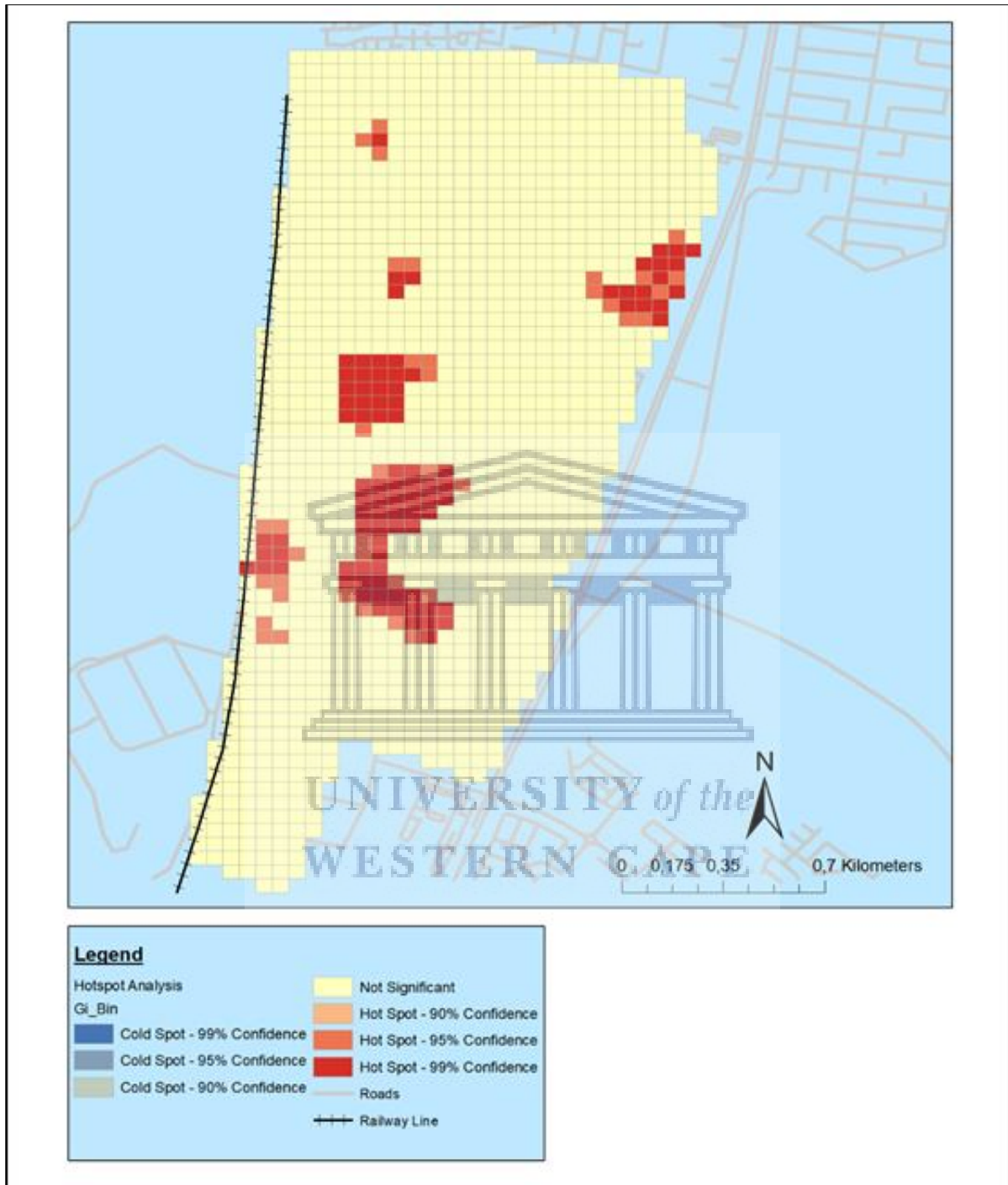
### *4.3. Spatial statistics analysis*

#### *4.3.1. Optimised Hot Spot Analysis*

The Optimised Hot Spot Analysis tool was used to visualise the clustering of illegal dumpsites. The tool is commonly used in rainfall and epidemic modelling (Peeters et al., 2015). The Optimised Hot Spot Analysis (Getis-Ord  $G_i^*$ ) tool strictly calculates the Getis-Ord  $G_i^*$  statistic. The Optimised Hot Spot Analysis tool can be used to determine where there are

numerous incidents (illegal dumps) happening or incident intensity. For this analysis, only incident data was used. Incident data are points representing events, occurrence or objects; the focus is on the presence and absence of the feature points rather than a specific attribute associated with each point. The data was first processed to make it usable within a hot spot analysis. Part of the process was aggregating the incident data to create an attribute value (number of points that fall within an aggregating polygon). A fishnet tool was employed to create weighted features from incident counts. The Fishnet tool is a method of incident point aggregation which creates a polygon grid over the point features (illegal dumpsites). A spatial join was carried out within the tool which counted the number of events (illegal dumpsites) falling within each grid polygon. The Hot spot Analysis is most useful when there are at least 30 features within the dataset. The resulting map is presented on the next page.





Map 10: Hot spots of illegal dumpsites- Getis-Ord GI\*



#### 4.3.2. Illegal dumpsites hot spot map

In Map 10, the polygons are colour coded according to their statistical significance. The map also represents different ranges of confidence. The yellow colour-coded polygons represent areas that are not statistically significant and correlate with a low z-score where there was no clustering of illegal dumpsites. In other words, there was a random distribution of illegal dumpsites and the area did not qualify as distinctly different from the random hypothesis. Conversely, the dark red colour-coded polygons represent areas that had a 90-99% statistical confidence significance, representing a clustered distribution of illegal dumpsites. These areas deviate the most from the random distribution scenario. The Mbekweni administrative boundary polygon was used as the bounding polygon, which means the analysis was only carried out within the extent of Mbekweni. The red polygons also indicate a high density of illegal dumpsites near other high densities of illegal dumpsites, and there are no blue areas, thus implying the absence of apparent cold spots of illegal dumpsites within the analysis area.

#### 4.3.3. Spatial autocorrelation: Introduction

In this section, the goal was to investigate whether there is clustering happening based on specific feature classes such as the size and waste compositions of illegal dumpsites in Mbekweni. As it was deemed important to identify the presence of any clustering within the data source, spatial autocorrelation Global Moran's I analysis was utilised to achieve this.

The purpose of utilising spatial analysis tools in GIS is to identify areas with the highest clustering of illegal dumpsites so that we can target development efforts towards these areas through increased service delivery. Cluster analysis is one such way to achieve this objective in GIS. Cluster analysis within GIS means using local statistics to identify areas of clusters which are defined areas of features that are clustered together based on some common attribute. This analysis will help in defining how important spatial characteristics are in affecting a given object (illegal dumpsites) in space, and the possible relationship of objects to spatial properties. The question being addressed here is to determine which locations are clusters of illegal dumpsites in Mbekweni. The first step is to find out whether there is any clustering going on in the data; however, this is not always apparent.

4.3.4. *Spatial autocorrelation: Illegal dumpsite sizes*

The purpose of cluster analysis is to identify clusters of features (in this case, illegal dumpsites) with similar values such as area size and waste composition. The tool goes to every little point and looks at the values of all the points around it and at varying distances. The objective of the Global Moran's I spatial autocorrelation analysis was therefore to identify how different the distribution of illegal dumpsites was from the null hypothesis of a random distribution, based on similar values (attributes) such as the sizes of the illegal dumpsites. Furthermore, the objective was also to identify whether there was a spatial relationship between the distribution of illegal dumpsites and a specific attribute such as size. Since this tool only accepts feature classes (attributes) that have numerical values, a numerical code was developed for the various size categories of illegal dumpsites, namely small = 1, medium = 2 and large = 3. The analysis was carried out on the spatial distribution of dumpsites in relation to the specific size categories. The following results, shown in Figure 18, were produced.

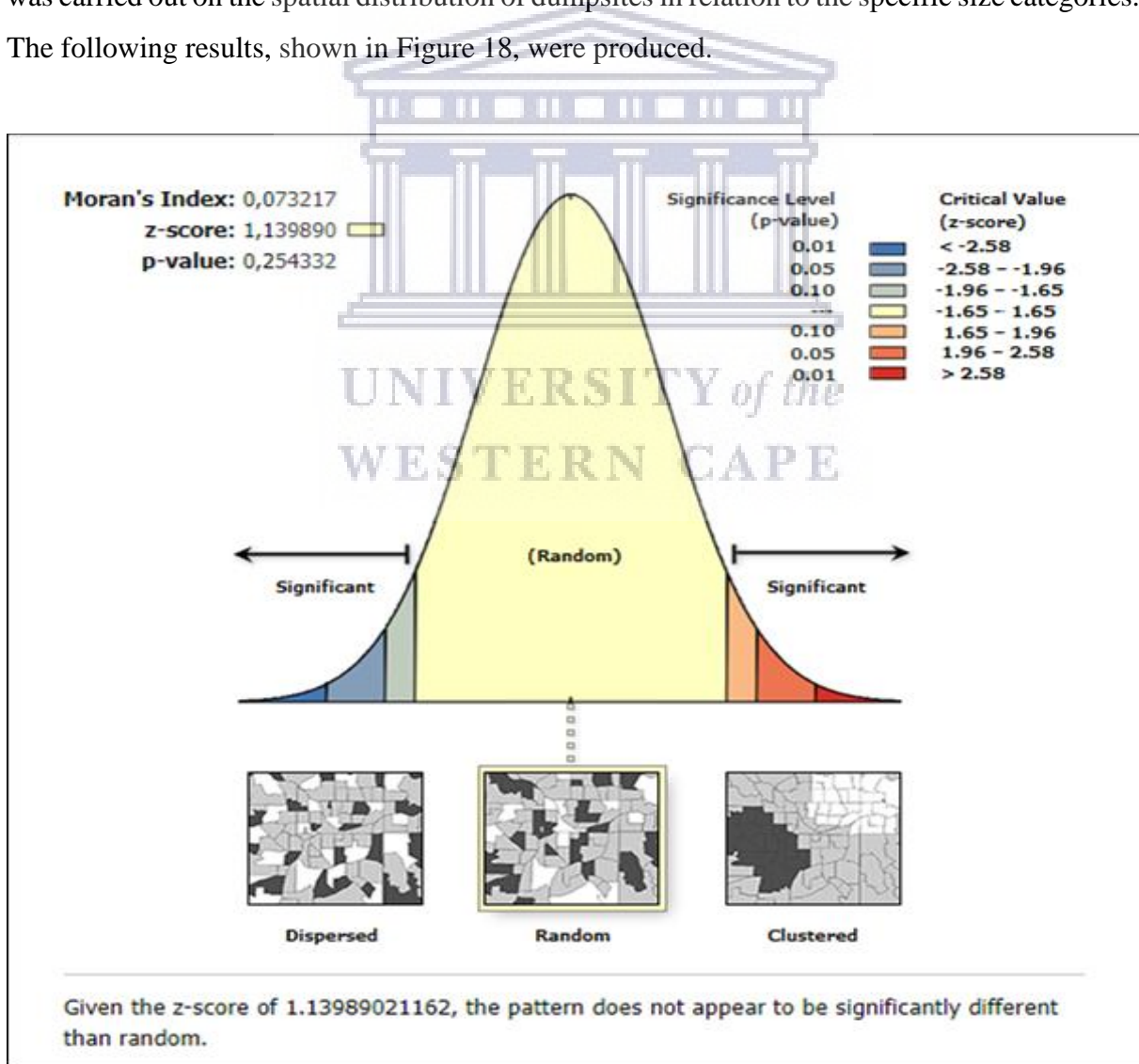


Figure 18: Spatial autocorrelation result of illegal dumpsites and size

Figure 18 shows that there is a random distribution of illegal dumpsites in Mbekweni, based on their size category. Simply put, there is no correlation between the spatial distribution of illegal dumpsites and their different size categories. The spatial autocorrelation Global Moran's I calculated the data as correlating with the null hypothesis. The low z-score value also shows that the distribution of illegal dumpsites and their different size categories was not statistically different from the random scenario. Essentially, the attribute being analysed (size) is randomly distributed among the illegal dumpsite features in Mbekweni, and thus the distribution of illegal dumpsites is the result of random spatial processes. This analysis is crucial because it shows that the sizes of the illegal dumpsites were randomly distributed, meaning the size of the illegal dumpsites did not determine how they were spatially distributed. A clustered distribution of illegal dumpsites based on their size categories would have indicated that some areas were more likely to have many small-sized dumpsites over other areas that would have many medium-sized dumpsites and large-sized dumpsites. Large illegal dumpsites already indicate sites of reoccurring issues, and if there was a particular clustering of large dumpsites it would certainly have indicated an excessive dumping of waste in some areas over other. The low correlation between dumpsite distribution and their sizes, however, indicates that dumpsites of varying sizes are in existence all over Mbekweni and in a completely random pattern. A summary of the results is presented below in Figure 19.

<b>Moran's Index:</b>	0,073217
<b>Expected Index:</b>	-0,016393
<b>Variance:</b>	0,006180
<b>z-score:</b>	1,139890
<b>p-value:</b>	0,254332

Figure 19: Tabular summary of spatial autocorrelation results

Figure 19 shows the results that were derived from the analysis of the Global Moran's I statistical analysis of illegal dumpsites and their specific size categories. The low Global Moran's I, z-score and p-value indicate a negative correlation amongst illegal dumpsites with similar waste types. A negative correlation like this one indicates that very different results (size categories) were found near each other. A similar result was illustrated in Figure 18 whereby the spatial distribution of illegal-dumpsite size categories fell within the random

scenario (null hypothesis).

#### 4.3.5. Spatial autocorrelation: Waste composition

Next, the goal was to investigate whether there was a clustering of illegal dumpsites with similar waste compositions. As previously, the spatial autocorrelation analysis was carried out. In this instance, the waste composition of illegal dumpsites was the feature class of focus. The objective was to identify a possible relationship between the distributions of illegal dumpsites with regards to their waste composition types. Similar to the previous analysis, a numerical code from 1 to 7 was developed to represent the seven different waste composition types, i.e., mixed = 1, glass = 2, C&D = 3, garden = 4, plastic = 5, household = 6 and metal = 7. The analysis was carried out on the spatial distribution of dumpsites with regards to the waste composition types. The results of this analysis are presented in Figure 20 and Figure 21.

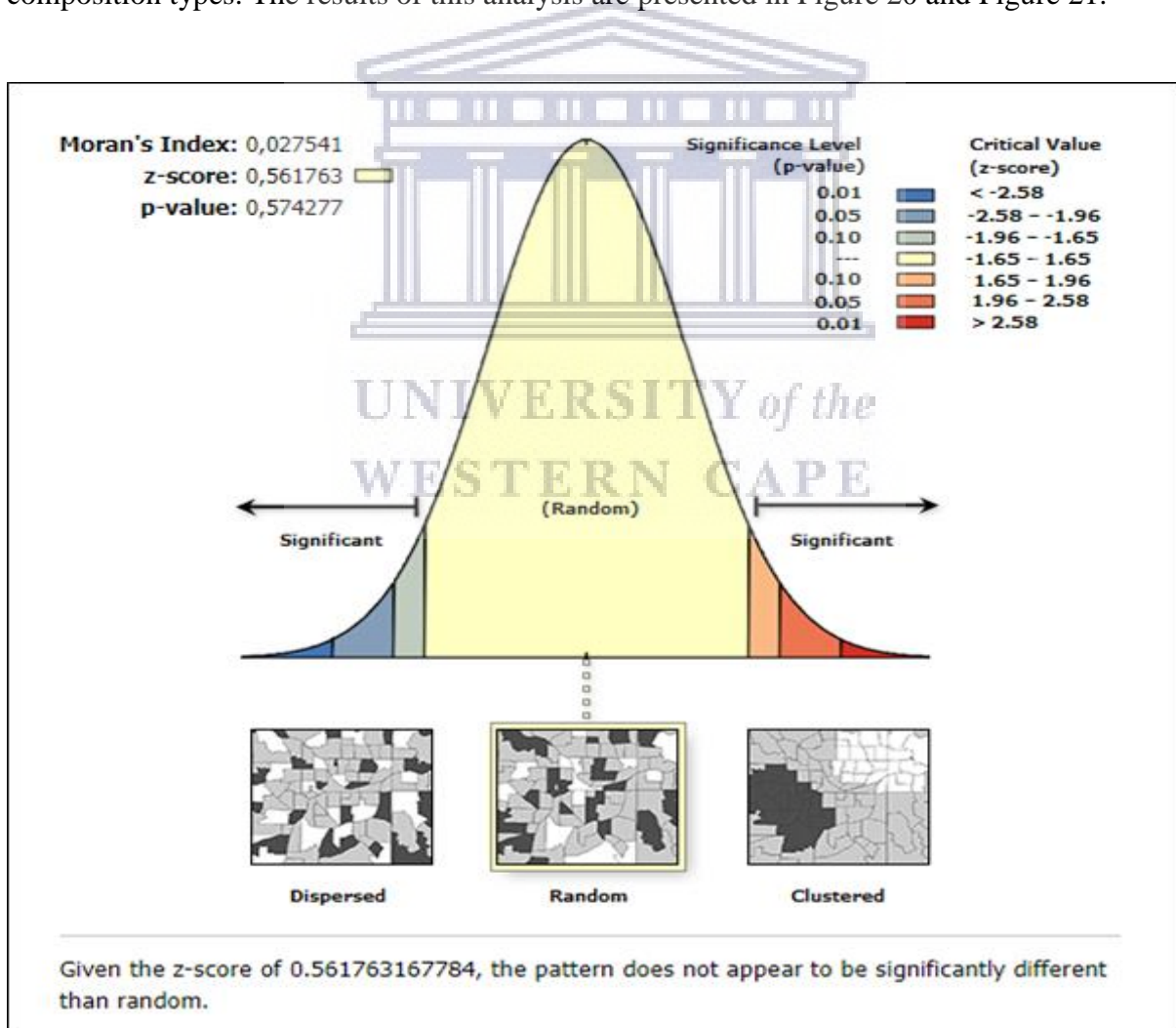


Figure 20: Spatial autocorrelation result of illegal dumpsites and waste composition

Much like the results of the illegal dumpsite sizes, Figure 20 indicates that the distribution of illegal dumpsites with regards to the different waste compositions was not statistically significant and was not different from the null hypothesis of a random distribution. Based on the z-score and the p-value, the results show a low statistical significance. The results represent random spatial processes of illegal dumpsites that have similar waste composition. Likewise, what these results indicate is that there was no apparent spatial relationship between illegal dumpsites and the type of waste composition.

Additionally, illegal dumpsites with similar waste composition types, such as C&D waste, for instance, did not have a statistically significant spatial relationship to each other and there was no apparent clustering of any one type of waste composition type amongst the illegal dumpsites. In contrast, statistically significant results would have indicated a strong spatial correlation between illegal dumpsites and the waste composition type. Furthermore, there would have been a clustering of similar waste composition types amongst illegal dumpsites, which would have suggested that specific types of waste types were being dumped at specific sites. For instance, there might have been an area where there was a particular clustering of C&D waste dumps, which would invite further investigation and scrutiny into why that particular area was specifically susceptible to C&D waste dumpsites. However, the results showed that this was not the case and that there was no spatial relation between similar waste dumpsites. A summary of the results is presented below in Figure 21.

<b>Moran's Index:</b>	0,027541
<b>Expected Index:</b>	-0,016393
<b>Variance:</b>	0,006116
<b>z-score:</b>	0,561763
<b>p-value:</b>	0,574277

Figure 21: Tabular summary of spatial autocorrelation results

Figure 21 indicates the results that were derived from the analysis of the Global Moran's I statistical analysis of illegal dumpsites and their specific waste composition types. The low Global Moran's Index, z-score and p-value indicate a negative correlation amongst illegal dumpsites with similar waste types. A negative correlation like this one indicates that very different results (waste composition types) were found near each other. A similar result



illustrated in Figure 20 also shows that the spatial distribution of illegal dumpsites waste composition types fell within the random scenario (null hypothesis).

#### 4.3.6. *Significance of the Optimised Hot Spot Analysis*

In this section, the significance of the Optimised Hot Spot Analysis results presented in the previous section is discussed. This section focuses specifically on the spatial distribution of the illegal dumpsites and the apparent clustering, and what additional information this clustering may reveal about the characteristics of the area. The figure below identifies two specific areas in Mbekweni that this analysis focused on.

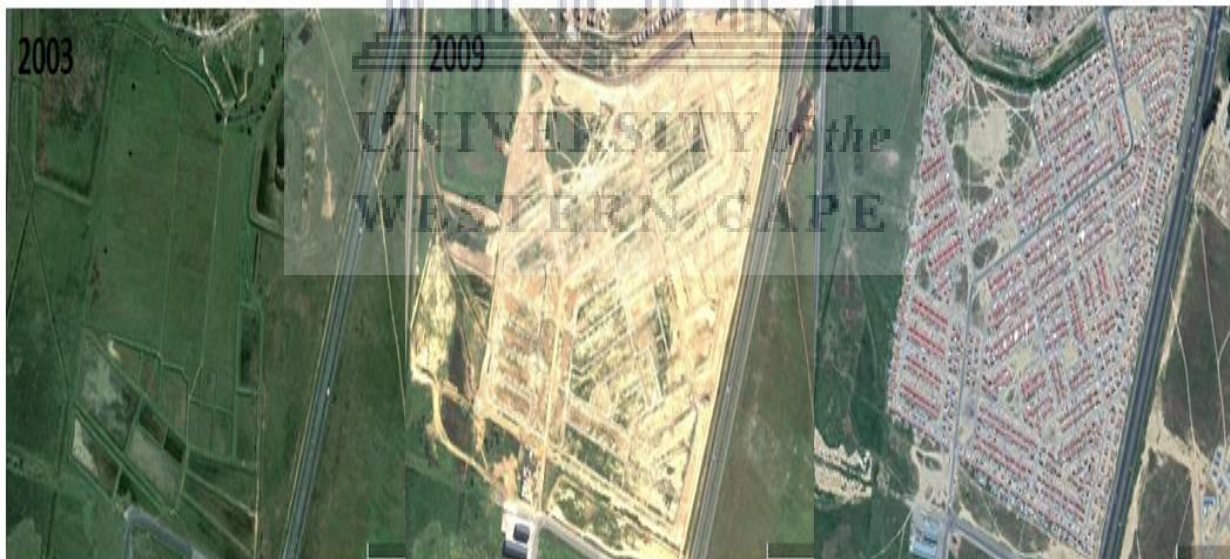


Figure 22: Areas of highest clustering of illegal dumpsites

In Figure 22, the general areas of highest clustering of illegal dumping sites have been highlighted. The Optimised Hot Spot Analysis together with the density heat map that was created made it clear that the highest clustering of illegal dumpsites was situated in two or three general areas in Mbekweni. The assumption is that areas of the highest clustered distribution or density of illegal dumpsites represent hot spots and problem areas. Furthermore, what is peculiar to these areas that has led to a particular clustered distribution and density of illegal dumpsites can be understood using the three main characteristics or factors. These factors are street pattern/configuration, presence of river streams and open peripheral spaces.

##### 4.3.6.1. *Street configuration*

The street pattern of the neighbourhood at site A is different from the general street patterns of other areas in Mbekweni. The general street pattern in Mbekweni is characterised by irregular and congested roads and have homes built very near to each other. At site A, the street pattern is more planned and regular with symmetrical spaces in between homes and well-delineated communal spaces. There is a possibility that the configuration of the street pattern allows for conditions in which illegal dumping can take place. This is because when the street patterns are more organised, it may translate to easier accessibility, especially via foot or vehicle, thus making it easy for potential perpetrators to negotiate their way through the neighbourhood to site A without any restrictions or physical barriers. As previously pointed out in Map 8, well-delineated communal spaces provide possible sites for illegal waste disposal because they usually remain unclaimed and at times uncared for. Figure 23 illustrates how part of site A consists of a neighbourhood that was built relatively recently (completed in 2013). This is especially recent considering that most of Mbekweni was established and built in the 1960s. Figure 23 shows how recently the community was built and why it is different from other areas in Mbekweni and how this difference in the neighbourhood street pattern may have led to these areas being targeted.



*Figure 23: Historical archive of community development at site A*

#### 4.3.6.2. *Proximity to streams*

One of the other reasons for the clustered distribution of illegal dumpsites, particularly at site A, is the channelled river stream in the vicinity (see Map 7). From an analysis of the distribution of illegal dumpsites in proximity to streams in Mbekweni, it was found that several dumpsites were situated in the proximity of streams. The channelled stream situated at site A was a significant contributor of illegal dumpsite sightings. Approximately eight illegal dumpsites were located in the stream, with many more situated close to the stream. The location of these dumpsites near and around the channelled stream partly contributed to the general clustered distribution and density of illegal dumpsites, particularly at site A. Streams and rivers in Mbekweni might be viewed as a good 'hiding spot' for illegal waste disposal sites due to the slope aspect of fluvial landscapes, the tall vegetation that helps conceal the existence of dumpsites and the water that may carry the waste away. Streams in Mbekweni are also very accessible since there are no physical barriers preventing people from approaching them.

#### 4.3.6.3. *Open peripheral areas*

Open land on the periphery of Mbekweni like the one found at site B is one of the most common types of locations where illegal dumpsites were found. Open land found at site B is different from the small communal spaces found at site A, for instance, in that they are a lot larger and there is usually little or no traffic in these areas since they are situated on the periphery of Mbekweni. Open public spaces in site A are often used and interacted with by the residents while site B is situated on the outskirts of Mbekweni, and the land is mostly uninhabited and not used for any function. This makes site B an ideal spot for illegal waste disposal. Such open unused land allows for perpetrators to dump their waste without fear of being caught since it is not used by community members. Open lands on the periphery are also uncared for, and whatever is done to these areas is indirectly felt by the residents within the surrounding, unlike those living in small communal spaces. In addition, annoyances emanating from the illegal waste disposal sites would have a greater direct impact on the community if they were situated on communal spaces, as opposed to land on the periphery where they are mostly out of sight and therefore out of mind. Open lands like these are thus targeted for these reasons.

#### 4.4. Questionnaire Results

The information in the following section emerged from the interviews that were conducted with the selected residents in Mbekweni. The section focuses on the results from the questionnaire section of the interviews, and therefore highlights the experiences of residents and their perceptions of illegal dumping and related issues, such as the temporality and frequency of dumping and specific effects felt from illegal dumpsites.

##### 4.4.1. Awareness of illegal dumping

Respondents were asked about their awareness of illegal dumping in Mbekweni, as well as if they had witnessed illegal dumping taking place. Table 2 below shows the results.

<b><u>Question</u></b>	<b><u>Yes</u></b>	<b><u>No</u></b>
<b>Are you aware of illegal dumping in Mbekweni?</b>	25	0
<b>Have you personally witnessed illegal dumping taking place in your community?</b>	23	2

Table 2: Awareness and witnessing of illegal dumping

Out of the 25 participants that were interviewed, all of them admitted or said yes to being aware of illegal dumping in Mbekweni. This is not particularly surprising as illegal dumping is indeed a prevalent and visible issue in Mbekweni. This question was important in establishing the participants' awareness of their surroundings and environment. Secondly, participants were asked whether they had personally seen or witnessed illegal dumping taking place, and 23 out of 25 participants replied yes. It is therefore easier to admit to a problem in the community when you actually witness it occurring.

##### 4.4.2. Temporality and frequency of illegal dumping

Respondents who acknowledged to witnessing illegal dumping taking place were then asked about the temporality and frequency of illegal dumping in Mbekweni. The results are presented in Figure 24.



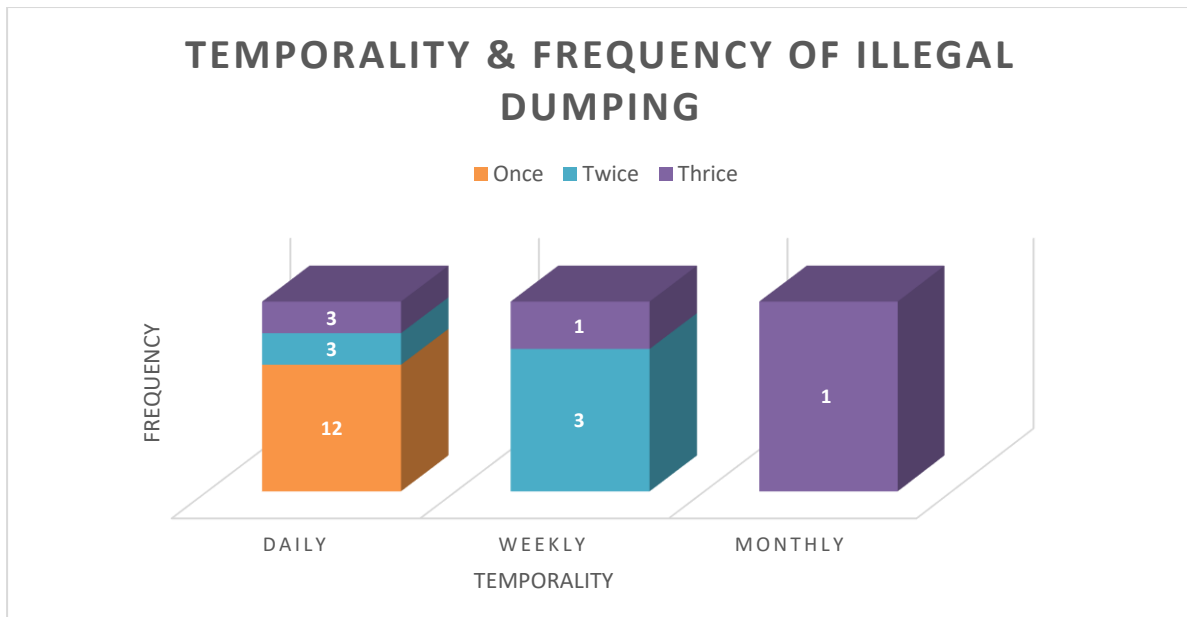


Figure 24: Temporality and frequency of illegal dumping reported by residents

Of the 23 participants who indicated that they had witnessed illegal dumping, 18 of them stated that they saw it take place approximately on a daily basis, while four indicated weekly and only one indicated monthly. However, of the 18 participants who indicated witnessing daily illegal dumping, 12 indicated seeing it happening approximately once a day, while 3 indicated twice a day, and a further 3 indicated witnessing three times a day. Additionally, of the 4 participants who indicated witnessing illegal dumping on a weekly basis, 3 indicated seeing it twice a week, while 1 indicated seeing it three times a week. Only 1 participant indicated witnessing illegal dumping approximately monthly, saying it only took place three times per month.

#### 4.4.3. *The occurrence of illegal dumping*

The same 23 participants for the previous question were asked about what days and what times they had observed illegal dumping occurring. Figure 25 summarises the results.



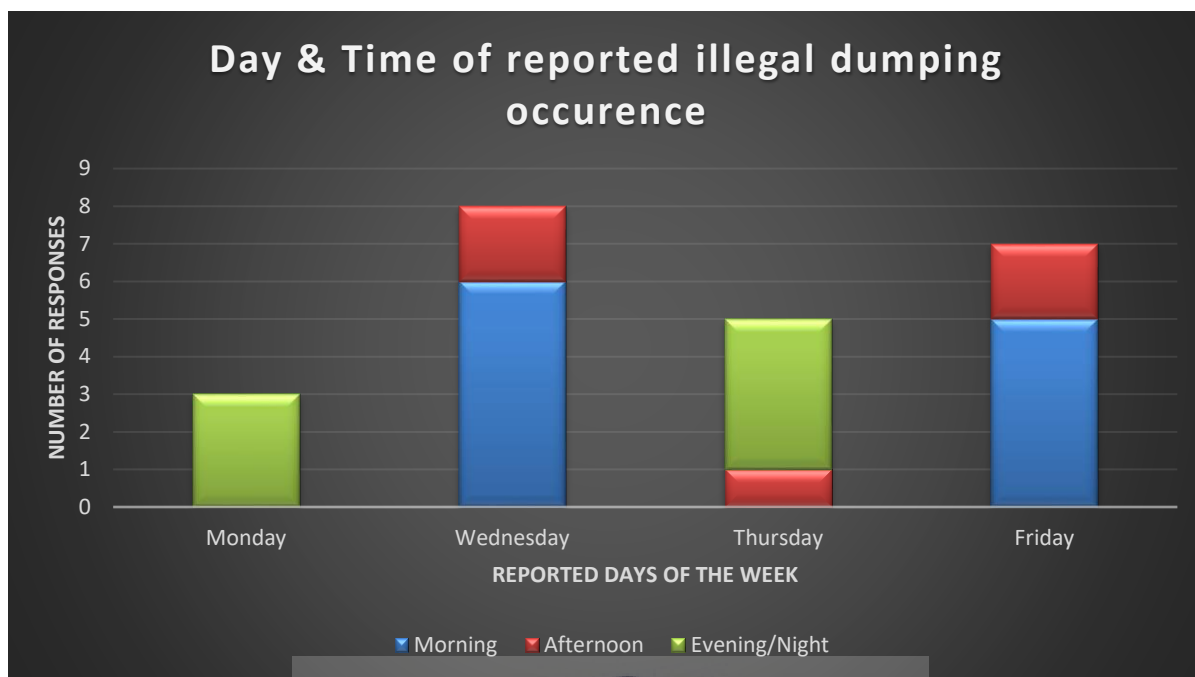


Figure 25: Day and time of reported illegal dumping occurrences

The same 23 participants who initially indicated having witnessed illegal dumping were asked about the day and time that they had witnessed illegal dumping taking place. Wednesday and Friday represented 34% and 30% respectively, of participants reporting seeing illegal dumping. Morning represented 47% of illegal dumping sightings. Coincidentally, these days and this time correspond to the refuse collection times in Mbekweni- (Wednesday, the day before refuse collection and Fridays, the day after refuse collection). Interestingly, participants reported that residents tend to dump their household waste in the morning just before the refuse collection truck arrived and, soon after the refuse collection, the residents would then also dump their waste at illegal dumpsites. This was explained as being a result of some households having excess waste and/or households who do not have waste bins. This practice was most prevalent at the largest communal illegal dumpsites which had in effect turned into informal waste disposal sites.

According to the participants, individuals disposed of their waste illegally during the night so as to avoid confrontation or to avoid being seen and identified as the perpetrator. To this end, 4 participants reported witnessing illegal dumping occurring in the evening/night, particularly on Thursdays (refuse collection day).

#### 4.4.4. Reasons for illegal waste dumping

Participants were asked about their perceived reasons for why people dispose of their waste illegally. The following reasons provided by participants are presented in no particular order:

- **Lack of resources:** Most participants felt that there was a lack of resources to dispose of their household waste correctly. Many felt that they needed additional resources, such as black bags and rubbish bins. It was often reported that some residents dispose of their household waste at illegal dumpsites merely because the waste was overflowing and they had no additional resources to store such waste until the refuse collection came by. Some participants also mentioned that they required extra facilities such as skips and drop-off facilities.
- **Carelessness or lack of duty of care:** Another reason provided by the participants was that people just did not care enough to dispose of their waste correctly. A common sentiment was that people only cared about their immediate surroundings but not for their neighbours or anyone else who may be passing by a particular place.
- **NIMBY:** A view similar to NIMBY ('not in my back yard') applies here. NIMBY suggests that, as long as the problem is not visible or does not affect them, residents are not bothered by it (Portney, 1984). Furthermore, some residents shared that some of the illegal dumping perpetrators come from other areas. To this point, some residents noted that people from different areas in Paarl dump their waste in Mbekweni. This reason was also given for the prevalence of C&D waste dumpsites in Mbekweni.
- **Laziness:** Mini drop-off facilities have been provided in some areas in Mbekweni by the municipality, and some participants felt that other residents were too lazy to dispose of their waste in the infrastructures provided and would rather dispose of their waste somewhere closer or within reach to their homes. The three mini drop-off facilities provided by the Drakenstein Local Municipality are located on the eastern extent of Mbekweni Township, opposite Jan Van Riebeeck Drive. For this reason, it was surmised that lack of motivation to transport waste to these drop-off facilities (or absence of the equipment to do so) might be responsible for illegal waste disposal.
- **Lack of education:** Some participants felt that there was not enough information available regarding the proper way of disposing of waste, how to clean the community and what to do with unique types of waste such as organic waste and C&D waste. Some of the participants put forward the notion that if more information was provided and if they received environmental education on waste disposal, they would be able to handle waste in a better way.

- Congested households with backyard rentals: An interesting reason given for why people dump waste illegally is that some households in Mbekweni were too overcrowded and might, in turn, produce more waste than a typical household would. Simply put, some homes had many people living in them, more than a typical household; hence these households ended up producing excessive amounts of waste which could not all be disposed of via the refuse collection service. Thus people turned to the alternative of dumping the excess waste at illegal dumpsites since they also know that the municipality will eventually clean the dumpsites.
- Price: Another interesting reason given for the prevalence of illegal dumping is that the disposal of waste at the landfill sites in Wellington are too expensive for many residents. This may have been the case when a particular individual had extraordinary waste such as dead dogs or even C&D waste but could not dispose of it through normal means. To dispose of this waste at a conventional landfill site would be too costly based on the gate fees charged at landfills and transportation costs to the landfill.

#### 4.4.5. *Effects of illegal dumping*

Participants were asked a range of questions about their personal experiences of illegal dumpsites in their community. The first question participants were asked was whether illegal dumpsites affected their families. All 25 participants indicated that they were affected by illegal dumpsites in one way or another. Below is a summary of the effects of illegal dumpsites experienced by participants. The information in Figure 26 was provided solely by the participants, and no individual responses were prompted.

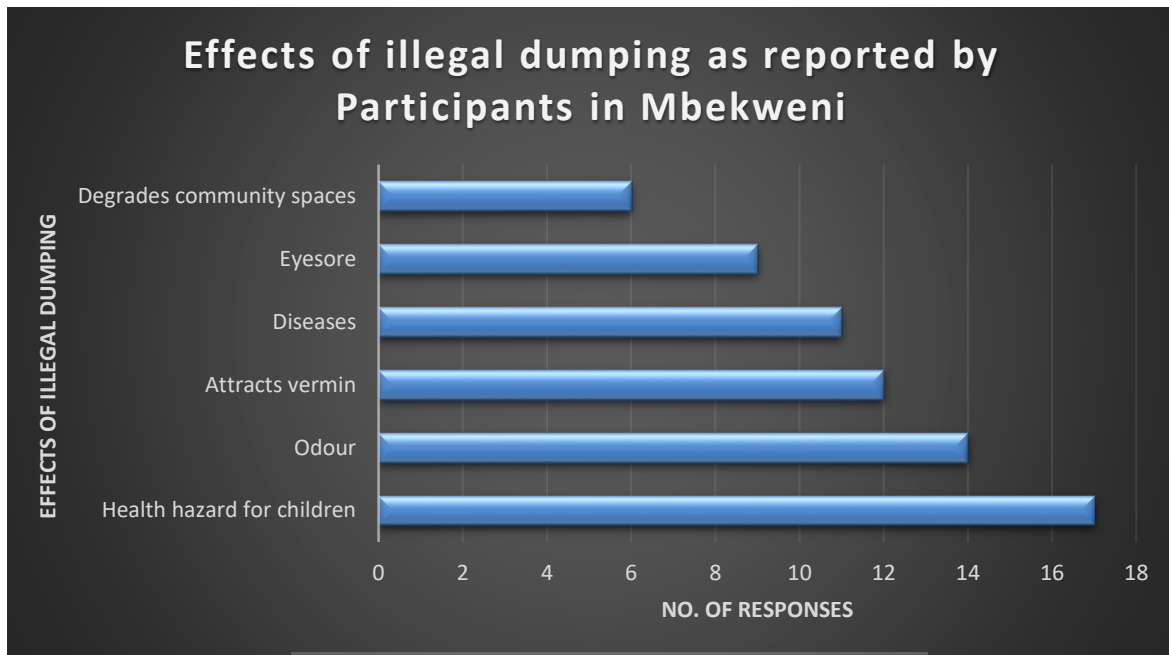


Figure 26: Effects of illegal dumpsites reported by residents

Based on the results in Figure 26, the most common effect of illegal dumping as reported by the participants was the health hazard posed to children. This effect or concern is based on the fact that many kids play outside near their home in open public spaces or fields unsupervised. The children are thus likely to come into contact with illegal dumpsites which contain a myriad of hazardous materials such as chemicals and rotting organic matter. Interestingly, this was more of a concern to participants than any other direct effect of illegal dumping. Perhaps this is due to the psychological impact of perceived danger, where parents may be continually concerned and worried about the inherent danger of their kids coming into contact with illegal dumpsites. It is essential to point out, though, that the participants reported more than one effect of illegal dumpsites; the three most common effects were the potential health hazard for children, smells and odours emanating from dumpsites and vermin such as rodents and insects. All these effects were related to people's health and hygiene, which were the main concerns of the participants whenever they reflected on illegal dumping in Mbekweni. Other effects reported, such as the eyesore that illegal dumpsites represent, were also quite telling as they show that the participants and, generally speaking, residents of Mbekweni are aware of their environment and community spaces and are generally concerned about the degradation and aesthetics of their environments.

#### 4.4.6. *Sighting of animals and pests*

Participants were also asked whether they had seen any animals at illegal dumpsites. Subsequently, participants who indicated that they had indeed seen an animal or animals at an illegal dumpsite were asked to name them. The results are presented in Figure 27. The researcher did not prompt any of the answers or responses.



Figure 27: *Animals spotted at illegal dumpsites by residents*

21 out of 25 participants indicated that they had spotted an animal or animals at illegal dumpsites in Mbekweni. The chart above represents the results provided by the 21 participants. Many of the participants indicated seeing more than one type of animal at an illegal dumpsite. The most common sightings were dogs, rodents and insects. This correlated with the typical kinds of pests or vermin you would associate with illegal dumpsites or any other unhygienic environments. The rodents refer specifically to rats, although some of the participants did not make any distinction between rats and mice, but instead used them interchangeably. Insects, in this instance, referred to mosquitoes and flies, as reported by the participants. Some of the participants also mentioned that the dogs would be typically scavenging at or around illegal dumpsites in Mbekweni. This made sense, as many stray dogs were seen roaming the streets in Mbekweni. It was quite interesting that livestock was identified as one of the animals seen at illegal dumpsites in Mbekweni. This was in particular reference to the open fields on the outskirts of Mbekweni, in which some illegal dumpsites are present and which also happens to



be where some of the livestock kept by residents would graze.

Participants were asked whether they had seen children playing at or near an illegal dumpsite. This question relates to one of the significant concerns with regards to illegal dumping in Mbekweni. A total of 25 participants were asked, and 17 participants indicated that they had seen or witnessed children playing at or near an illegal dumpsite. This particular topic or theme correlates with the previous questions and results in which the most common effect of illegal dumping reported by the participants was the health hazard posed to children. As mentioned before, illegal dumpsites represent a specific danger to children, mostly because children might come into contact with it either playing outside or walking home from school. This also adds to the urgency of why eradicating this problem is so important.

#### 4.4.7. *Waste composition reported by residents*

The waste composition of illegal dumpsites is essential as we want to know the most common type of waste being dumped. This may help shed light on the root of the issue in Mbekweni Township. Participants were asked to provide or name the type of waste product that they had seen at illegal dumpsites. No prompting of answers was initiated by the researcher, and all answers or results were provided by the participants themselves. The results of this question are provided in Figure 28.



Figure 28: Waste types at illegal dumpsites reported by residents

The most common type of waste seen at illegal dumpsites was general household waste, used diapers, plastics and garden waste. These types of waste represent the most dominant type of waste at illegal dumpsites as reported by the residents interviewed. In this case, waste products such as used diapers were distinguished from general waste by the residents because, in some instances, used diapers were the most visible and evident waste content. Similarly, plastic waste materials included plastic containers, packaging material and bottles. In some instances, when the participants described waste materials such as old and used appliances and generally large types of waste such as sinks and old couches, they were categorised as general bulky waste. Some residents also made a distinction between dead dogs and animal carcasses. Waste material such as dead dogs was a common waste type identified by some residents. Respondents noted that seeing rotting dog carcasses at illegal dumpsites was quite an unsightly and unsanitary view. Animal carcasses in this instance were referred to the bones of sheep, goats and cows visible in illegal dumpsites. Garden waste was identified as consisting of piles of cut grass, tree branches and leaves.

#### 4.4.8. Household waste disposal methods

As a way to investigate the waste disposal practices in Mbekweni, residents were asked about how they disposed of their household waste. The results are summarised in Figure 29 below.

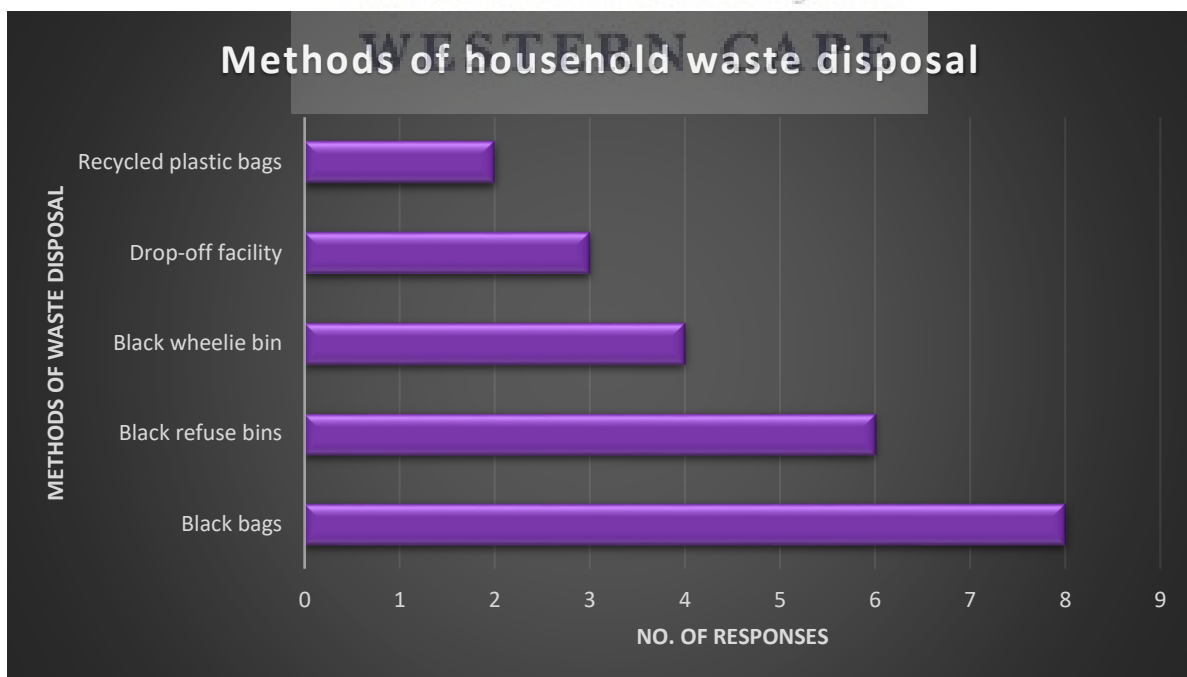


Figure 29: Household waste disposal methods reported by residents

Figure 29 represents the results of all 25 responses. The different methods or waste disposal practices are listed in the same format as the answers provided by the participants. Black bags were the most common form of household waste disposal, followed by refuse bins and the municipal black wheelie bins. Using black bags as a form of waste disposal refers to household waste placed inside a black bag, which is placed on the kerb or sidewalk for the refuse collection truck to collect. Black refuse bins were in some cases used by households as a substitute for the municipal wheelie bins. In this instance, some participants pointed out that sometimes recycled plastic bags would be used alongside the regular refuse bins in situations where there was excess waste. This is because the 85-litre refuse bins are far smaller than the 240-litre municipal wheelie bins.

It is of note that there was a direct correlation between the method of waste disposal and the type of dwelling. To this point, in areas where the participants resided in informal houses, such as in the OR Tambo Informal Settlement, the primary form of waste disposal was using recycled grocery plastic bags, black bags provided by the municipality and the mini drop-off facilities. Noticeably, in situations where participants resided in more formal type housing, municipal wheelie bins were the most common method of waste disposal. This point is further emphasised by the fact that only registered households can receive the municipal wheelie bins, and this is not possible for informal dwellings. In situations where the participants resided close to drop-off facilities, they sought this as their primary form of waste disposal, and they would place their household waste on a wheelbarrow, and simply walk over to the drop-off facility and drop their waste there.

#### **4.5. Interviews**

In this next section, several themes that were developed from the qualitative interviews are discussed. The various themes related to specific questions and their responses are presented in the following section.

##### **4.5.1. Reasons for illegal dumping**

One of the key objectives of the study was to find out from the residents themselves why people dumped their waste illegally in Mbekweni. From this question, we were able to uncover some

hidden and less obvious reasons why residents of Mbekweni dumped their waste. One of the critical perceptions amongst residents was that not enough resources were given to them or provided by the municipality. In this sense, many residents felt that the main reason people dumped their waste in Mbekweni was that they did not have the resources to dispose of their waste correctly. The following excerpts corroborate the above points:

***‘People don’t get the bins, they don’t get the plastics.’***

***‘The municipala should give more bins.’***

Lack of resources in this regard, as pointed out by the residents, referred to black bags, municipal bins and additional infrastructures such as drop-off facilities and communal skips. This was particularly the case because many residents who lived on the informal side of Mbekweni (OR Thambo Informal Settlement) did not have the means to purchase black bags for their household waste, or the black bags sometimes provided for them by the municipality were simply not enough. In this case, when there was excess household waste, this would result in residents dumping their waste at an illegal dumpsite.

For this same reason, the residents also expressed their wish that additional drop-off facilities be built on *‘their’* side of Mbekweni so they can dispose of their excess household waste properly. It was also pointed out by some residents that the weekly refuse collection service did not come regularly and that even entire streets would be skipped or ignored. One solution to this problem, as pointed out by one gentleman, was for the municipality to provide all the houses in Mbekweni with registered house numbers, and maybe then the refuse collection trucks would not miss certain dwellings and streets.

It also appeared that the needs of the people with regards to waste disposal and illegal dumping were different based on where they resided in Mbekweni. For instance, many residents on the informal side of Mbekweni (OR Thambo Informal Settlement) often reported their need for black refuse bags and even drop-off facilities in case the refuse truck missed their house or if there was excess household waste. But many residents on the more formal side of Mbekweni mainly complained about the absence of regular street clean-ups and monitoring of public spaces. Lack of knowledge with regards to household and community waste management was also mentioned in addition to lack of resources, and in this specific instance, some residents reported not knowing what to do with unique types of waste such as dead dogs, used diapers (*‘kimbi’*) and C&D waste. Some participants mentioned that:

***'The problem here is that the people don't know where they can throw the kimbis and (dead dogs)... kimbis do not belong on a bin.'***

***'You can't put the rubble in the bin yabon, so people they throw it here.'***

It was often cited by residents that this was, in fact, the real issue or reasoning behind illegal dumping in Mbekweni.

Furthermore, it was pointed out that the refuse collection trucks or workers would not accept certain types of waste, such as dead dogs or animal carcasses or even C&D waste. For this reason, it was perceived that residents would simply then just dump those types of waste in an open space or an illegal dumpsite. One of the participants explicated that:

***'People have to learn and understand one thing, where can we put the dirty things, how we can clean our place... they have to educate the people.'***

Also linked to this was this was the lack of knowledge on how the residents themselves could get involved in regular clean-ups or engage in cooperative community waste disposal practices.

Another critical perception behind the reasoning for illegal dumping in Mbekweni was the general lack of duty of care and carelessness of residents. Many a time, it was uttered that people in Mbekweni just did not care about their fellow neighbours and the environment or cleanliness of Mbekweni. This could have been as a result of little or no community pride of some residents. The following excerpts corroborate people's perception in Mbekweni as regards illegal dumping.

***'Other people don't care about other people... people care for themselves.'***

***'Some people do not have care that this place is not somewhere to dump... They don't put that rubbish on dustbin.'***

Negligence was also pointed out, specifically due to the generally hazardous nature of illegal dumping. This was also explicitly mentioned in conjunction with the concern that many children play outside and may therefore get sick from the illegal dumps. This perception was also often linked to the belief that residents from other parts of Mbekweni or even other communities in Paarl would come and dump their waste specifically in Mbekweni. In such instances, the perpetrator would not have any personal stakes in the cleanliness or general conditions of Mbekweni, and would simply dump their waste where it is far from sight, therefore making it far from mind. This perception correlates strongly with the concept of NIMBY syndrome, which states that individuals taking part in illegal waste dumping would do



it somewhere far from where it might affect them in whatever form. The thought process, in this case, is, ‘as long as the waste is “not in my back yard” where it will inevitably affect my family or me, I can go on with my life without care.’

#### 4.5.2. Unemployment and social disorganisation as a driver of illegal dumping

A common issue that was often linked to illegal dumping in Mbekweni was the issue of unemployment. When residents were asked what they felt could be done to prevent illegal dumping in Mbekweni, many felt that the municipality could employ more people within Mbekweni to clean the community. One of the participants said that:

***‘The municipality can employ more people, because I’m sitting down and I’m willing to be part.’***

During the interview process, some residents used the issue of illegal dumping in Mbekweni as an opportunity to voice their grievances and unhappiness with the growing rate of unemployment in Mbekweni. In this way, they saw the problem of illegal dumping in Mbekweni as a potential opportunity for the Drakenstein Local Municipality to employ more people in Mbekweni. It was even alluded to by a couple of residents that people in Mbekweni dumped their waste as an act of displeasure at being jobless as well as at the municipality’s failure to employ residents. From this, it was evident that people in Mbekweni were desperate for jobs, and some of the residents felt that the only plausible action that could be taken to keep the community clean would be to pay people to clean their communities. There was an apparent linkage between illegal dumping and waste management issues and unemployment or lack of jobs available. The following excerpts corroborate people’s grievances as concerned illegal dumping.

***‘We need work from the municipala, we must be employed. When the municipala starts to employ us, we can start to do the work.’***

***‘They must employ people to clean every time so it always stay clean. That is one of the reason people are doing this (dumping waste)... They are looking for jobs from the municipala, but have not heard anything.’***

Also, it was often proposed that if people in Mbekweni were paid something to actively keep the streets clean, there would be greater level of community pride. The issue of unemployment is also an indication of some level of social disorganisation and how this can perpetuate and

exacerbate illegal dumping in Mbekweni. In a more positive direction, it was evident from the residents that there may be a general duty of care with regards to illegal dumping, the only caveat being that the residents have to be rewarded for their efforts. It could be argued that it would be more concerning from a behavioural point of view if the residents lacked concern or duty of care for their surroundings regardless of incentive or not. Some participants confirmed that:

***'The municipality need to employ more community workers that will deal with the waste... people will be more motivated to keep their places clean.'***

***'They must give us jobs to clean and get salary.'***

Another indication of social disorganisation was the fact that many residents, especially in the OR Tambo Informal Settlement, frequently re-echoed not enjoying good service delivery in Mbekweni. The residents often complained of not having sanitary facilities such as functioning toilets and clean tap water. To these individuals, the lack of service delivery was a bigger issue than the prevalence of illegal dumping in Mbekweni. It is evident from this that while illegal dumping is a prominent and current issue in Mbekweni, residents in some parts of Mbekweni felt they had more pressing issues, such as clean water and ablution facilities. In some cases, these two issues have corroborated each other, as one form of community displeasure, such as a lack of service delivery, leads to the persistence of another problem, such as illegal dumping. The excerpt below also confirms some of the complaints made by the residents.

***'We are living in a dirty place here... dirty water, 1 toilet for all of us.'***

#### 4.5.3. Perceived relationship between illegal dumping and children

When speaking about what illegal dumping represented to the residents, many made a clear correlation between the hazardous nature of illegal dumps and their harmful effects, especially on the children in the community. There was a very apparent concern that the prevalence of illegal dumps first and foremost had an effect on children or at least affected the environment children interacted with. Many children in Mbekweni often play outside in open community spaces such as an open field or on the street, hence the likelihood that children will come into contact with illegal dumps. Illegal dumps contain harmful substances and materials that pose a risk to children, and could possibly lead to children contracting diseases. Furthermore, the children themselves might not understand or be aware of the hazardous nature of illegal dumping, further exacerbating the possible risk. All of this means that the ubiquitous presence

of illegal dumps is incompatible with the structure of the community, in which children spend a lot of time outdoors. Some excerpts from the interviews provided corroborating opinions:

*'The people that put the rubbish here, we have children here and there is nothing that is been done.'*

*'The diseases that come with it, children that are playing in it.'*

*'Waste should not be dumped around like this, because there are diseases, the children can get many diseases.'*

During the data-collection process there was a particular instance in which there was a group of children playing on a heap of C&D waste. It appeared that the children were looking for something, possibly playthings or toys, and that they were unaware of the potential danger of the illegal dump. It was a peculiar scene, as the children were doing this in full view of all the homes in that area, with cars passing by. This particular scene did not seem to bother anyone. The scene also prompted the question that, if these children were playing on C&D waste, what kinds of waste were other children playing around or in. This observation represented a microcosm or snapshot of one of the main issues relating to illegal dumping in Mbekweni. The kids were unaware of the potentially harmful effects of illegal dumps, and so were the bystanders and passers-by. This instance also relates quite strongly to the concerns voiced by numerous residents that illegal dumping will inevitably end up harming children.

In another similar scene, in a different part of Mbekweni, there was a group of children scavenging for waste in an open illegal dumpsite situated on an open field. In this instance, however, the children seemed to be scavenging mainly for recyclables such as cardboard boxes, pieces of cotton, plastic, etc. This group of children were without fear or concern while walking in and around a massive illegal dump, seemingly aware of what they were looking for. The presence of old shopping trolleys indicated that this might have been a common practice. It is also possible that they were doing it under the instruction of some sort of parent or guardian, as they appeared to know exactly what they were doing. Waste such as cardboard and tins were apparently items of value to these children. This represents another facet, albeit a unique one, of the relationship that exists between illegal dumping, waste and children, and of the potential opportunities that illegal dumpsites represent to some people in Mbekweni.

#### 4.5.4. Residents' perception of the Drakenstein Local Municipality

The residents were asked about their perceptions of the municipality's effectiveness with regards to general clean-up efforts in Mbekweni. Two contrasting perceptions emerged from their answers. The first was that the municipality was not doing enough to clean up Mbekweni and all the illegally dumped waste. Distrust and unhappiness between the residents and the municipality were expressed. Many lamented that the municipality was simply not doing enough to clean up Mbekweni or even collect residents' waste. One particular resident alluded to the fact that protests were the only form of language that the municipality would listen to and that without the residents constantly pushing the municipality, nothing would be done. More specifically, many residents in the informal part of Mbekweni claimed that they often had to take matters into their hands by cleaning up the streets themselves because they were not receiving the needed service delivery in that regard.

In some cases, however, the distrust was mostly shown towards the elected community leaders such as the ward councillors of Mbekweni. In this regard, some residents felt that their voices were not being heard about the level of 'dirtiness' and lack of service delivery, that their complaints were falling on deaf ears. Their perceptions are also indicated in the following interview excerpts.

*'The municipality is not doing their job, cause where I live it very dirty.'*

*'Municipala does not clean here, they come to put stuff on the drain but do not pick it up.'*

*'In order for the municipala to do anything, we have to stand and protest... the municipality don't do nothing if we don't push to take an action on anything.'*

Residents also complained about a lack of transparency between the councillors and the residents of Mbekweni. Some residents even went so far as to proclaim that they do not know where to take their complaints and queries and that even if the complaints and queries were received by the councillors or the municipality, the residents would not receive any feedback. The residents' general perceptions of the elected community councillors seemed to be one of overall ineptitude. I could discern from this that maybe there was a possible disconnect between the residents, councillors and the municipality, and that the messages and concerns from the residents were getting lost somewhere along the way. It was also discovered that residents had differing views of the power structure or hierarchy in Mbekweni. Some placed the onus of

Mbekweni's problems at large on the Drakenstein Local Municipality, while others felt it was the responsibility of the councillors. It seemed that the residents viewed one level of the hierarchy as independent of the other. In other words, the municipality on the one hand and the councillors on the other hand were commonly viewed as separate, almost discrete and independent entities.

Another contrasting perception of the municipality was that the municipality was doing all that it could to keep Mbekweni clean, but that residents themselves did not comply. In some cases, residents vehemently refused to put the so-called 'blame' on the municipality and instead placed it on the people in Mbekweni who did not care enough about each other to respect public community spaces. There was an explicit acknowledgement by some residents that the blame should be placed solely on the residents of Mbekweni. In one instance, an older woman instinctively pointed out that there was an inherently contradictory mindset in Mbekweni where, on the one hand, people complained and blamed the municipality for not doing enough to take care of the illegal dumping issue in the community and, on the other hand, these same people did not want to comply with the rules and regulations set out by the municipality to mitigate illegal dumping. This particular notion seemed to be indicative of the general mindset amongst some residents in Mbekweni. Some residents explained that:

***'The municipality are doing their job, but the people don't think of themselves because people just come from other places and just dump.'***

***'The municipality are doing their work... I can't give the problem to the municipality.'***

***'I'm very happy cause the municipality did collect the dirt out.'***

#### 4.5.5. Household waste removal satisfaction

The residents were asked whether they were satisfied with the current household waste removal service in Mbekweni. The purpose was to get an idea of general satisfaction levels and to ascertain whether certain dissatisfactions were linked to the prevalence of illegal dumping in Mbekweni. The general sentiment was that people in Mbekweni were unsatisfied with the waste removal service in one way or another. While the question was about household waste removal, the participants indicated that they regularly voiced their dissatisfactions with service delivery in general. This was more prominent amongst the residents from the informal side of Mbekweni, who revealed that:

***'The truck doesn't come every time.'***



***'The municipala always skip my house.'***

***'They should clean the streets here better.'***

The dissatisfaction of the waste removal service as expressed by the participants varied spatially. In some cases, residents who lived in the informal part of Mbekweni, OR Thambo Informal Settlement, often had concerns with the lack of refuse collection in their community, citing situations where collection trucks would not come for some weeks, and another situation where some homes would be skipped and neglected. For those residents living in the formal side of Mbekweni, the issue was inadequate street clean-up. In this regard, the residents didn't have an issue with the waste removal services but rather with the street cleaning services. From these two distinct issues brought up by the participants, it was clear that there was a level of spatial variability with regards to concerns felt by the residents. They revealed that:

***'They go there on the houses side... but not here.'***

***'They skip our houses here, but go that sides where it is clean.'***

There also seemed to be a belief, particularly among residents of the informal side, that other areas of Mbekweni received better waste removal services than the informal side. A connection was made between the perceived lack of consistent waste removal and tendency that residents would turn to dumping their household waste as a last resort.

#### 4.5.6. Mbekweni's waste facilities

The residents were asked about their awareness of the location of the three mini drop-off facilities in Mbekweni. The intention was to get an idea of the residents' awareness of the relative locations of the waste facilities in Mbekweni. All the participants admitted to knowing the location of the drop-off facilities, but their responses often included their concerns about the locations of the mini drop-off facilities as well as their effectiveness. The drop-off facilities were often described as being located at the 'back' of Mbekweni. In this instance, the participants were referring to the side of Mbekweni that is closest to Jan Van Riebeeck drive (the eastern side). In addition, many participants voiced their concerns about the location of the drop-off facilities and how they were too far for most of the residents to make use of them. The excerpts below also indicate their concerns.

***'The waste buildings are at the back end of Mbekweni, near the main road.'***

***'The dumping spots (drop-off facilities) are on that side of Mbekweni... the dumping***

*spots are too far, people are dumping here because of that.'*

*'Too far...people don't have the stuff to carry our waste that side.'*

A common notion felt by participants was that the drop-off facilities were simply too far away for them to function as an alternative method of household waste disposal. It is important to note that this perception was common amongst the residents who lived further from the drop-off facilities. Similarly, the residents who took up the particular issue of the distance of the drop-off facilities were those who resided in the OR Thambo Informal Settlement. The participants from this side of Mbekweni felt that people like them who did not have access to proper waste management facilities seriously needed the drop-off facilities, more than any other place in Mbekweni. This need was expressed in relation to the massive communal dumpsite that existed on the informal side of Mbekweni, especially near the train station. Many residents on the informal side of Mbekweni often cited the communal dumpsite as a good reason for the need of additional waste facilities on 'their' side of Mbekweni. Some residents maintained that:

*'People on that sides, they benefit from the dumping spots... it's cleaner there.'*

*'You see it's dirty here, we need the buildings like that sides.'*

*'The houses sides is cleaner because of the dumping spots.'*

Four participants residing near the mini drop-off facilities also shared their concerns about how the drop-off facilities were being used by residents, and the seeming lack of cleaning up of the drop-off facilities. The participants said that:

*'People bring their waste here and just drop it... not even inside.'*

*'This place is dirty, people just drop around... they have no care.'*

*'The municipala doesn't clean it all the time, then the waste go everywhere.'*

*'The people (municipality) need to come and clear the waste... it can spread easily.'*

The drop-off facilities were being used for waste disposal by the residents living close to them, but the residents on this side were still unhappy with the level of upkeep of the facilities. The main concern, in addition to other residents being careless with the facilities by dumping their waste around instead of inside, was that the insides were not regularly cleaned and cleared. This may have been as a result of there being so much waste being disposed of at the facilities that weekly clean-ups were simply not enough to maintain the cleanliness of the mini drop-offs.

#### 4.5.7. Suggestions for waste disposal improvement

Participants were asked two questions closely related to each other to do with possible suggestions for improved household waste collection and disposal services as well as illegal dumping interventions. Like the previous question on satisfaction with household waste collection, the suggestions provided by the participants were different based on where the participants lived. For instance, in the OR Thambo Informal Settlement, the participants suggested more regular refuse collection, additional waste facilities and resources such as black bags and waste bins especially.

It is important to note that their main concerns were based on having access to black bags and bins, as some participants noted that, even though they did receive black bags from the municipality, it was not on a regular basis. Those participants who lived in the formal parts of Mbekweni mainly made suggestions along the lines of better cleaning services, better supervision of the people who cleaned the streets and an improved monitoring of public spaces that were often targeted for illegal dumping sites. Some of the participants explained thus:

***'It's easy, we need black bags and rubbish bins.'***

***'The municipala must build waste facilities... like that sides.'***

***'They must come every week... to my house for my rubbish.'***

***'They must watch the people that come to clean here... they don't do a good job yabon.'***

In a separate question, the participants were asked about possible interventions that the municipality could implement to curb illegal dumping. Possible interventions provided by the residents were diverse. The participants who were of the opinion that illegal dumping was the municipality's responsibility suggested that the municipality could increase the frequency of refuse collection as well as of street clean-up. This particular suggestion was also linked to a need for better transparency and communication or collaboration with the ward councillors and the municipality authorities. In this particular instance, the participants suggested having a platform to voice their concerns to the authorities, particularly concerning waste management and illegal dumping. Others also suggested stakeholder engagement meetings where decisions could be discussed and made with the community members with regards to waste management issues. They said that:

***'If the municipala (refuse truck) can come for my rubbish more times.'***

*'The municipala must clean the trash better... the street will be clean.'*

*'The municipala can listen to us... that will be good.'*

*'The authorities must listen to us, maybe if we can meet or something.'*

*'They must consult us.'*

Other interesting suggestions included environmental and infrastructural interventions such as establishing flowerbeds and vegetable gardens, building play parks for children, planting more trees and having restricted access to some open areas through gates and fences. In sum, participants maintained that:

*'If the municipality can put gardens here, maybe some flowers you know.'*

*'The trees and plants will be good, it will be cleaner.'*

*'They need to put up fences to stop these people who are dumping here.'*

*'The people need to care more mos.'*

*'We must care for each other yabon... to know not to dump here.'*

From an individual perspective, residents' suggestions included better duty of care, environmental consciousness and caring for one another. In this sense, some residents acknowledged that people in Mbekweni, especially those who are responsible for dumping, should change their decisions and action for better. They also called for more accountability and duty of care amongst residents in Mbekweni.

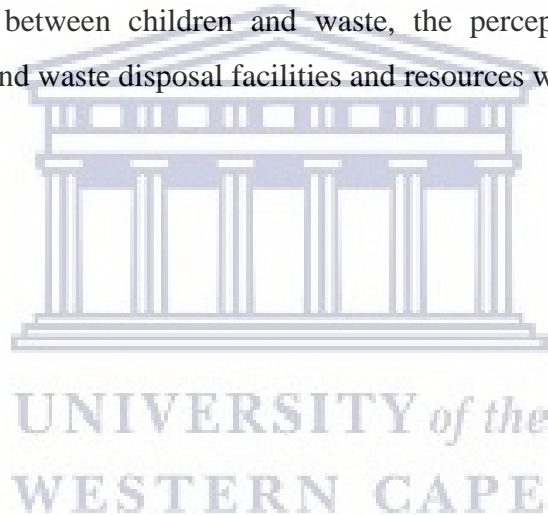
#### **4.6. Conclusion**

This chapter reviewed the results and analysis of the quantitative GIS and questionnaire data as well as the results of the qualitative interview findings of the study. The various findings were presented in four main sections. The first category of the results presented the analysis of GIS data which included the relative locations of dumpsites and their relation to waste disposal facilities, the density of dumpsites presented in a heat map, the size and waste composition of dumpsites in Mbekweni, a proximity analysis of dumpsites to rivers and annoyances emanating from dumpsites and the relation between dumpsites and community spaces.

The second section looked at the results of spatial analysis of dumpsites carried out using various GIS tools such as the Optimised Hot Spot Analysis tool and spatial autocorrelation.

The results of the Optimised Hot Spot Analysis were presented, which showed that there was apparent clustering of dumpsites in Mbekweni. The spatial autocorrelation analysis of illegal dumpsite sizes and waste compositions were also presented in this section. The spatial autocorrelation analysis showed that there was no statistical significance in the distribution of dumpsites based on their sizes and waste composition.

The third section examined the results of the quantitative questionnaire data. Various questions relating to awareness of illegal dumping, temporality and frequency of dumping, reasons for dumping and perceived effects of illegal dumps were explored. The results and analysis of the qualitative interview data were examined in the last section. The results were presented in six subheadings which explored the reasons for dumping in Mbekweni as reported by residents, aspects of social disorganisation and frustrations of unemployment. Additionally, other aspects such as the relationship between children and waste, the perceptions of the municipal authorities and issues around waste disposal facilities and resources were analysed.





## **Chapter 5: Discussion**

### ***5.1. Introduction***

The following chapter delves into the meaning, relevance and importance of the results presented in the previous chapter. This chapter focuses on explaining and evaluating the findings of the research and showing how it relates to the research objectives and literature review. Triangulation of quantitative and qualitative data is provided in this chapter.

### ***5.2. Accountability of illegal dumping in Mbekweni***

One theme that constantly reappeared during the interview process was the issue of accountability with regards to community cleanliness and illegal dumping. It is clear from the interview results that there are two contrasting views on the issue of accountability. There is a section of residents who feel that the municipal authorities are responsible for keeping Mbekweni clean by clearing illegal dumpsites and insuring efficient waste collection and disposal services, and there is another section of residents who feel that other community members are not upholding their responsibility to keep their environment clean and follow the guidelines and rules set by the municipality.

The first opinion, that the municipality are responsible for keeping Mbekweni clean, is a common mindset observed amongst the majority of residents interviewed. This mindset is in some ways the crux of the issue of illegal dumping in Mbekweni. This mindset is paradoxical because, while there is a general acknowledgement that residents partly contribute to illegal dumping, it remains the responsibility of authorities (the municipality) to clear the waste, regardless of who contributed to it. This aspect is particularly interesting when viewed against the backdrop of the questionnaire results, which showed that most of the respondents admitted to witnessing illegal dumping, therefore revealing that most people were aware of the dumping and have directly observed other community members engaging in it. The aforementioned mindset shows that some residents therefore do not take responsibility for something that appears to be a relatively common behaviour. This could be as a result of a conditioned mindset, as described by Abel (2014), that authorities (and by extension the government) are responsible for every aspect of societal life. Abel (2014) notes that this mindset is also as a result of promises made by the government for decades which have conditioned people to expect

everything from the government.

Therefore, from this conditioned mindset, many expect that the authorities should provide everything, including a clean environment, despite the fact that it is the residents themselves who contribute to the unsanitary conditions of Mbekweni. This mindset is also indicative of a larger societal mindset in South Africa (Abel, 2014). Godfrey et al. (2019) and Nagpure (2019) emphasise that we need to move away from this mindset as a society and take responsibility for our own spaces and communities. The focus should be on changing the attitudes and perceptions which influence community members' behaviours, particularly with regards to responsible waste management practices on a community level. This perceived lack of accountability on the part of residents partly stems from a culmination of other grievances such as the general lack of effective service delivery, opportunities and employment for the residents. The perception that the municipality should provide everything is indicative of a general expectation when it comes to aspects such as employment, housing and service delivery. There is therefore a clear need to change residents' perceptions and attitudes with regards to environmental duty of care and general responsibility for one's own community and surroundings. It must be mentioned that there were participants who acknowledged the role played by residents in the community's cleanliness or lack thereof. This indicates that some do care and may even be willing to be part of the solution.

### **5.3. *Disparity of service delivery***

A common perception amongst some residents, especially on the informal side of Mbekweni, the OR Thambo Informal Settlement, was that there was inequality in the level of service received by different parts of Mbekweni. Residents residing in the OR Thambo Informal Settlement felt that the street clean-ups and the refuse collection services there were not as regular as in other areas of Mbekweni. The common belief was that the refuse collection trucks went to the 'houses' side of Mbekweni, and did not service the informal side as frequently. This commonly held view was also linked to the belief that only some places in Mbekweni were 'dirty' or were affected by illegal dumping, whilst others were clean. Furthermore, participants indicated their belief that it was because of the level of unequal service delivery in Mbekweni that some areas had more illegal dumping than others. Some residents even alluded to the assumption that the municipality only cared about the 'houses' side of Mbekweni and regularly neglected residents who lived in the informal parts of Mbekweni. It was clear from

these perceptions that residents residing on the informal side of Mbekweni were frustrated and unhappy with the perceived lack of service delivery such as refuse collection. It is important to note, however, that some of these frustrations may have originated from grievances about other aspects of Mbekweni, such as the lack of housing, sanitary facilities and clean water.

It was clear that the level of service-delivery needs varied across Mbekweni. More specifically, the OR Thambo Informal Settlement lacked adequate infrastructure and had congestion of homes which made it difficult for refuse collection trucks to navigate through the community. Therefore, these areas required frequent refuse collection and increased street cleaning to compensate. In contrast, formal communities in Mbekweni did not necessarily need more service delivery but needed better street cleaning to curb the effects of illegal dumping. Furthermore, the formal side of Mbekweni was perceived as cleaner because there were fewer barriers for useful refuse collection and street cleaning. More specifically, homes were less congested, there were likely fewer people per household using one bin and the streets were better defined and easier for refuse trucks to navigate. Mamady (2016), Nagpure (2019) and Kodua and Anaman (2020) highlight congestions of homes and the structure of communities as barriers for proper waste collection. Furthermore, Garg and Mashilwane (2015) add that township characteristics such as backyard dwellings or backyard rentals contribute to a higher generation of waste in households, which leads to more waste being produced than a single household waste bin can handle. Garg and Mashilwane (2015) explain that the excess waste being produced in township homes because of backyard dwellings or rentals may lead to indiscriminate waste disposal, as many refuse collection services cannot accept more than one waste bin per household.

Similar to the perceived inequality of service delivery in Mbekweni, several residents also felt that there was an inherent ineffectiveness in the way the clean-up programmes were conducted throughout Mbekweni. Many residents complained that the street cleaners (EPWP workers) who were employed by the municipality did not do a sufficient job and that there were irregularities in how some areas were cleaned compared to others. According to some residents, the cleaners would do some work for a short time and then sit around the rest of the day or the shift to pass the time. In this regard, there was a lack of adequate supervision which resulted in streets not been cleaned thoroughly and properly. Residents indicated that the cleaners would only sweep the streets and ignore the illegal dumpsites or other waste lying around, therefore making it appear as if no clean-up had occurred.

In some cases, the dumpsites remained on the streets. To this point, Dladla, Machete and Shale (2016) acknowledge that inefficient waste management services such as inadequate street cleaning in African communities often contribute to the dirtiness and negative image of a community. However, the questionnaire results revealed that illegal dumping took place daily. Therefore, when considering this point, it would make sense why certain parts of Mbekweni continuously appear to be dirty because no matter how often the street cleaning takes place, illegal dumpsites always reappear or occur elsewhere in Mbekweni. Hence Mbekweni is in a constant state of dirtiness. The high frequency of dumping also means that street clean-ups are rendered futile.

#### **5.4. *Necessity vs criminality***

A point of contention that emerged from the perceptions of illegal dumping in Mbekweni was the contrast between dumping waste out of necessity versus dumping waste as a criminal offence. No particular participant explicitly admitted to personally dumping waste, though it was often emphasised that dumping waste was done from necessity. In this regard, indiscriminate dumping of household waste (albeit still illegal) was deemed necessary, as far as it was done out of need or necessity. This particular perception correlates with the fact that some respondents reported not having access to adequate resources such as black bags and household waste bins. From this situation, it was noted that illegal dumping was often an alternative method of waste disposal, and, in that particular instance, it was not viewed or regarded by participants as a criminal offence. Illegal dumping in this way was somewhat justified and regarded as permissible, in the view of residents; the violation of illegally dumping waste was 'decriminalised'. Part of the problem, as noted by Godfrey et al. (2019), is that illegal dumping is viewed as an acceptable form of waste disposal because the municipality is expected to clean up after the residents. The Council for Scientific and Industrial Research (2011) notes that when illegal dumpsites are cleaned up by municipal services, a message of consent is sent to residents.

There was the contrasting perspective, mainly emerging from participants who lived in a different part of Mbekweni, that illegal dumping was, in fact, a 'criminal' offence and very much frowned upon. The prevailing sentiment expressed by residents with this perception was that illegal dumping was inherently selfish as it placed other community members in harm's

way. It was from this school of thought that residents felt that the prevalence of illegal dumping was not a municipality issue but rather a community issue. Meanwhile, there is an apparent spatiality between the two contrasting perceptions. On the one hand, residents who lived in the informal part of Mbekweni (OR Thambo Informal Settlement) believed that indiscriminate dumping of household waste was necessitated due to their conditions; on the other hand, residents who lived in the formal part of Mbekweni believed that dumping was a negligent, harmful and self-serving act and was detrimental to other community members. In one way, it appeared as if there was a line drawn between the 'haves' and the 'have nots' in Mbekweni. This difference in attitudes and perceptions is represented in many of the other discussion points in this research. The spatial dynamics of Mbekweni seemed to have shaped residents' perception of illegal dumping and community cleanliness in very different ways.

### **5.5. *Relationship between distance and convenience***

This particular theme relates to the mini drop-off facilities that were built in Mbekweni in 2018 and the contention about their location. It is important to note that three of the mini drop-off facilities in Mbekweni are situated on the far eastern side of Mbekweni Township along Jan Van Riebeeck Drive. To some residents, the location of these drop-off facilities was too far away and was part of the reason why people dumped their waste illegally. Many residents noted that the drop-off facilities were too far for them to transport their waste; in most cases, people transported their waste in wheelbarrows due to lack of access to any type of vehicle. This perspective was more common amongst residents who lived far from the mini drop-off facilities than the residents who were situated closer to them. Also, based on the socio-economic and spatial dynamics of Mbekweni, it would be a safe assumption that numerous residents living in the informal settlement would need to drop off facilities more urgently due to lack of resources.

These residents, however, have been limited to transporting their household waste via wheelbarrow to the other side of Mbekweni or dumping their waste at one of the 'communal' dumping sites. Adding to this, Brandt (2017) and Sotamenou, De Jaeger and Rousseau (2019) note that characteristics such as distance and the lack of accessibility of waste facilities contribute to illegal dumping in some communities. This demonstrates the apparent relationship between the distance of waste management infrastructure and convenience. Based on residents' responses, we can surmise that the distance of the mini drop-off facilities from



people's homes has an impact on the willingness of residents to dispose of their waste properly when there are no other waste management resources available. There was no direct evidence alluding to this, although the common perception amongst residents seemed to be that they were willing to utilise mini drop-off facilities or any other kind of waste management facility if it was convenient and close to them. Transporting waste for long distances to the mini drop-off facilities is too strenuous and cumbersome. Hence, some residents who lacked resources such as black bags and bins felt that because of the distance of the drop-off facilities, dumping waste was the next convenient alternative. Similarly, because the drop-off facilities were unequally distributed, there was a perception that only communities situated close to the facilities benefited from them, which is also why the streets were cleaner in those specific communities.

This particular finding correlates with a study by Abel (2014) in eThekweni in South Africa, where the distance of waste facilities was found to influence residents' willingness to utilise the facilities – therefore making a strong linkage between distance and convenience of waste facilities. Okot-Okumu (2012:10) adds that, in instances where waste facilities such as skips were too far, communities turned to indiscriminately dumping their waste. Furthermore, a study by González-Torre and Adenso-Díaz (2005) on the relationship between recycling and distance found that people would be more willing to participate in recycling if it was made convenient through conveniently and strategically placed recycling bins. Also, a higher degree of recycling was reported when the bins were closer to households. Achor, Ehikwe and Nwafor (2014) suggest that communities plagued by illegal dumping would benefit from the strategic placement of waste facilities and bins. Therefore, waste management and environmental cleanliness in Mbekweni would greatly benefit from strategically placed waste management infrastructure so that all residents in Mbekweni can have access to waste facilities and in turn help curb illegal waste disposal.

### **5.6. *Changing behaviour***

Changing the behaviour of unruliness, specifically illegal dumping, is seen as one of the best and most sustainable ways to combat illegal dumping. The Council for Scientific and Industrial Research (2010) notes that this is because strategies such as regular clean-ups and increased waste collection are not sustainable and often tend to place increased costs on an already constrained municipal budget. The Council for Scientific and Industrial Research (2011) further

adds that clean-up programmes do not usually help in curbing illegal dumping, and they may even in some cases incentivise illegal dumping. This was evident not only from the presence of large communal-type dumpsites but also from the general attitude on illegal dumping and community cleanliness amongst many residents. Rahji and Oloruntoba (2009) maintain that it is therefore essential that, at the heart of any campaign, behavioural change should be the primary objective. Furthermore, by doing so, you can convert knowledge into action, especially in a place like Mbekweni where the prevailing attitude to illegal dumping among some parts of the community is that the municipality should clean up after residents.

One proposed method of behavioural change could be through environmental education. The assumption is that the more learned individuals are on a specific issue, the better their decision-making will be and the more conscious they will be about the issue. This method is not always guaranteed, however. Rahji and Oloruntoba (2009) posit that having more education does not necessarily change behaviour. Adjusting individual attitude and behaviour is usually more challenging than merely attaining more knowledge. It is possible, however, that such a method could work in Mbekweni as many residents identified partial or no knowledge and education of waste management as one of the roots of illegal dumping. Providing more information about waste management could therefore assist with filling the knowledge gap that residents complained about. In other instances, certain residents expressed a desire to know more about how to deal with certain wastes; therefore, there is a need to learn more and know better. As suggested by Rahji and Oloruntoba (2009), a behavioural-change strategy based on increased knowledge would have the most significant effect if aimed at the youth. Rahji and Oloruntoba (2009) assert that younger people are more receptive to increased learning and have a greater environmental awareness. Furthermore, you have a better chance of changing attitudes and behaviours of future generations by educating younger people about responsible environmental care. However, such a notion may not always be true, especially in a place like Mbekweni, which has a unique socio-economic and demographic structure that is different from more affluent communities. Therefore, Rahji and Oloruntoba (2009) put forward that a tailored approach is required for any type of educational and awareness campaign. This approach must account for the conditions of the community, and the information has to be quickly disseminated and have simple language and concepts.

### 5.7. *C&D waste as a priority waste stream*

C&D waste originates from the high demand for infrastructure such as housing. Construction activities such as renovation and demolition, which produce a lot of residual C&D waste, are then often left in the environment and disposed of illegally, which leads to environmental damage and landscape deterioration. According to Seror and Portnov (2018:22), C&D waste contains harmful chemicals such as oil, solvent and resins, which when left in the environment may contaminate soil and groundwater. Similarly, the oil in C&D waste can cause fires in high heat conditions due to their volatile nature. C&D waste is an essential stream of waste mainly because of its often-large quantities, which may have significant effects on an environment, but also because of the variety of waste which is recyclable and reusable. The prevalence of C&D-waste dumpsites shows that there is a problem of this specific type of waste in Mbekweni. Through the GIS analysis of illegal dumpsites in Mbekweni, it was discovered that C&D waste was the most common type of waste composition of illegal dumpsites. Part of the issue of C&D waste as expressed by the residents was partial or no knowledge of how to deal with such waste and the fact that refuse collection trucks did not accept C&D waste. It was, however, pointed out by the municipal authorities that gate fees for C&D waste at the Wellington landfill had been scrapped. This practice was initially formulated to combat the prevalence of C&D waste left in the environment. However, as noted by Barnes (2016), the issue of motivation comes into play as many people in Mbekweni lack the means to transport their waste to the local landfill site situated in Wellington. It may therefore be viewed as more convenient for some residents to dump their C&D waste in an open space as opposed to struggling with transporting their waste or looking for alternative measures to transport their waste. Some residents also shared suspicions that some of the C&D waste in Mbekweni was being disposed of by opportunistic offenders that lived outside of Mbekweni, although this is unconfirmed by this study.

It is also possible that the apparent prevalence of C&D dumpsites is an indication of an increase in the amount of C&D waste generation. Barnes (2016) notes that the increase in C&D waste generation could be as a result of the infrastructural transitions that many houses in Mbekweni are undergoing. The Drakenstein SDF (2016) notes that many of the houses in Mbekweni were built as far back as 1960s, and many homes today are old and dilapidated and in need of infrastructural upgrades. Some residents take it into their own hands to upgrade their old homes. This, in turn, has likely led to an increase in C&D waste generation. The proliferation of

informal dwellings such as shacks in some parts of Mbekweni has also contributed to the generation of C&D waste such as steel, drywall and wood products, which are sometimes too unique to dispose of through the standard route and are therefore dumped. C&D waste needs to be made a priority waste stream across the Drakenstein Local Municipality and in particular in Mbekweni Township. The Council for Scientific and Industrial Research (2011) suggests that the implementation of targeted and strategic collection of C&D waste could help alleviate the issue of illegal dumping. The provision of additional waste facilities such as drop-off facilities specifically catering for C&D waste could be one way to increase the waste management of C&D waste. Barnes (2016) and GreenCape (2020) point out that builders' rubble or construction waste represents a unique economic opportunity in the waste sector and that the implementation of recycling processes and strategies for builders' rubble could yield economic benefits such as job creation for the local economy. Recycling and reusing C&D waste will ensure the use of products to the end of their life cycle, therefore limiting waste generation and promoting a circular economy. Santos, Mendes and Teixeira (2019:1143) establish that economic losses are sometimes linked to dumped C&D waste due to the loss of primary resources (rock, cement, clay) and the use of fuel consumption it takes to transport such materials to their destination. Therefore, the prevalence of C&D waste presents an economic opportunity for the Drakenstein Local Municipality, in which much-needed jobs could be created.

As observed, C&D waste may also have social effects such as health hazards and a change in how communities view and consume public space (Santos, Mendes and Teixeira, 2019). The illegal disposal of C&D waste is a global problem affecting both developed and developing countries. For instance, da Conceição Leite et al. (2011 cited in Seror and Portnov, 2018:22) mention that Brazil produces approximately 16 000 tons of C&D waste daily, of which two-thirds are disposed of illegally. Ichinose and Yamamoto (2011) reveal that 20% of illegal dumping cases in Japan consist of C&D waste while other countries incur massive expenditures for C&D clean-up activities, like the UK, who spend about 45 million pounds per year on C&D clean-up activities. Eberhard (2018) argues that builders' rubble is a significant component of illegal dumping in Cape Town, South Africa. In the CoCT, 35% of illegally dumped waste consists of builders' rubble. The prevalence of C&D waste is also evident from the fact that 45% of all waste that ends up at landfills consist of builders' rubble. Furthermore, due to the high costs of gate fees at landfills, builders and contractors dump construction waste illegally to avoid the related costs (such as transportation costs). This has been such a big issue in the

Western Cape that the CoCT eliminated gate fees at landfills for the disposal of clean builders' rubble. Additionally, 25 drop-offs opened their operations to accept clean builders' rubble. As part of the CoCT's illegal dumping prevention strategy, the CoCT's waste management by-laws also require the IWMP applications of any property larger than 500 m<sup>2</sup> to be approved by the council.

### **5.8. *Opportunity reduction***

Opportunity reduction is based on the idea that you can design something in a way that reduces or takes away the opportunity for a criminal act to take place by making it inconvenient and therefore disincentivising the practice (Crofts et al., 2010). Opportunity reduction assumes that by making a particular criminal act harder and more challenging to carry out, the perpetrator can make a rational decision and choose not to partake. This concept is linked strongly to illegal dumping because illegal dumpsites mostly tend to be uninhabited spaces and land within communities or on the periphery of communities. Crofts et al. (2010:7) acknowledge that there is an element of risk and reward associated with criminal acts such as illegal dumping. This is also the case in Mbekweni, as identified through GIS analysis of illegal dumping in Mbekweni. A common characteristic of illegal dumpsites in Mbekweni was that they were located on open communal spaces within the community and on large open land on the outskirts of Mbekweni. Crofts et al. (2010:7) suggest that opportunity reduction through infrastructural and environmental design thus becomes important. Crofts et al. (2010:8) further point out that the goal should be to create infrastructure such as gates and fences and structural elements such as vegetable gardens and flowerbeds on open communal spaces so that you can reduce the opportunity for perpetrators to dump their waste on these open spaces, therefore disincentivising illegal dumping (see Appendix F). This is not a guaranteed solution for illegal dumping, but it is a simple strategy to help prevent or reduce illegal dumping. The underlying belief is, therefore, if the risk can outweigh the reward, then the particular environmental crime might not occur.

Bowling et al. (2006) point out that perceptions of your environment influence your attitude towards it and therefore your behaviour. That is why it is so important to change negative perceptions into positive ones. This is particularly relevant in Mbekweni as many people appeared to have a negative perception or view of Mbekweni itself. It is therefore possible that the negative perception of their surroundings influenced some residents' behaviour particularly



with regards to illegal dumping. The assumption is that if you view your surroundings as dirty and undesirable, you are more likely to contribute to the perceived dirtiness by dumping waste or simply not taking care of your surroundings. Various studies (Westphal, 2003; Bonham Jr and Smith, 2008; Kim, Kim and Lee, 2011; Tan, Wang and Sia, 2013; Joo and Kwon, 2015) found that positive environmental designs such as flowerbeds and increased greenery throughout a community have the potential to influence the perceived cleanliness of the environment and therefore reduce criminal incidents. Environmental design solutions such as vegetable gardens on open communal spaces could provide residents with a sense of ownership and therefore territorialism, which may reduce opportunities for potential offenders to dump their waste illegally in the communities. Environmental design features such as gardens, flowerbeds and parks could help improve the aesthetics of Mbekweni, therefore creating a positive image and perception of Mbekweni for the residents. This in turn would enhance residents' pride in the community and acts as a further deterrent for illegal dumping as people start to have pride and take care of their community.

Furthermore, natural surveillance, environmental design and opportunity reduction are closely related. Crofts et al. (2010:10) state that hot spots for illegal dumping are often areas that have little or no natural surveillance. Natural surveillance is possible within a community when the physical features are designed and configured in a way that allows for easy access, free movement and visibility for the whole community. Moreover, Crofts et al. assert that natural surveillance is also based on the 'perception that people can be seen' (2010:10). This usually reduces the opportunity for crime to take place and increases the risk and scrutiny for the perpetrators. Thus the environmental design of a community can increase natural surveillance opportunities.

#### **5.9. *Impact of proximity of illegal dumpsites to households***

The proximity of illegal waste dumps to residential areas is another factor to consider when dealing with the health effects of illegal dumpsites. Abul (2010:21) reveals that the proximity of residential regions to dumpsites can often lead to residents being subjected to nauseating odours. Abul (2010:21) also mentions that those obnoxious odours emanating from dumpsites have the potential make people living close to landfills ill. This point correlates with Mbekweni's residents' general perceptions of dumpsites as being unsanitary and contributing to odours and other nuisances. The various ways in which people can become exposed to

harmful substances include inhalation of deleterious substances like persistent organic pollution (POP) from the dumpsites, contact with contaminated water or soil and direct consumption of products and dirty water (WHO meeting report, 2015). Alam and Ahmade (2013:167) further state that mismanaged solid waste may enter an ecosystem of which humans are part through biodegradation of material that is absorbed into the soil, which may lead to plant uptake, ventilation and pollutants vectored by birds, rats, flies and other animals. POP emanating from dumpsites may be particularly harmful to human health because of its resistance to biodegrading, which leads to bioaccumulation in the environment and which can affect human food chains (Macías-Zamora, 2011). Furthermore, Wrensh (1990, cited in Abul, 2010:22) suggests that the odours emanating from dumpsites may be a source of harmful airborne chemical contamination, which is usually transported to the nearby residents through gas and particle migration. Sankoh, Yan and Tran (2013:6) believe that households situated near illegal waste dumps are more likely to be impacted by the odours than those situated further away. The situation is made worse in the summer months especially, when the rate of biodegradation is speeded up by extreme temperatures (Abul, 2010).

#### **5.10. *Potential environmental consequences of illegal dumping in Mbekweni***

The level of environmental consequences such as land degradation and river pollution were not measured in this study. However, through the use of GIS mapping analysis and photographs, the extent of illegal dumping in Mbekweni was made clear, as well as the consequent potential environmental impacts. One of the main metrics used to highlight the extent and severity of illegal dumping in Mbekweni was the area measurement or sizes of illegal dumpsites in Mbekweni. The majority of the dumpsites were categorised as small (ranging from 1 m<sup>2</sup> to 50 m<sup>2</sup>), but there were several dumpsites that exceeded 100 m<sup>2</sup> in size. This specific finding was alarming, especially considering the environmental and health impacts illegal dumpsites can have.

Moreover, Al-Delaimy, Larsen and Pezzoli (2014) point out that larger illegal dumpsites present the greatest risk for environmental and health hazards due to their size and spatial extent. In addition, these dumpsites represent sites of reoccurring dumping and in some cases are even designated as communal waste dumpsites. Another issue is the possibility for all the medium-sized dumpsites to eventually grow into large-sized dumpsites if they are not monitored effectively and cleared regularly. Large illegal dumpsites are sites of particular

concern and require more attention from authorities, especially since large illegal dumpsites are a symptom of underlying waste collection issues in specific areas. Large land degradation can also take place if there are several small dumpsites located close to each other or if there is a sizeable illegal dumpsite located on communal land.

Apart from the obvious negative visual impact that illegal dumpsites can have, therefore making the landscape appear degraded, the process of clearing and cleaning dumpsites can add to further degradation of land as large machines are used to plough the soil and ground where the dumpsite is located. Vaverková et al. (2019:2) add that part of the problem is that, when an illegal dumpsite is cleared, the particular landscape is left in its degraded form, therefore making it even more undesirable. When the landscape is perceived as undesirable, further illegal dumping is likely to occur. To combat this problem, Vaverková et al. (2019:4) suggest that illegal dumpsites that have a history of reoccurrences therefore need to be replaced with another land use (such as vegetable gardens) in order to help prevent any future dumping on that particular land.

Another key finding of illegal dumpsites in Mbekweni was the waste composition of illegal dumpsites. The waste composition analysis revealed that illegal dumpsites consisted of a myriad of waste types, but C&D waste and household waste were the most prominent waste types found at illegal dumpsites. The C&D waste dumps were an indication of a particular problem with this specific waste type in Mbekweni. Unsurprisingly, household waste was the second-most prominent waste type, possibly indicating a particular issue of household waste collection and/or disposal in Mbekweni. The prominence of this specific waste type coupled with household waste disposal issues such as lack of facilities and resources showed that illegal dumping in Mbekweni was partly as a result of waste management inefficiencies, which is similarly indicated by Dladla, Machete and Shale (2016) and Mushaka (2016). Waste management inefficiencies is an issue for developing nations in particular, and lead to illegal dumping similar to what was observed in Mbekweni (Dladla, Machete and Shale, 2016). Furthermore, the different waste compositions have varying levels of toxicity and harmfulness for the environment and ultimately the health of the residents. Banerjee, Aditya and Saha (2013:235) note that household waste in particular is dangerous because of the organic waste that is present, which can decompose and create odour, unsanitary conditions (which attract vermin) and breeding grounds for biological vector-borne diseases. These vector-borne diseases, such as dengue, can be carried by mosquitoes and infect nearby human populations

(Banerjee, Aditya and Saha, 2013).

A river or waterway becomes polluted when harmful substances such as chemicals and microorganisms enter the river stream and contaminate the water, therefore degrading the water quality and damaging the aquatic ecosystem (Ifeoluwa, 2019). Surface water such as rivers and streams are particularly vulnerable to pollution because water is a universally solvent liquid. The environmental hazard of illegal waste dumping was highlighted by the prevalence of illegal dumpsites in Mbekweni which were located in and near river streams. The locations of these dumpsites were of particular concern because of the environmental risk they pose for aquatic biodiversity but also because of the impact that they could have on the river streams further down the water course (Malinowski, Wolny-Koladka and Jastrzebski, 2015). It is important to note that rivers have increasingly become sites of illegal household waste disposal (Cheng et al., 2018) because the nature of rivers and fluvial systems is to wash away the waste, therefore hiding the 'secret' of illegal dumping for the perpetrator. Many of the illegal dumpsites found in streams were well hidden by tall aquatic vegetation (for instance, reeds) that grows on the non-perennial streams. Malinowski, Wolny-Koladka and Jastrzebski (2015) also note that tall vegetation often makes good hiding spots in rivers for dumping waste. They point out that tall vegetation conceals the location and presence of illegally disposed waste, therefore making it harder for authorities to notice the dumpsites (Malinowski, Wolny-Koladka and Jastrzebski, 2015).

Illegal dumping in rivers represents two types of pollution: point source (PS) and nonpoint source (NPS) pollution. According to Wu and Chen (2013:299), illegal dumping that takes place through PS pollution is when the waste is dumped from a single source straight into the stream. NPS pollution occurs when waste debris from an illegal dump on land is washed into the stream via rainfall; thus there is no single point of pollution or a single identifiable offender (Denchak, 2018). Dassenakis et al. (1998:7) point out that NPS pollution from illegal dumping can also occur when contaminants originating from illegal dumps (such as chemicals and toxins) are washed or diffused into streams and rivers. Fluvial systems such as the Berg River are intrinsically connected as part of the hydrological system, meaning that when pollution occurs at any part of the river course or its tributaries, there are far-reaching effects that may not particularly affect the point of pollution. Granted, the pollution coming from the illegal dumps are minute; however, Mihai et al. (2012) and Malinowski, Wolny-Koladka and Jastrzebski (2015) emphasise that the pollution may accumulate over a long period, therefore

becoming a bigger issue further down the line. That is why it is crucial for river streams to be monitored and cleared of illegal dumpsites. Even the clearing of river streams can be harmful for aquatic environments as large amounts of sediment and silt which contain important nutrients for the health and growth of aquatic plant life are disturbed (Kang, Zhang and Duan, 2020). The illegal dumpsites that were situated in close proximity to the streams pose a risk to the marine environments. Becker, Gerstmann and Frank (2008) note that pollution emanating from the waste can leach into the soil over time and enter the river streams through the subsurface flow. Wu and Chen (2013:302) assert that the effects of NPS pollution from illegal dumping are significantly exacerbated in the rainfall seasons when there is an increase in overland flow (and river flood line) which may transport higher concentrations of contaminants and debris into river streams. These authors also found that rainfall had a rinsing effect on soil near streams which increased the number of contaminants reaching the East River (Dongjiang) in China, and that this process gradually increased as the rainfall season approached.

POP chemicals have the most significant effect on organisms and the ecosystem, and, unlike some other contaminants, POP may persist in the environment for a very long time. Macías-Zamora (2011:275) adds that POP usually has incredibly long half-lives. Also, its other properties such as hydrophobicity and lipophilicity mean that it is not affected by water. Due to its incredible persistence in the environment, POP has a higher chance of entering human food chains through fish contamination, and Munafo et al. (2005:95) maintain this may be particularly biomagnified. Moreover, the impact of illegal dumping in rivers is two-fold, as it affects not only the environment but also human health. The fragility of aquatic ecosystems in fluvial systems makes them incredibly susceptible to pollution and contamination (Scavia et al., 2003), and, as observed, environmental impact associated with pollution mainly comes in the form of eutrophication. Eutrophication in aquatic environments takes place when an excess of nutrients is introduced into surface water (Lenartova et al., 1997). These nutrients, which are mainly nitrogen, phosphate and some others, reduce the oxygen content of surface water – which is also known as hypoxia (anoxic) (Scavia et al., 2003). The reduced oxygen leads to algal blooms and an increase in phytoplankton and macrophyte growth. Li, Li and Zhang (2011:2), explain that these conditions make it hard for aquatic species to survive and lead to further microbial growth. Furthermore, Ma and Hipel (2016:4) report that contaminated inflows from rivers have been known to introduce large amounts of pollutants into lakes and other water features in a watershed, which therefore creates even more extensive and far-reaching ecological and sanitary problems. Due to the linkages in the fluvial system, such



environmental issues eventually start to affect human populations (Rabouille et al., 2008). Alemayehu (2001:2) likewise emphasises that surface water acts as the primary receiver and transmitter of pollutants into groundwater. Groundwater and surface water such as rivers are linked through various geological mechanisms (Brunke and Gonser, 1997). The pollution of waterways primarily through illegal dumping thus becomes more than just an environmental problem but affects both the environment and humans, as both are inextricably linked to one another. It is therefore essential for authorities to focus on streams and rivers to ensure that there are no far-reaching environmental and health effects caused by pollution originating from illegal dumpsites in and around waterways.

### ***5.11. Reflection on ethical concerns***

Several ethical concerns were encountered during the research process. Some of these concerns were pointed out by the participants while others were identified during the proposal and the data-collection phase of the research. One of the main ethical problems encountered during the interview process and which was pointed out by the participants was the issue of confidentiality, especially with regards to questions posed about who was responsible for illegal dumping. A number of residents that were approached to participate in the interview process turned down the opportunity mainly due to fear that some of the research questions would expose them.

More specifically, some residents voiced concern that they did not want to answer specific questions because there were fears that people who took part in the dumping might see them talking to researchers and perceive that as the residents reporting them to authorities. Relating to this point, some residents pointed out that they had made efforts in the past to stop offenders of illegal dumping, but were threatened and told that they did not own the public land and that it was not their concern. Some residents felt that they could not even approach ward councillors as they were cautioned against doing that by the offenders. Before each interview was conducted, it was made clear that all information obtained from participants would remain confidential and would not be used by anyone else. However, certain residents did not budge and opted not to take part in the research. Their decisions were respected and no further pursuit was made, which could have been interpreted as badgering or aggravation.

On a similar note, some participants voiced their discomfort with signing anything (such as a

consent form) as they viewed this as the potential to be scammed or giving away personal information. In response to these concerns, the participants were ensured that no personal information would be captured and that the data collected would only be viewed and used by the researcher. However, in the instance that participants were not convinced, to ease their concerns they were given a choice to add their signatures to the consent form or to just indicate their willingness to participate in the interview by noting some kind of a symbol.

Additionally, moving around from home to home and interviewing residents was sometimes misinterpreted as doing research or work for the municipality. In some instances, residents asked whether the interviews that were being conducted were for the municipality. Others immediately arrived at that conclusion and often shared more information than was needed and veered off into other topics that were not relevant to the research topic. Some participants even used the interviews as an opportunity to voice all their concerns and unload their frustrations about the situation in Mbekweni and the shortcomings of the Drakenstein Local Municipality. The challenge in these instances was to bring them back to the topic at hand in a composed and respectful way that would not be interpreted as being uncompassionate to their situations. There were also sometimes expectations, either explicitly or implicitly communicated by the participants, that I would be able to do something for them, as if I was some sort of intermediary between the residents and the municipal officials. In such situations, it was explicitly stated that the information was for research purposes and that there was no direct link between the research and the Drakenstein Local Municipality.

It must be noted that a sense of yearning to voice concerns and worries was picked up on from my interactions with the residents. It felt as if they had been longing to speak to someone empathetic to their plight. This also links back to the original feeling of neglect from the authorities. The majority of the reactions from residents towards the interviews was a feeling of appreciation and gratitude that someone was willing to listen to the problems that they encountered, especially with regards to illegal dumping and waste management.

#### **5.12. Research challenges and limitations**

Several challenges were encountered during the research process. These ultimately did not hinder my research but certainly made the study more difficult and had an impact on the research. In the following sections, several challenges and limitations encountered during the

research process are identified and discussed.

There were instances during the interview process where participants initially struggled to understand some of the questions. In such cases, I had to find less complicated ways of asking the questions which may have influenced the type of response that was given. The translator assisted in this regard as well. It was not a big issue, although it certainly made that part of the data collection more intensive and time consuming. The time-consuming nature of some of the interviews might have therefore limited the overall number of people interviewed. In some cases, some residents eventually declined to either participate in or continue the interview. Certain participants felt intimidated by the questions or even by the way that the questions were articulated. However, for those participants who felt uncomfortable conversing in English, there was a translator available to communicate the questions in isiXhosa. Taking the time to fully explain the questions I was trying to investigate ultimately made the interviewing process more meaningful as the participants were given time to elaborate on their responses fully.

During the second phase of data collection, in which the interviews were conducted, the distance of the study area was a challenge. I was in Cape Town and therefore required to travel to and from Mbekweni Township every day during the fieldwork period. If it were not for the distance, we would have certainly have considered making more trips to Mbekweni. The far distances travelled made the process more strenuous and limited the time we spent in the field on individual days, so this was a time-constraint challenge, not to mention the cost of petrol to travel to Mbekweni so frequently.

The Drakenstein Local Municipality previously communicated that there was preliminary GIS data available that they had collected with regards to illegal dumpsites and signage they had installed. We found out that their data was not comprehensive enough to be of any relevance to the study. This required me to conduct the GIS data collection from scratch without any assistance from previously identified hotspots. Also, the research hoped to be able to compare the signage data with the existence of illegal dumpsites in Mbekweni and determine whether the signage has an impact on the distribution of illegal dumpsites. However, that was not possible because the signage data was insufficient.

The lockdown restrictions that started in late March and early April 2020 due to the coronavirus pandemic limited any additional data collection that I had planned to conduct. The first set of

auxiliary data I intended to gather in Mbekweni included additional photographs of illegal dumpsites as well as updating my database with possible new illegal dumps and those that may have been cleared but had reappeared. The intention was to illustrate the temporal and reproductive nature of illegal dumpsites in Mbekweni and to identify further areas or hot spots for illegal dumping. After revising the study area, I had hoped to identify additional points of analysis with regards to the GIS data. The expectation was also to conduct further interviews with more residents to find out whether new themes and issues had emerged since the last interview process. Unfortunately, none of this could now take place and I was limited to using the data I had collected during the first data-collection process.



## Chapter 6: Conclusion and Recommendations

### 6.1. *Summary of key research findings*

The main perceptions of illegal dumping in Mbekweni revolve around four main aspects: the health risks to children; the lack of resources and effective waste management; accountability for cleaning illegal dumpsites and keeping the community clean; and distrust in the municipality.

The potential health impacts that illegal dumpsites could have on children was highlighted as the main concern with regards to illegal dumping in Mbekweni. This concern was linked to the fact that many children play in communal spaces that are often targeted as sites for illegal dumping. Children were therefore pointed out as the most vulnerable to the health impacts of illegal dumps.

Participants perceived two different parties as being responsible for the problem of illegal dumping in Mbekweni. On the one hand, some participants thought the municipality was mainly responsible for cleaning up after the residents, and, on the other hand, others viewed the other residents, the community, as responsible for the problem of illegal dumping. The prevailing attitude among some residents that the municipality is responsible for keeping Mbekweni clean was emphasised as the central issue behind the prevalence of illegal dumping in Mbekweni. This perception also contributed to the feeling of mistrust and frustration towards the municipality that most residents indicated. This harboured mistrust was as a result of the lack of effective waste management services, the lack of communication between residents, councillors and municipal officials, and the feeling that certain residents were being neglected. The residents' perceived neglect by the municipality was not only in terms of waste management but also for other aspects such as service delivery (water, housing and sewerage) and employment opportunities. To this point, one of the main frustrations expressed by the residents was also related to the lack of employment opportunities, especially because many residents looked to the municipality to provide jobs, such as EPWP labour jobs.

One of the most significant attributes that contributes to illegal dumping, which was highlighted in the literature and was present in Mbekweni, is a lack of resources and the perceived inadequacy of waste management services such as waste collection and street cleaning.



Specifically, in the informal section of Mbekweni, irregular waste collection, inefficient street cleaning and lack of additional resources such as black bags, bins and waste facilities were pointed out as the main drivers of illegal dumping. The unequal distribution of waste facilities contributed to this perceived lack of resources. From a distribution analysis of waste facilities, it was discovered that the mini drop-off facilities were not spatially distributed equally, which was linked to a perceived disparity of service delivery in different parts of Mbekweni. The perception of a gap in service delivery originated from residents residing in the informal settlement of Mbekweni, while residents in the more formal parts did not share the same perceptions. The differences in attitudes and perceptions thus correlated with the contrasting types of housing in Mbekweni, namely formal and informal.

The biggest illegal dumpsites in Mbekweni were sites of reoccurrence of dumping. These areas had therefore turned into communal dumpsites. These dumpsites also pose the biggest threat to environmental degradation as well as having the biggest health impacts and the most other nuisances such as odour and vermin. Importantly, the various sizes of illegal dumpsites showed that there was more dumping taking place in some areas over others. Moreover, it is also important to note dumpsites that were categorised as medium sized had the potential to turn into large illegal dumpsites if they were not effectively monitored.

The waste analysis composition of illegal dumpsites revealed that C&D waste was a problematic waste type in Mbekweni, with C&D waste being the most common waste type seen in illegal dumpsites. The particular issue of C&D waste in Mbekweni correlated with the notion reported by residents that illegal dumping occurred due to a lack of knowledge of how to treat certain types of garbage. C&D waste, dead dogs and waste materials such as nappies (*'kimbi'*) were highlighted as the waste types that residents found hardest to handle. Part of the problem with the management of these waste types is that no information was provided on how to manage them and there were not sufficient waste facilities available for disposal of such waste. C&D waste is a challenging waste type to dispose of because many waste collection and disposal systems do not account for the management of it. The prevalence of C&D waste dumps was also attributed to the fact that the refuse collection service did not accept it. Related to this was the miscommunication between residents and the municipality about the handling of C&D waste.

The spatial distribution of illegal dumpsites revealed that rivers and water streams were a prime

target for dumping sites. The prevalence of dumpsites in rivers was attributed to the concealing effect provided by the rivers. Rivers and waterways were also highlighted as hot spots needing more intensive cleaning and monitoring. Rivers were also of particular importance due to the potential environmental harm that dumpsites could cause through pollution. This pollution had the potential to have far-reaching impacts on water streams not only in Mbekweni but also further down the fluvial course. Community characteristics such as open and uncared-for spaces and open land on the outskirts of the township made it easier for offenders to dump waste and get away with it without the fear of being apprehended. These open spaces were also easily accessible by car, and the street patterns of some communities made it easier for offenders to move in and out of the community with ease. Due to these characteristics, environmental designs such as parks, flowerbeds, vegetable gardens and fences were identified as ideal prevention measures to reduce opportunities for illegal dumping and increase the perceived risk of dumping waste in certain areas for potential perpetrators.

## **6.2. Conclusion**

Illegal dumping is an increasing and significant problem in Mbekweni Township. It is a reoccurring problem that shows signs of not going away any time soon. Illegal dumping is having an impact on the environment, the quality of life of residents and the way the residents view their community. The purpose of this study was to investigate the perceptions of residents on illegal waste dumping and to capture and understand the spatial variables related to illegal dumping and how they contribute to the occurrence of illegal dumping in Mbekweni. The outcomes demonstrated that illegal dumping was a problem spread spatially across Mbekweni but that there were some areas more heavily impacted by the occurrence of illegal dumpsites than others. Furthermore, the varying sizes of illegal dumpsites, especially the abundance of large dumpsites, indicated that there were sites of reoccurring dumping and sites that need increased monitoring.

It was also demonstrated that illegal dumping was a symptom of a lack of resources particularly amongst informal settlement residents, and that illegal dumping was in some way viewed as an alternative waste disposal method. This was coupled with the fact that, while most residents viewed illegal dumping as detrimental to the health of the community, they did not accept responsibility for the dumping of waste but rather expected the municipality to clean up after them. It can be deduced that there is little or no consideration on the part of some residents for

their fellow neighbours or even the potential environmental consequences of the activity. The problem of illegal waste disposal was found to be partly a consequence of the residents' actions as well as a number of other reasons, including absence of access to resources, poor judgment informed by not knowing better and lack of strict enforcement. It is too easy to tell people to desist from dumping their waste illegally and that they should exercise responsible waste disposal. Part of the problem, however, is that illegal waste disposal is not considered a big problem as long as the municipality keeps cleaning illegal dumpsites. There is only so much that the municipality can do such as providing regular refuse collection and cleaning up street regularly. However, community cleanliness should be a community responsibility as much as it is the municipality's responsibility. The community in Mbekweni needs to take responsibility for their actions while also understanding that the way in which they use and what they do in their community spaces has an impact on others as well. The misperceptions of waste management present in Mbekweni calls for increased engagement between the community and the municipal authorities. Illegal dumping is a complex and multifaceted problem that requires a multifaceted approach. There is no single solution. Part of the problem is that current solutions and measures to curb illegal dumping do not accommodate for a multifaceted approach, but it is also possible that budgetary constraints limit what approaches can and cannot be implemented.

Waste management issues such as illegal dumping are issues that need to be handled and approached in a realistic and practical way. One such framework that supports this type of approach is pragmatism. Pragmatism in this regard is based on practical rather than theoretical considerations. Also, pragmatism states that the pursuit of knowledge is only useful when it is used to address issues in real life and can be used to develop practical solutions. Therefore, the following recommendations were developed from a pragmatic point of view, in which they can be applied to reality and are based on practical considerations.

### **6.3. Recommendations**

#### **6.3.1. Practice recommendations**

Based on the findings of this research, the following recommendations are proposed.

There needs to be targeted and regular awareness and educational campaigns to educate and

inform the residents of Mbekweni on the importance of responsible waste disposal practices, as well as on the dangers of illegal dumping and how it can affect all aspects of community life. From the interview data gathered, it was noted that education and knowledge around aspects of waste management were lacking in Mbekweni. Residents expressed a need for educational information around environmental duty of care and waste management. The campaigns should be aimed at changing and overcoming the current attitudes of residents with regards to illegal dumping, environmental duty of care and alternative household disposal methods such as drop-off facilities. A sense of responsibility needs to be instilled in all residents, starting at the household level. Educative approaches must also emphasise the harm that illegal dumps can have on the community, especially the children of Mbekweni. By appealing to the benevolent and compassionate side of people, residents may think twice before dumping waste the next time.

Coupled with the need for increased awareness, a platform on which residents can engage with municipal authorities on issues such as illegal dumping seems to be a necessity. Residents regularly expressed a need for such a platform to discuss issues in Mbekweni and possible solutions with the municipality. A platform for community engagement and consultation with municipal officials was highlighted as one of the main needs in the community. A platform such as regular community stakeholder meetings and engagements would establish an open line of communication between the residents, ward councillors and municipal authorities. This would help the authorities be proactive and current about community problems and concerns, but it will also assist in making the residents feel as if their concerns are being heard and acted upon, which may further boost trust between residents and authorities. The enhanced confidence and belief between the two may promote better intra-community governance and residents would probably be more willing to listen and abide by rules and regulations. Community engagement efforts would provide a good platform for additional dissemination of critical educative information.

From an environmental and infrastructural point of view, environmental designs such as flowerbeds, vegetable gardens and parks would assist in reducing the opportunity for illegal dumping while also increasing the risk and effort of illegal dumping and reducing the reward for such activities. Different types of land uses were proposed by some residents as a possible solution for curbing illegal dumping. Setting up and constructing small vegetable gardens and flowerbeds on open community spaces would be beneficial in a variety of ways. Firstly,

changing the land use of community spaces with vegetable gardens, for instance, reduces the opportunity for people to dump their waste on these community spaces. The added benefit of vegetable gardens in particular is that you can create an alternative source of food and even livelihoods for people who really need it. Secondly, land uses such as flowerbeds improve the aesthetics of the community, which has the benefit of improving the residents' perceived image of Mbekweni which may further enhance important community functions such as natural surveillance, intra-community governance and community pride. Residents of Mbekweni would then hopefully be more willing to actively monitor their own community and keep it clean and rid of illegal dumps. Thirdly, community parks would provide safe spaces for children to play and encourage exercise.

Linking to the previous recommendation, the biggest problem with illegal dumping sites is that they remain sites of reoccurring dumping for a long time. This study recommends that cleaned dumping sites, especially the largest ones in Mbekweni, should be remediated with a different form of land use such as gardens, instead of leaving the land bare and degraded with a high possibility of dumping to reoccur. The remediation of the degraded landscapes may deter offenders from dumping their waste in that particular site the next time. It is important to note that while this approach may appear costly, the reduction in illegal dumping will save the municipality from spending unnecessarily in the long term while having the immediate benefits for the environment and the residents.

From a management and monitoring perspective, TrashOut would be a useful tool for the municipality to adopt in their monitoring efforts of illegal dumping in Mbekweni. This study has demonstrated how the mobile application TrashOut can be used for locating and monitoring illegal dumpsites. One of the main benefits of TrashOut is that it is collaborative and does not necessarily have to be used only by municipal officials but can also be used by any resident of Mbekweni who can assist with the monitoring of dumping sites and locating newer sites across Mbekweni. Another benefit of TrashOut is the relative low cost of using such a tool, which would make it easier to implement as part of the strategies and methods to increase monitoring efforts and which may reduce illegal dumping in Mbekweni and even other areas of the Drakenstein Local Municipality.

An important finding of this research was that there was a need for and a perceived lack of waste facilities such as waste drop-off facilities in Mbekweni. It was noted that there was a



lack of adequate waste disposal facilities available for all residents in Mbekweni. While there are already three mini drop-off facilities in Mbekweni, the spatial distribution of the drop-off facilities means that not all residents in Mbekweni have access to the facilities. Therefore, more mini drop-off facilities need to be built in Mbekweni not only to help reduce illegal waste disposal but to also provide all residents, especially those in the informal and more impoverished areas of Mbekweni, with access to an alternative method of waste disposal. It is also important to ensure that the current mini drop-off facilities are being used and managed properly. While you cannot expect the municipality to monitor these facilities at all times, due to lack of personnel – which is dictated by budgetary constraints – a co-management strategy could be followed to manage and monitor these facilities. A co-management approach would include a partnership based on an agreement between certain members of the community and municipal authorities on monitoring that the facilities are being utilised in a proper way.

### 6.3.2. *Policy recommendations*

The last recommendation entails punitive measures with regards to illegal dumping. Punitive measures such as fines need to be implemented more harshly in Mbekweni in an effort to discourage potential offenders from dumping waste illegally. This is based on the understanding that illegal waste disposal is currently not perceived as an illegal offense but merely as an alternative means to waste disposal. By implementing harsh and expensive punitive measures such as fines for offenders, there will be an understanding that dumping waste is not permissible and that the consequences will be harsh. This may lead to residents taking the rules and regulations around waste disposal more seriously. The emphasis on illegal waste disposal as a punishable offense will further create community awareness of and concern for the issue. Residents will understand that illegal waste disposal of any kind is wrongful and punishable.

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## Appendices

### *Appendix A: National Legislation*

#### 1.1 The Constitution of South Africa, 1996

The underpinning legislation that ultimately gave rise to the environmental laws in South Africa is the Constitution. In the often-quoted Section 24, the Constitution of South Africa (1996) states that:

*‘Everyone has the (fundamental) right –*

*(a) To an environment that is not harmful to their health or well-being; and*

*(b) To have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that –*

*(i) Prevent pollution and ecological degradation;*

*(ii) Promote conservation; and*

*(iii) Secure ecologically sustainable economic and social development.’ (RSA, 1996:24)*

#### 1.2 National Environmental Management: Waste Act 59 of 2008

Currently, the overriding legislation covering illegal dumping in South Africa is the National Environmental Management Act: Waste Act 59 of 2008 (NEM:WA). The preamble to this Act reinforces the Constitution, stating that:

*‘Whereas everyone has the constitutional right to have an environment that is not harmful to his or her health and to have the environment protected for the benefit of present and future generations through reasonable legislative and other measures that –*

*a) Prevent pollution and ecological degradation;*

*b) Promote conservation; and*

*c) Secure ecologically sustainable development and the use of natural resources while promoting justifiable economic and social development.’*

*(NEM:WA, 2008:2)*

The preamble further acknowledges that ‘poor waste management practices can have an adverse impact both globally and locally.’

For the purpose of uniform understanding, the following definitions are repeated from

NEM:WA, 2008 previously referenced:

- ‘Disposal’ means the burial, deposit, discharge, abandoning, dumping, placing or release of any waste into, or onto, any land;
- ‘General waste’ means waste that does not pose an immediate hazard or threat to health or the environment, and includes –

a) Domestic waste;

b) Building and demolition waste;

c) Business waste; and

d) Inert waste.

- ‘Storage’ means the accumulation of waste in a manner that does not constitute treatment or disposal of that waste;
- ‘Waste’ means any substance, whether or not that substance can be reduced, reused, recycled and recovered – (a) that is surplus, unwanted, rejected, discarded, abandoned or disposed of;
- ‘Waste management activity’ ... includes...

c) the accumulation and storage of waste;

g) the transportation of waste;

h) the transfer of waste. (NEM:WA, 2008:12-16)

In terms of Section 16 (1) (NEM:WA, 2008:32), ‘a holder of waste must, within the holder’s power, take all reasonable measures to –

c) ... ensure the waste is treated and disposed of in an environmentally sound manner;

d) waste... does not endanger health or the environment or cause nuisance through noise, odour or visual impact;

e) prevent any employee or any person under his or her supervision from contravening this Act; and

f) prevent the waste from being used for an unauthorised purpose.’

In the event that any legal entity (person or organisation) does store waste, the following precautions must be taken in terms of Section 21 of the Waste Act:

‘(c) the waste cannot be blown away;

(d) nuisances such as odour, visual impacts and breeding of vectors do not arise;

and

(e) pollution of the environment and harm to health are prevented. (NEM:WA, 2008:38)

Transporters of waste are no less liable for the illegal disposal of waste. Section 25 (3) and (5) of NEM:WA stipulates that the transporter must ensure the facility is duly authorised to accept waste before off-loading such. Further, it is assumed that the driver and owner ('person who is in control of the vehicle, or in a position to control the use of the vehicle') knowingly deposit the waste at that particular location (NEM:WA, 2008:40).

Section 26(1) of NEM:WA goes on to reiterate that 'No person may—

(a) dispose of waste, or knowingly or negligently cause or permit waste to be disposed of, in or on any land, water body or at any facility unless the disposal of that waste is authorised by law; or

(b) dispose of waste in a manner that is likely to cause pollution of the environment or harm to health and well-being.'

Contravention of NEM:WA, whether intentionally or in ignorance, carries penalties in terms of Section 68 of NEM:WA. Penalties range from six months in prison with or without a fine, up to R10 000 000 or 10 years in prison. Where offences are not remedied after conviction, a further fine of R1 000 per day and / or 20 days imprisonment (per day the offence persists) can be levied (NEM:WA, 2008:74).

### 1.3 National Water Act (36 of 1998)

The preamble of the National Water Act (NWA) acknowledges the scarcity of water and recognises the need to achieve sustainable water use and protect water quality. Part 4 of the act is the portion that covers prevention of pollution, especially where that pollution results from land-based activities. Section 19 states it as follows:

'19. (1) An owner of land, a person in control of land or a person who occupies or uses the land on which -

(a) any activity or process is or was performed or undertaken; or

(b) any other situation exists, which causes, has caused or is likely to cause pollution of a water resource, must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring...

(4) Should a person fail to comply, or comply inadequately with a directive given ..., the catchment management agency may take the measures it considers necessary to remedy the situation.

(5) ... a catchment management agency may recover all costs incurred... from the following persons:

(a) Any person who is or was responsible for, or who directly or indirectly contributed to, the pollution or the potential pollution;

v

(b) the owner of the land at the time when the pollution or the potential for pollution occurred, or that owner's successor-in-title;

(c) the person in control of the land or any person who has a right to use the land at the time when -

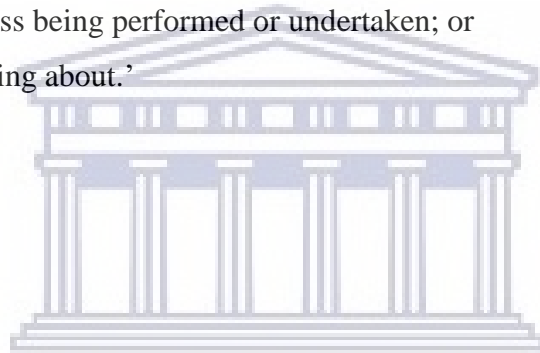
(i) the activity or the process is or was performed or undertaken; or

(ii) the situation came about.

(d) any person who negligently failed to prevent -

(i) the activity or the process being performed or undertaken; or

(ii) the situation from coming about.



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## Appendix B: Questionnaire



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email: [3535526@myuwc.ac.za](mailto:3535526@myuwc.ac.za)

Department of Geography, Environmental Studies and tourism

Dear Respondent

I, Alex Kimani (student number 3535526), a registered Masters student in above-mentioned department, is doing research on the *GIS mapping of community perceptions of illegal waste dumping in Mbekweni, Paarl*.

The following questionnaire forms part of the fieldwork that I am conducting in the study area. To this end, I wish to collect data regarding the physical locations of illegal dumpsites, their sizes as well as your opinions and views on illegal dumpsites and dumping of waste in Mbekweni.

Your input in answering the following questions will be appreciated and assurance is given that all responses/data collected/output based on this survey, will be treated with the necessary confidentiality and academic integrity as prescribed by the research ethics guidelines of the University of the Western Cape.

### Personal information and illegal dumping awareness

1. Are you aware of illegal dumping in Mbekweni? Y/N
2. Where in Mbekweni do you stay?/Address
3. Have you personally witnessed illegal dumping taking place in your community? Y/N
4. If yes, how often do you witness waste been dumped illegally

Period	Frequency (once, twice, etc.)
Monthly	
Weekly	
Daily	
Never/Not Applicable	

5. Where in Mbekweni did/do you observe illegal dumping?
6. On what day(s) and at what times does the illegal dumping that you have observed normally occur?
7. Why do you think people dump their waste illegally?

### **Impacts of illegal dumping**

8. Does illegal dumping affect you and your family? If yes, in what ways does it affect you?
9. Have you observed any animals at illegal dumpsites?
10. I yes, name them.
11. Have you ever seen children playing at or near an illegal dumpsite?
12. Name the waste products that you have seen at the illegal sites.

### **Waste disposal management/governance in Mbekweni**

13. Who or which organization is responsible for keeping public open spaces clean in Mbekweni?
14. How do you dispose your household waste?
15. Are you satisfied with household waste removal services in Mbekweni? Y/N
16. Explain your answer to question 15.
17. Provide suggestions to improve waste disposal and removal services in Mbekweni.

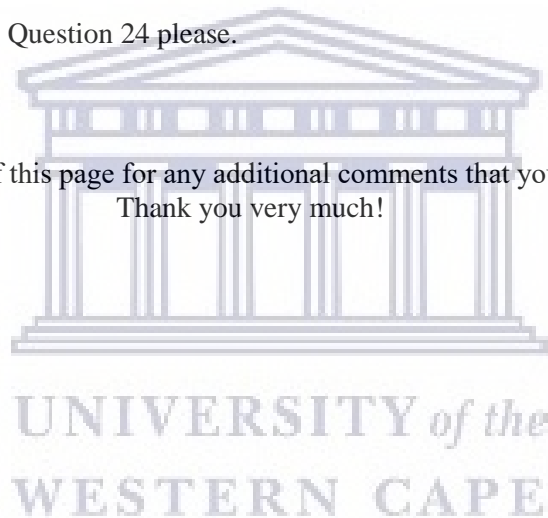
### **Illegal dumping interventions and prevention measures**

18. What do you think the municipality/authorities should do to encourage residents to keep their private and public spaces clean?

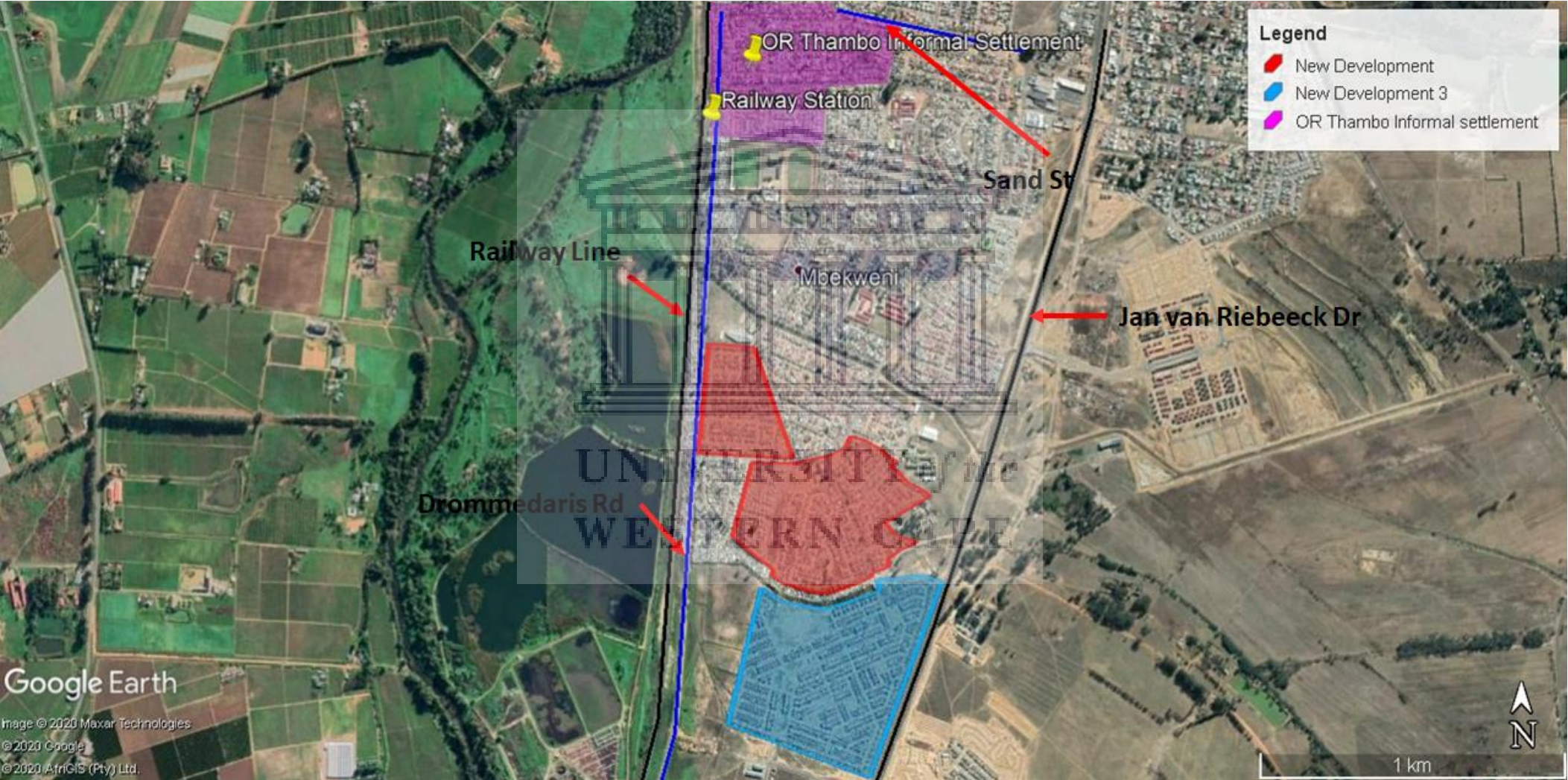


19. What do you think can be done from a household point of view to negate illegal dumping in Mbekweni?
20. What do you think can be done from a community point of view to negate illegal dumping in Mbekweni?
21. Do you know where the closest drop-off facility is? Y/N
22. If Yes, name the location of the facility.
23. How far would you be willing to travel, to drop your waste off?
24. Are there ways that people can generate income from waste? Y/N
25. Explain your response to Question 24 please.

Please use the reverse side of this page for any additional comments that you'd like to make.  
Thank you very much!



Appendix C: Mbekweni Township Reference Map





*Appendix D: Illegal Dumpsites Before and After Being Cleared*

Before



Before



Before



After



After



After





*Appendix E: Mbekweni Mini Drop-off Facilities*



This is the current state of the mini drop-off facilities in Mbekweni. All three drop-off facilities have been burnt down, with only the brick structure remaining. Excessive dumping of waste around the drop-off facilities still persists. It is clear from the images above that the drop-off facilities have become dumping sites. Similarly, it appears as if C&D waste is still an issue in the area, as it is the most prominent type of waste found at the drop-off facilities. The images below provide a sense of how damaged the drop-offs are.







*Appendix F: Illegal Dumping Mitigation Design Features*



These images depict some of the design features that are being used in Mbekweni to help curb illegal dumping. The use of old tyres appears to be a common material used to create small barriers or fences in an attempt to prevent offenders from dumping waste in those spaces. It is a good way to utilise old materials that would otherwise end up at a landfill or dumpsite. Notably, the image in the top left corner illustrates how simple and relatively cost-effective materials can be used to try and beautify shared spaces. Small gardens have been built in an attempt to bring some aesthetics to the space. This is also good for creating spaces that people can take ownership and responsibility of.