

AN INVESTIGATION OF THE EXTENT OF IMPLEMENTATION OF EIA  
REGULATIONS TOWARDS HEALTH HAZARD PREVENTION AT KWAMATHUKUZA,  
NEWCASTLE

by

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## **DECLARATION**

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Student number: **44376995**

I declare that the thesis hereby submitted for the Master of Science degree at the University of South Africa is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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SIGNATURE

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DATE

**An investigation of the extent of implementation of EIA regulations towards  
health hazard prevention at Kwamathukuza, Newcastle**

## DEDICATION

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I dedicate this thesis to my late mother Mrs Nompumelelo Mbatha - Miya for the good values and confidence she instilled in me. This is where she left off I'm moving further to the peak. There's not a day that I don't think about you. I love you so much.

Mbatha, Shandu ka Ndaba  
Gumbi Lama Gwala  
Sontshikazi, Mthiya othiya ngenkomo abafokazana bethiya ngamahlala  
NDABEZITHA!

UShandu ubengengakanani,  
ngoba entendeni yesandl uyenela  
Nasothini lomkhonto uyahlala athi cababa,  
Mazalankosi!  
Mavungama!  
Mathabathanyawo!  
Makhabaluthuli!  
Makhub'anothuli!

uShandu ongayimbathi ingubo  
oyimbatha ngokusibekela kwelanga,  
Wavala ngehemu emizini yamadoda  
uShandu omuhle ngamazinyo akhe;  
uZihlabathi zoLwandle;

NDABEZITHA!!

NDABA KOMKHULU!!

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## ABSTRACT

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Chemical (gaseous) emissions from wastewater treatment plants (WWTP) are perceived as odour and can generate undesirable health reactions. These could affect the quality of life to those regularly albeit intermittently exposed, although regular exposure may result in tolerance and loss of recognition of the odour. Consequently, research is necessary to establish the role of Environmental Impact Assessment (EIA) in ensuring that facilities such as WWTP do not pose a threat to local communities, particularly in relation to housing developments for poor communities.

The aim of this study was to investigate if the EIA regulations were effectively implemented before building of the Residential Development Project (RDP) houses at KwaMathukuza, in Newcastle South Africa. Furthermore, the study intended to determine the impact the (WWTP) has on the health of people who reside close to the site and to establish if the families staying close to the WWTP have any common ailments such as handicapped babies, early deaths within families. Findings would also indicate if RDP houses should be built in close proximity to such sites.

Data was collected through a survey of 85 residents living within five kilometers and ten residing beyond five kilometers from the WWTP. The participants were selected randomly. Municipality employees who worked with the WWTP were also sampled together with healthcare givers. Data included information about health of the community, their perception of the gases released from the WWTP as well as EIA meetings and processes related to the construction of the RDP houses.

The outcome of this study revealed that EIA regulations were not adequately implemented and that this residential site was unsuitable for the construction of RDP houses. It emerged that the residence regularly experience unpleasant odours released from the WWTP. These could be associated with ill-health of the residents as well as

degradation the environment in general. The study also found that the effect of the WWTP affects even those communities who reside beyond five kilometers from the WWTP. The researcher argues for more stringent mechanisms to ensure that EIA regulations are properly implemented to prevent adverse effects on the communities.

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## ACCRONYMS AND ABBREVIATIONS

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<b>CWT</b>	Centralised Wastewater Treatment
<b>DEA</b>	Department of Environmental Affairs
<b>DWT</b>	Decentralised Wastewater Treatment
<b>ECA</b>	Environment Conservation Act
<b>EIR</b>	Environmental Impact Report
<b>EIA</b>	Environmental Impact Assessment
<b>FET</b>	Further Education and Training
<b>FIDOL</b>	frequency, intensity, duration, offensiveness, and location
<b>HIA</b>	Health Impact Assessment
<b>IEM</b>	Integrated Environmental Management
<b>NE</b>	North East
<b>NEMA</b>	National Environmental Management Act
<b>NEPA</b>	National Environmental Policy Act
<b>NW</b>	North West
<b>PDA</b>	personal digital apparatus
<b>ROD</b>	Record of Decision
<b>RDP</b>	Residential Development Project
<b>SAWS</b>	South African Weather Services
<b>SPSS</b>	Statistical Programme for Social Sciences
<b>SW</b>	South West
<b>UNCED</b>	United Nations Conference on Environment and Development
<b>WM</b>	Waste Management
<b>WWTP</b>	Waste Water Treatment Plant

# CHAPTER 1: INTRODUCTION

---

## 1.1 Background

Waste is any material or substance that is of no further use and has been discarded. It can be any matter, whether solid, liquid, gaseous or radioactive, which is discharged, emitted or deposited in the environment in such volume, constituency or manner as to cause an alteration of the environment (Botkin and Killer, 2007). Waste management is therefore the process of monitoring waste materials to reduce their effect on health and the environment, through ensuring that all waste is collected, disposed and processed accordingly (Keirungi, 2006). The waste management hierarchy requires firstly that the generation of waste is reduced, waste that cannot be reduced is reused (reclaimed) or recycled, waste that cannot be reused or recycled should be treated either mechanically, biologically, chemically, thermally, or using other means to ensure environmental sustainability (WHO, 2004).

All residential developments must be served with wastewater collection and treatment facilities to ensure environmental sustainability through protecting the environment and keeping away hazards from people. A wastewater treatment plant (WWTP) is a facility, which handles all processes that involve the removal of contaminants from wastewater (Botkin and Killer, 2007). The process involves biological and chemical treatments to a certain specification and can be further treated, if needed, to produce a quality of water that will be conducive for human consumption, without leading to outbreak of any diseases (Botkin and Killer, 2007). The reuse of treated wastewater applied for industrial and municipal purpose has become a vital component of sustainable water resource management for urban and rural areas around the globe (Levine and Asano, 2004). WM can differ for developed and developing nations, for urban and rural areas and for residential and industrial producers. Some areas prefer the centralized

wastewater reclamation system, which refers to the wastewater reuse systems that are applied on a large scale. Whereas other areas, prefer a decentralized wastewater reclamation system, which is a specialized system for reuse of water that caters for small scale such as hotels, universities and official buildings (Jia *et al.*, 2005).

In America, the United States Environmental Protection Agency (USEPA, 2009), through its construction grants program funded the construction of new (centralised and decentralised) WWTP's throughout the United States. In Asia, there has been the emergence of decentralized wastewater reuse systems in urban and rural areas around Beijing, which are highly influenced by the number of industries found in the central region, even though the centralized system is there to cater for a larger scale (Jia *et al.*, 2005). Furthermore the wastewater treatment in all parts of Europe has notably improved significantly since the past 15-20 years (EEA, 2010).

In several countries in north-western Europe there has been an increase in the population connected to waste water treatment thus the decentralised system has begun emerging. However the percentage of population connected to the centralized waste water treatment is relatively low in southern Europe and in the Accession countries (EEA, 2010). Nevertheless, in the Middle East, in the state of Israel the local authorities are legally responsible for the collection, treatment and sanitary disposal of wastewater generated within boundaries (Hophmayer-Tokich, 2007). The same principle applies in South Africa, where local government through municipalities is responsible for WWTP's construction. With this in mind, some scholars such as Hophmayer-Tokich (2007) have argued about the use of the centralized reclamation systems, as currently being used not only in South Africa, stating that it poses health risks to the receiving end as it may still have contaminant loads. This suggests that it is only a minor fraction of the high quality water distributed in urban areas that is good for human consumption. This leaves a gap for other scholars to further investigate.

## 1.2 Problem Statement

Chemical emissions from waste treatment processes are perceived as odour and can be occasional, repeated or continuous and vary strongly by intensity (Aatamila *et al.*, 2011). The variability of gases released is influenced by time, atmospheric conditions and the subjectivity of the smell perception. The odours arise from the complex nature of reactions associated with sewage processing and the decomposition of volatile organic materials (Frenchen, 1992). The major components of gases released from the WWTP can include nitrogen ( $N_2$ ), hydrogen sulfide ( $H_2S$ ), carbon dioxide ( $CO_2$ ), methane ( $CH_4$ ) and ammonia ( $NH_3$ ). Zarra *et al.* (2008) reported that gases released from WWTP generate undesirable health reactions ranging from physical symptoms, including sensory irritations, headaches, respiratory problems, nausea and vomiting. In overall, these gases will affect the quality of life to those regularly albeit intermittently exposed, although regular exposure may result in tolerance and loss of recognition of the odour.

The South Africa's Constitution (1996), Section 24 guarantees all its citizens the right to an environment that is not harmful to their health and well-being. However the constitution appears to be ignored if in principle is not applied to solve any issues that concern the wellbeing of society. Given that South Africa has a diverse management tools, such as the environmental impact assessment (EIA), which is an integral process done to review all projects to promote development design that limits or reduces vulnerability to hazards, furthermore EIA helps to assess the impact of the project on the environment and ensures mitigation measures are properly incorporated to reduce the negative environmental impacts (Rossouw *et al.*, 2003). It emerges strongly therefore to question the regulations that govern the building of housing systems in KwaMathukuza, Newcastle if the municipality only worried about providing shelter and ignored the health impacts and many other possible environmental impacts that may be associated with weak developmental policies and regulations.



### 1.3 Rationale

Protecting the environment and societies has long been the mainstay of public health practice, given that the chemicals and gases released in the air system result in serious health hazards (French, 1994). The current author shares this sentiment particularly in relation to rural communities in South Africa. In this instance, there is a great concern towards the health of communities who are based in a developing town of Newcastle at kwaMathukuza Section, which has been labeled as 'emanukwini' which means the filthy place in Northern KwaZulu Natal.

In KwaMathukuza people reside in close proximity to a water treatment plant as they are from poor backgrounds. Given the health hazards raised from the introduction of this proposal, much research needs to be done to investigate the extent of implementation of EIA regulations towards health hazard prevention at KwaMathukuza, Newcastle. There is limited knowledge of whether EIA studies were conducted before those Residential Development Project (RDP) houses for these communities were built.

### 1.4 The research questions

Based on the below objectives, the current study intends to respond to the following research question:

***To what extent were the EIA regulations implemented to prevent health hazards in Newcastle?***

To respond to the above research question, the following sub-questions will be asked:

- 1) How were the integrated environmental assessment (EIA) regulations applied and proper mitigation measures considered for people's safety?

- 2) What is the impact of gases released from the sewage treatment facility on health of residents living adjacent to such sites in Newcastle?
- 3) Should residential houses be built close the WWTP?
- 4) Do families that reside close to the WWTP present common ailments such as deformities or early deaths within families?

## **1.5 The aim of the study**

The aim of this study was to determine the extent to which the EIA regulations were implemented to prevent health hazards in Newcastle.

The specific objectives of the study were to:

- To investigate if the integrated environmental assessment (EIA) regulations were effectively implemented before building the (RDP) houses.
- To evaluate whether the (RDP) houses should ever be built close to such sites.
- To investigate the impact the (WWTP) has on the health of people who reside close to the site.
- To establish if the families staying close to the WWTP have any common ailments such as handicapped babies, early deaths in family.

## **1.6 Conclusion**

The findings of this study will contribute to the existing knowledge on EIA application. It is known that EIA helps the developers make informed decisions therefore it is the researcher's interest to investigate if whether EIA regulations and applicable policies and measures were properly applied to reduce the impact especially with regards to a separation distance between a WWTP and a residential area in preventing health hazards.

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## **CHAPTER 2: LITERATURE REVIEW**

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### **2.1 Introduction**

This chapter presents a comprehensive view of EIA and its importance for any envisaged development. It further looks at EIA on health impacts from global perspective down to local perspective, all to try and explain the importance of EIA in environmental protection. There is in-depth explanation of waste management in relation to wastewater treatments and the range of efforts made to render the water reusable. Further explanation is done on approaches to manage odours released during wastewater treatment plants, factors that render the wastewater treatment plants odour emissions as health hazards to humans are also brought into consideration.

### **2.2 Background on EIA**

EIA is a pro-active and systematic process where potential environmental impacts both positive and negative associated with proposed activities are assessed and reported before the project is undertaken (Patel, 2009). The aim of EIA is to provide decision-makers (be they government authorities, the project proponent or financial institutions) with adequate and appropriate information about the potential positive and negative impacts of a proposed development and associated management actions in order to make an informed decision whether or not to approve, proceed with or finance the development (DEAT, 2006). It is also undertaken to examine compliance with environmental policies and legislative environmental requirements in order to verify risks associated with any upcoming project and expose them for correction (Retief and Chabalala, 2009).

The main objective of EIA therefore is to promote sustainable development by ensuring that the development does not undermine critical resource and ecological functions or

the wellbeing, lifestyle and livelihood of the communities who depend on them (Panigrahi and Amirapu, 2012; Gaudreau and Gibson, 2010). Policies and laws that relate to EIA aim to evaluate potential environmental social, economic, cultural, natural impacts, socioeconomic impacts which include an assessment of land use, visual and aesthetic impacts on neighbours at promoting cognizant environmental management (Sheate, 2009).

### **2.2.1 EIA at International level**

The legal, methodological and procedural foundations of EIA were established in 1970 by the enactment of the National Environmental Policy Act (NEPA) in the United States of America (USA). As far as one can ascertain EIA is employed in nearly all countries of the world. Morgan (2012), for example suggests that 191 of the 193 member nations of the United Nations either have national legislation or have signed some form of international legal instrument that refers to the use of EIA. Due to a wide range of developments in Asia, EIA in China emerged in 1973. In Australia the State Pollution Control Commission of New South Wales issued EIA guidelines in 1974. Most European countries introduced laws and guidelines for EIA in the 1990s (Morgan, 2012).

### **2.2.2 EIA in Africa**

A number of developing countries in Africa have evolved substantially over the past decade due to the introduction of legal requirements for EIA. This is the case of Kenya, Tanzania and Mozambique. One country that extensively embraced the concept of sustainable development and at the same time faces formidable sustainability challenges is South Africa. Remarkable transformation in EIA consideration has been notable in South Africa as from 1994 to this present day (Sandham *et al.*, 2013).

The EIA greatly reduces the chances of sudden attributions hindering the progress of development by enabling the development review process to better encourage and promote development design that reduces vulnerability to hazards (Toro, 2012). Considering South Africa's need for economic growth, the EIA is helpful to prevent development from being held back by environmental concerns. According to Harris *et al.* (2009), internationally the inclusion of health within EIA has been shown to be limited. Advocates of human health have been interested in the inclusion of human health in EIA for a range of reasons to protect people and the environment (Wärnbäck and Hilding-Rydevik, 2009).

EIA potentially covers a wide range of negative and positive health impacts that can be direct (for example, odour nuisance from a wastewater treatment plant) and indirect (for example, majority of people in an area who suffer from chest pains). Furthermore, because EIA is a regulatory requirement in many countries, it provides a potentially powerful mechanism for addressing the health and wellbeing of populations. Erlanger *et al.* (2008) noted that integration of health considerations can add differential distribution of impacts on various population subgroups to the EIA process. Nevertheless, international experience to date indicates this inclusion is problematic. For the past 20 years empirical research into EIA practice and documentation has consistently revealed lack of coverage and deficiencies in consideration of health (Harris *et al.*, 2009).

### **2.2.3 The South African EIA experience**

The EIA process in South Africa started on a non-mandatory basis in the 1970s when EIA was practiced voluntarily as part of Integrated Environmental Management (IEM). It became mandatory in September 1997 with the promulgation of EIA regulations in terms of the Environment Conservation Act (ECA) of 1989 (Sandham *et al.*, 2013). The EIA system established by these regulations consisted of the following main steps, in line with international practice:

- Submission of application for authorization to undertake an activity;

- Scoping Report (including extensive public participation and plan of study for EIA);
- Environmental Impact Report (EIR) (including public involvement, specialist reports and draft Environmental Management Plan);
- Review of EIR by the competent authority; and
- Environmental Authorization (including conditions of approval).

There was a requirement for comprehensive scoping and emphasis on extensive public participation. When a competent authority or a developer undertakes scoping there are three key questions to be answered:

- What effects could this project have on the environment?
- Which of these effects are likely to be significant and therefore need particular attention in the environmental studies?
- Which alternatives and mitigating measures ought to be considered in developing the proposals for the project?

Due to the requirement for all projects to undergo such comprehensive scoping and extensive public participation, the usual result was a drawn-out and expensive administrative procedure. Consequently, the majority of assessments (over 80.0%) were authorized on the basis of an extended Scoping Report in terms of Regulation no. 6(3) (a) (South Africa, 2006). In these cases the content of the Scoping Report was extended to include more information than usually envisaged for a Scoping Report, but less than that for a formal full EIR as required by the 1997 regulations and international best practice. The ECA regulations had been in effect for just over a year when the first comprehensive environmental management legislation was promulgated in 1998 in the form of the National Environmental Management Act (NEMA), replacing some of the provisions of the ECA (Sandham *et al.*, 2013).

A good scoping amongst other things will include:

- Maps and photographs showing the location of the project relative to surrounding physical, natural and man-made features.



- Existing land-uses on and adjacent to the site and any future planned land uses.
- Zoning or land-use policies.
- Protected areas and sensitive areas.
- Details of any alternative locations which have been considered.
- Impacts on people, human health, fauna and flora, soils, land use, material assets, water quality and, air quality, climate, noise and vibration, the landscape and visual environment, historic and the interactions between them.
- Nature of the impacts (*i.e.* direct, indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative).
- Extent, magnitude and complexity of the impact (geographical area, size of the affected population/habitat/species).
- Probability of the impact.
- Duration, frequency and reversibility of the impact.
- Mitigation incorporated into the project design to reduce, avoid or offset significant adverse impacts.

Some notable differences in the early years of South African EIA from international best practice were the virtual absence of time-frames (apart from time to respond to the public participation opportunities, and a 30-day period of appeal of the authorization), and the lack of provision for follow-up after authorization (Kidd and Retief, 2009; Sandham *et al.*, 2013). Whilst it is acknowledged that EIA is not the only tool to achieve sustainability, the EIA process is still a very effective tool in evaluating the sustainability of development proposals. However, to measure the extent to which EIA's substantially addressed "sustainability", the sustainability criteria must go beyond adherence to procedural requirements and address substantive considerations such as the sustainable use of resources, poverty and inequality (Mayer, 2008).

Internationally there is a growing demand for EIA to move away from its traditional focus towards delivering more sustainable outcomes (Morrison-Saunders and Retief, 2012). South Africa is an example of a country where the EIA system seems to have embraced

the concept of sustainability The global imperative for sustainable development is well understood and has been firmly on the political agenda seemingly in most countries of the world since the first Earth Summit, United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992; propelled the concept onto the global stage. Most countries appear to have incorporated sustainability related policies or legislation into their governance arrangements. Morrison-Saunders and Retief (2012) noted peaks in political activity for sustainability coinciding with the 1992 Earth Summit and the ten year follow-up Earth Summit 2002 in Johannesburg.

The current author finds it crucial that further modifications be made to the EIA system towards assessing health impacts to vulnerable communities and provide clear provisions to safeguard communities from environmental injustice. Papu-Mzakaxa *et al.*, (2010) indicated that “South Africa has progressive legislation to both prevent and clean up environmental contamination. However, recent research has highlighted a large gap between legislation and practice”. One scholar (Taylor *et al.*, 2013) has also noted that around the world policy makers, who design and implement policy and regulation, face the challenge of choosing among a range of policy and regulatory instruments to achieve their governments' environmental and economic objectives, pursuing ‘clean’ or ‘dirty’ development paths as their economies grow.

## **2.3 EIA on health impacts**

The world is undergoing massive and rapid socio-economic changes leading to environment and population health challenges such as a large increase in non-communicable diseases, the emergence and re-emergence of infectious diseases, new health risks associated with environmental pollutants and escalating health inequality (MHC, 2008). These health issues are affected by multiple determinants which can be influenced by planned policies, programs, and projects. Laws and regulations for an EIA enable a health impact assessment (HIA) whenever physical changes in the environment may significantly affect health (Morgan, 2011).

Steinemann (2000) indicates that most EIA programs around the world require consideration of human health impacts. Yet relatively few EIA documents adequately address those impacts. An empirical study of 42 environmental impact statements found that more than half contained no mention of health impacts. In others, health impacts were analyzed narrowly, if all, using risk assessment to quantify the carcinogenic potential of a single substance over a single generation. This analytical focus overlooks other significant morbidity and mortality risks, cumulative and intergenerational effects, and broader determinants of health. Other scholars such as Nicell (2009) argue that there's a need for assessment and regulation of odour impacts.

According to Nicell (2009), the public usually reacts to objectionable odorous episodes by registering complaints with the local authorities (e.g., municipal by-law officers, police, and fire or health units), regional government agencies, and/or the personnel associated with an odour-emitting operation. The extent of this problem is evident from complaint statistics collected over a number of decades. For example Nicell (2009) indicates that, the United States National Research Council Committee on Odours (1979) estimated that more than 50% of the complaints related to air pollution deal with exposures to odours. More recently, an analysis of the 25 responses to a survey of regulatory agencies in the United States of America (USA) indicated that in 1994 more than 60% of air pollution complaints were related to odours with an estimated total of over 12, 000 registered complaints (Leonardos, 1995). These complaints originated from impacts associated with a wide variety of industries and operations including agriculture, wastewater treatment works, and landfills, among others. It has been claimed that the growth in the number of complaints has arisen due to the increasing number of persons that are being exposed to odours as a result of the creation of new or expanded facilities that emit odours (Nicell, 2009).

### **2.3.1 Health Impacts Assessments Internationally**

Health has always had a place in wider impact assessment activities, from the earliest days of the NEPA in the United States (Morgan, 2011). However, early thinking tended to focus on health protection and environmental health issues, especially in relation to the effects of pollution. The adoption of wider models of health was reflected in impact assessment circles from the early 1990s, with particular emphasis on an integrated approach to impact assessment, especially at the project level, which would see HIA benefiting from working with other forms of impact assessment, such as social and ecological. Yet twenty years later, integration still seems a distant prospect in many countries.

Huang (2012), states that HIA has played an important role in environmental protection in China, however, the emergence, progress and challenges of HIA in China have not been well described. The enormous challenges lie ahead in ensuring the institutionalization of HIA into project, program and policy decision-making process due to limited scope, immature tools and insufficient professionals in HIA practice. This has led to a slow and unbalanced HIA development among central, provincial and local level and among different areas in China these years. The reasons for this include: (1) there is not a national plan to coordinate environment and health actions among tiers and sectors of government. (2) there is not a HIA guideline for a systematic approach to HIA in EIA across the country. However, there are increasing demands for HIA with the large scale infrastructural development and economic growth of China (Tobias *et al.*, 2008).

Harris and Spicket (2011) argue that a unified and clear HIA approach is required as a prerequisite to gaining the understanding and support for HIA in the public and private sectors and the wider community. Equity in HIA enables consideration of the differential distribution of potential impacts of a proposal on different population groups – in essence who may benefit from a proposal and who may lose out – that are both unfair

and modifiable (Harris *et al.*, 2009). Minimum HIAs should consider who may win and who may lose across socio-economic status, locational disadvantage age, gender, culture and ethnicity, aboriginality, and current health status (Harris, *et al.*, 2007). These scholars (Harris and Spicket, 2011) further suggest that HIA should broaden its horizons by encompassing physical, chemical, biological and socio-economic aspects.

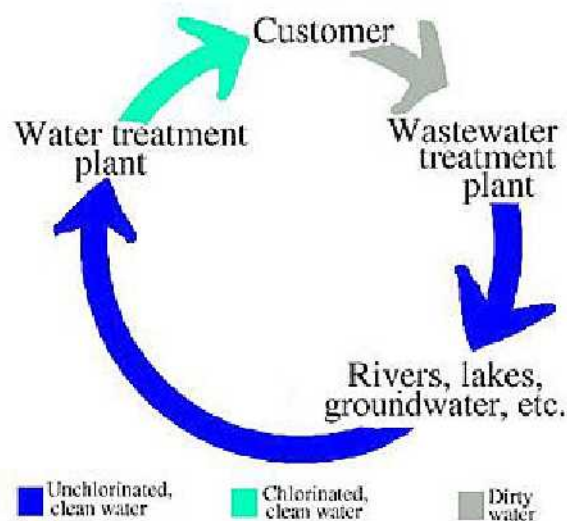
### **2.3.2 Health Impacts Assessments in Africa**

There's currently limited literature on HIA from the Mediterranean region to the African continent. It would be expected that HIA be regarded as an integral component of the EIA process in a developing country however lack of evidence in literature context is easily discernible. This large gap in policy implementation from large developed countries such as China and the United States of America (USA) display a need for adoption of tools, to ensure sustainable development considerations in policy formulation when it comes to health impacts (Hebert *et al.*, 2012). It is important that these countries build the capacity to assess the implications of health impacts and their integration into policy developments especially given that such countries are models for developing countries. The current author finds that there's still a gap for much research in the sphere of HIA and how improvements can be made in order to improve the legal and administration system, a sustainable development strategy and public participation in environmental governance.

## **2.4 Waste Management**

Wastewater reuse is becoming increasingly important for supplementing drinking water supply needs and/or to reduce costs in many communities around the world (Van der Merwe, 2006). As part of the water reuse strategy wastewater is channeled to a wastewater treatment plant (WWTP) where it is cleaned and released back into lakes and rivers. Before the final effluent is released into the receiving waters, it may be

disinfected to reduce the disease-causing microorganisms that remain in it. The most common processes applied is the use of chlorine gas or a chlorine-based disinfectant. This water re-enters the hydrologic cycle and will eventually be pumped back up by another water treatment plant to be purified and released to customers (see Figure.2.1). The main function of a WWTP is to minimize the environmental impact of discharging untreated water into natural water systems (Al-Jasser, 2011). Also a WWTP may get a resource from wastewater carrying out a tertiary treatment on the treated wastewater which can be reused in non-potable applications. Water reuse strategies are intended to address the problem of water scarcity without aggravating other environmental problems, thus reflecting the need of their environmental assessment.



**Figure 2.1: Showing an overview the wastewater treatment plant in the hydrologic cycle (MECC, 2013)**

It is important to note that water is of utmost importance for human health and dignity. Water is the essential basis for all forms of life and it is crucial for sustainable social and economic development (Parkes *et al.*, 2010). Wastewater treatment encompasses a broad range of efforts that promote effective and responsible water use, treatment, disposal and encourage the protection and restoration of waste materials. Wastewater must be purified before it is released into another body of water, so that it does not

cause further pollution of water sources and consequent damage to aquatic biota (Kalavrouziotis and Apostolopoulos, 2007). Wastewater treatment plants (WWTPs) are critical infrastructures for any modern city. They have historically, by virtue of odour and perception impacts, been located away from residential areas, and have been provided with buffer zones – more related to distance than specific odour modelling and odour mitigation strategies (Burgess *et al.*, 2001).

#### **2.4.1 Wastewater reuse practices, the centralised wastewater treatment versus the decentralised wastewater treatment**

The centralized wastewater treatment (CWT) approach for water use and wastewater treatment involves extracting water, treating it and sending it out through a potable water distribution system (Orth, 2007). Once the water is used, it is delivered back through a collection system to a treatment plant. The treated water is then discharged into a river where it is carried downstream. The CWT is considered to be high energy intensive, leading to a greater carbon footprint, due to transporting and collecting purified water and wastewater over vast distances (Orth, 2007).

On the other hand the decentralized wastewater treatment (DWT) approach to wastewater treatment provides a sustainable water use model. The wastewater can be extracted, consumed, treated onsite and returned close to its point of origin to recharge the aquifer (Massoud *et al.*, 2009). The low energy requirements yield a lower carbon footprint compared to the CWT systems. The DWT technology is less land intensive and provides suitable long-term treatment and is leading to better development practices.

In China, Beijing due to its rapid social and economic development, a DWT system was developed to provide treatment facilities on a comparably small scale, mostly for domestic wastewater from private households or communal institutions (Jia *et al.*, 2005). Due to the generally small distances between the place of origin of the

wastewater and the treatment facility, there is no need for an elaborate collection system within a decentralised concept, thus reducing the demand for material, technical equipment, sewerage maintenance and capital investment. This system has considerably improved water shortage in the Beijing (Jia *et al.*, 2005).

It is important to note that the odor problems remain to be the nuisance to the surrounding area, be it a CWT or DWT approach due to the fact that wastewater which comprises sewage is collected, conveyed or treated in both systems. Brunner and Fellner (2007) agree that the location of any wastewater treatment plant should be as far as practical from dwellings, public places and any allotments which will possibly be built on within the life of the plant. There should also be sufficient land (buffer zone) set aside to allow for any future alterations that there is no offensive odour detected at the property boundary.

## **2.5 The WWTP and separation distance to the residential area**

In general, older wastewater treatment plants were not specifically designed to limit odour in the area immediately surrounding the site boundary. Many of the sites were therefore built in areas that were remote from sensitive receptors. The close proximity of the proposed development to the wastewater treatment plant is a concern. The odours produced in the “noxious zone” will not stop at the fence line. This is why it is internationally recognized that in order to minimize odour annoyance a separation distance between the odour source and residential areas is required (Schauberger *et al.*, 2012). The noticeable odour from wastewater treatment plants can have a detrimental impact on the quality of the local environment for those living close by, yet water treatment plant works are essential for maintaining standards in water quality.



The high level of odour perception and annoyance in residents living near waste treatment plants draw attention to the need to prevent odour nuisance constricting emission peaks and frequent emissions. Since odours may affect fairly distant residential areas, planning of the locations of waste treatment operations is essential. Generally, but not always, impacts on the environment decrease with increasing distance from the source of the emission (Zarra *et al.*, 2008). If the impacts from a particular industry or industrial estate are considered to be unacceptable at the boundary of the site or estate, then there is usually a need for a buffer area to separate industrial land use and sensitive land use. The determination of the buffer area is necessary in many situations to avoid or minimise the potential for land use conflict. While not replacing the need for best practice approaches to emission management, the use of buffers is a useful tool in achieving an acceptable environmental outcome.

Odour varies in threshold, intensity and hedonic tone. Different individuals may have different responses to odour depending on the variation of concentration, duration of exposure and their olfactory functions. Secondly, odour sensing is a highly personal perception. Individual reactions are related to gender, age, health condition and private affectations. Thus an ability to perceive an odour varies widely among individuals. With regards to the degree of odour nuisance, it may exceed the maximum tolerable level for human health (Zarra *et al.*, 2008).

There are a number of different approaches to managing odours, ranging from law introduction to the establishment of criteria by governments who are responsible for modifying rules and ordinances to protect citizens (Brennan, 1993). One of the best ways to reduce odour nuisance is to use a separation distance between the odour source and residential areas. According to Schauburger *et al.* (2012) different governments have different rules and ordinances, yet there is a current global trend showing the implementation of major community involvement, individually and as a whole, in regulatory steps. This trend can be seen in regulations being proposed and promulgated in Europe, Australia, and North America (Frechen, 2003).

### 2.5.1 Regulation of WWTP separation distance internationally

In United States of America (U.S.A.), Ontario the recommended separation distance for a centralized WWTP whose capacity is equal to or less than  $500\text{m}^3/\text{d}$  is 150 meters (U.S. Environmental Protection Agency, 2008). A separation distance of less than 100 m may be permitted, however a qualified professional must produce a study showing the feasibility of the distance based on:

- a) the application of noise reduction equipment to any potential noise source(s), and;
- b) the degree and type of odour mitigation applied to the facility.
- c) other contaminants of concern (i.e. aerosols) which may need to be addressed.

In Asia, Singapore the recommended separation distance of a DWT is 30 metres whereas for a CWT the maximum distance applied is 40 m (PUB, 2013). Singapore, as China is coupled with high population density therefore a high standard of public health needs to be maintained in order to prevent the spread of diseases (Van der Poel *et al.*, 2009). Knowledge of whether the distance between WWTP and exposed populations is essential in identifying the type of interventions that are most likely to be effective in halting the spread of these diseases.

In Australia, western suburbs of Perth for the Subiaco plant, the recommended buffer distance would be 1000 m (CEE, 2001). While the Buffer Guidelines recommend a buffer distance of 400m to the nearest residential dwelling, the Northern Water Plant in Melbourne incorporates a varied buffer distance of 300 m (Maddocks, 2011). While the fixed buffer distance is defined as a guide, the policy suggests that wind patterns and topography also be taken into account when setting buffer distances to prevent prevalent winds from with high odour strength from being recognized as odourous.

### **2.5.2 Regulation of WWTP separation distance by continental countries**

In the Mediterranean city of Taranto (Apulia Region, South Italy) there's a 100 m distance required by the national guidelines. According Stellacci *et al.* (2010) the neighborhood has brought forward complains about occasional unpleasant odours and unhealthy effects associated with the WWTP erected in the 1970s in the Gennarini area. This has caused acute social and even legal conflicts with the Municipality with the potential need of transferring the WWTP to a new, more distant, location. The more common nuisances like foul odours, noise, traffic etc., improper (or no longer proper) siting of WWTPs in crowded areas of developed countries may pose occasional health risks on neighbouring residents due to long distance dispersion of aerosolized microorganisms. The study which was done in Taranto imposed a 300 m setback distance to be quite appropriate for health safety purposes (Stellacci *et al.*, 2010).

In Bekka, a city located on the western side within the Lebanese Republic, the WWTP was to be located 1000 m from the nearest house (BECA, 2007). Even though such a distance is kept between the WWTP and the residential area, there are no clear guidelines to indicate what should be taken into consideration before such sites are enacted (CEE, 2001).

Mediterranean countries are unequally developed, several being already equipped with wastewater treatment plants while others have virtually no equipment (Kamizoulis, 2006). Therefore, all countries cannot be expected to be able to meet the reuse guidelines at the same time. However, an implementation time frame can be set and agreed by all countries, each country committing itself to enforce the guidelines within a specified period, set according to its particular situation. International organizations

should foster efforts for more consistency between the different regulations and guidelines related to environmental impacts (Massoud *et al.*, 2003).

### **2.5.3 Regulation of WWTP separation distance in South Africa**

The existing wastewater treatment plant currently in use in Northern Cape, Alexander Bay from the Richtersveld local municipality is located within a distance of approximately 100 m from the nearest residential area. During the planning phase of the new wastewater treatment plant, the impact of the wastewater treatment plant on residents, especially as it relates to bad odours was raised as a concern and as such an alternative site, located at a reasonable distance of 500 m from the nearest residential area, was selected to mitigate for these impacts. The wastewater treatment plant currently in use will be decommissioned upon completion of the new wastewater treatment plant (DWA, 2012)

In KwaMathukuza, the current study area, the residential area stands 250 m away from the nearest house in relation to the WWTP. One may argue that the distance applied in a developed country such as the United States of America (U.S.A.) is almost similar to the one currently being used in South Africa therefore it can't be appalling but the fact is that it is likely to raise concern amongst those who are affected on health issues as discussed above (section 2.8).

## **2.6 Approaches to managing odours**

In South Africa, municipal governments directly oversee the wastewater treatment process, and are able to pass additional by-laws. Provincial governments generally assist municipal governments with funds to build and maintain infrastructure (van Harreveld, 2002). Municipalities need to ensure that every treatment plant is not subject

to flooding or is otherwise protected from flooding and has all weather road access. Moreover a sensible distance between the odour source and residential area should be considered in all development planning (Gostelow and Parsons, 2000). There should also be sufficient land (buffer area) set aside to allow for any future alternations and to avoid hazards associated with industrial plants in this case, wastewater treatment plants.

The EIA has been a statutory requirement in South Africa since 1997, therefore the transformation of undeveloped, vacant or derelict land is subject to compliance checks with environmental policies and legislative environmental requirements in order to determine risks associated with any upcoming project and expose them for correction (Péti, 2012). Therefore correlating this information with the study area is important to note that the WWTP was built before the low cost settlement housing. The housing development was only undertaken after year of 1997 which therefore puts to question the compliance of municipalities with the stipulated policies and appropriate measures to EIA (Bond and Morrison- Saunders, 2011).

## **2.7 Factors that may render WWTP odour emissions as health hazards to humans**

While individual responses to odours are highly variable and can result in a variety of effects, generally the impacts of odours arise from a variety of interacting factors, collectively known as FIDOL: frequency, intensity, duration, offensiveness, and location. In view of the need to prevent or mitigate such impacts, an approach to odour regulation is proposed in which the protection of the public from odour impacts is accomplished based on the FIDOL approach (Nicell, 2009).

Volatile compounds such as those released from the can cause irritation of the eye, nose and throat. In severe cases there may be headaches, nausea, and loss of

coordination. In the long run, some of the compounds are suspected to cause damage to the liver and other damages to various parts of the body. According to Muñoz *et al.* (2010) odour emissions affect the quality of life leading to psychological stress and a range of symptoms such as insomnia, loss of appetite and irrational behaviour (Zara *et al.*, 2008). Examples of these compounds include nitrogen ( $N_2$ ), mercury (Hg), hydrogen sulfide ( $H_2S$ ), carbon dioxide ( $CO_2$ ), methane ( $CH_4$ ), ammonia ( $NH_3$ ), biological organisms, water vapor, and other chemicals discharged (Bruno *et al.*, 2007). All these gases can come in contact with human body via inhalation and can lead to lung diseases as they have the ability to asphyxiate the body by denying it access to oxygen.

According to Al-Shammirri (2004) inhalation of low levels of  $H_2S$  can cause headaches, dizziness, nausea, cramps, vomiting, diarrhea, staggering, muscular weakness and drowsiness. Prolonged exposure to 50 ppm can cause bronchitis and pneumonia. Levels of up to 250 ppm can lead to numbing of extremities and death due to respiratory paralysis. Mercury on the other hand has long been recognized as toxic, principally in relation to its effects on humans following acute or prolonged high-level occupational exposures. Recognized target organs are the kidneys, central nervous system and thyroid glands. The limited research base suggests that several of the potential targets of long-term environmental exposure to mercury are similar to those occurring from occupational exposure including the renal, cardiovascular and immune systems. However, the evidence also suggests that, particularly in the case of organic mercury compounds, the most sensitive endpoint is central nervous system toxicity, especially in relation to exposure during the *in utero* period and childhood (Holmes *et al.*, 2009).

The effects of air pollution on health are very complex as there are many different sources and their individual effects vary from one to the other. The risk of inhaling dangerous chemicals that have found their way into the air, endangers human health (Raizanne, 2001). Generally if you are young and in a good state of health, moderate air pollution levels are unlikely to have any serious short term effects. However, elevated levels and/or long term exposure to air pollution can lead to more serious symptoms

and conditions affecting human health. Exposure to air pollutants is largely beyond the control of individuals and requires action by public authorities at the national, regional and even international levels.

Even though a real toxicological-sanitary risk is hardly ever associated with the odour impact from sources connected to the activities of WWTP, due to the rarely dangerous nature of the smells as well as the generally very low concentrations, the collective imagination often associates the bad smell to conditions of “unhealthy” air. In fact, a significantly higher than the one related to more dangerous contaminants not directly perceptible with our senses is often attributed to them (Zarra *et al.*, 2008).

Odour control remains one of the most important factors of wastewater treatment plant design, as wastewater treatment works are often known to be the source of obnoxious odours to the community (Zarra *et al.*, 2008). Both operators of works and consultants are often faced with existing works that are the source of odours and are a public bone of contention. Although most operators of works are well aware of the different processes at a works that give rise to odours, it is difficult to forecast the impact that these sources of odours will have on the surrounding areas (Hobson and Yang, 2001).

At the same time, facility owners/operators need to reach out to neighboring communities in order to completely understand how they are impacted. Presently, governments around the world are struggling with the odor regulation issue (Webster, 2006). The existing rules and ordinances have been found to be inconsistent and, in many cases, insufficient in defining, investigating, and enforcing violations. The most successful management tool, however, is use of one's own sense of smell in order to assure a liveable community.

Buffer distances should be established where surrounding terrain or prevailing wind will affect the dispersion or spread of odours, aerosol spray and/or disease vectors such as mosquito infestation. Considerably so many developers shouldn't just locate any site for

their developmental projects rather in-depth studies need to be first conducted to ensure that a particular land is secure and conducive even when the population increases beyond what was envisaged. The current study presents the discourse that EIA needs to be considered to protect the environment and to prevent, control and abate pollution and environmental harm (Bond and Morrison-Saunders, 2011). It goes without say that clean water is essential but public health is also crucial to ignore the odour nuisance.

## **2.8 Conclusion and Recommendations**

The wellbeing of people and a healthy environment depends mainly on the decisions governments make. Therefore effective regulations towards reasonable distances need to be properly revised to ensure that people enjoy their environment and live to the advanced old age. This therefore calls for odour control to start at design stage where the potential for odour generation and release should be minimized. Furthermore there's a need for governments at international level to modify the regulations when it comes to the distance between the WWTP and the residential area to avoid unacceptable impacts on amenities. There is a need to undertake future studies which will focus on the reasons that leads to inconsistencies on the regulations with regards to buffer distance between a WWTP and a residential area.



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## CHAPTER 3: RESEARCH METHODOLOGY

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### 3.1 Introduction

This third chapter discusses the methods that the researcher has used in order to collate and evaluate the data in accordance to the aim of the study. The chapter focuses on the description of the study area, the research methodology used, the sampling technique, the instrument used, the validation of the instrument and the administration of the instrument.

### 3.2 Locality

The study took place in KwaMathukuza section; an area located about 15.0 km east of Newcastle town. The Newcastle Municipality falls within Amajuba District which is located in the inland region on the Northwest corner of KwaZulu Natal, a few kilometers south of the Free State and Mpumalanga provincial borders, in the foothills of the Drakensberg Mountain (Figure 3.1).



Figure 3.1 Showing the locality of Newcastle in relation to Free State and Mpumalanga provincial borders (Newcastle, 2007)

### **3.2.1 Climate**

No site specific climatic data is available for the study area, and therefore the statistics for Newcastle town were used to describe the climate of the area.

#### **3.2.1.1 Mean monthly and annual rainfall of the Newcastle area**

The rainfall in the Newcastle region has a long term average of 55.56 mm occurring between January and December (Figure 3.2).

Figure 3.2 Showing the seasonal pattern of the rainfall in Newcastle (SAWS, 2013).

#### **3.2.1.2 Mean monthly maximum and minimum temperatures**

The average minimum and maximum temperatures for the study area are given in Figure 3.2 On average the maximum summer temperature in the area varies between

22°C and 30.8°C in summer, while in winter the minimum temperature varies between 5.6 °C to 18.6°C.

Figure 3.3 Monthly maximum and minimum temperatures (°C) from Newcastle area (SAWS, 2013)

#### **3.2.1.3 Mean monthly wind direction and speed**

The WWTP is in the north west of KwaMathukuza area. The area is characterised by the highest frequency of (in decreasing order) North West(NW),North (N), North East (NE) and South West (SW) winds especially during the warm months of August to January. Therefore the direction of wind is directly from the WWTP to KwaMathukuza. The wind speeds recorded over a five year period are generally low, 3.0 – 4.0 m/s having a frequency of less than 15.0 % and occurring only in September.

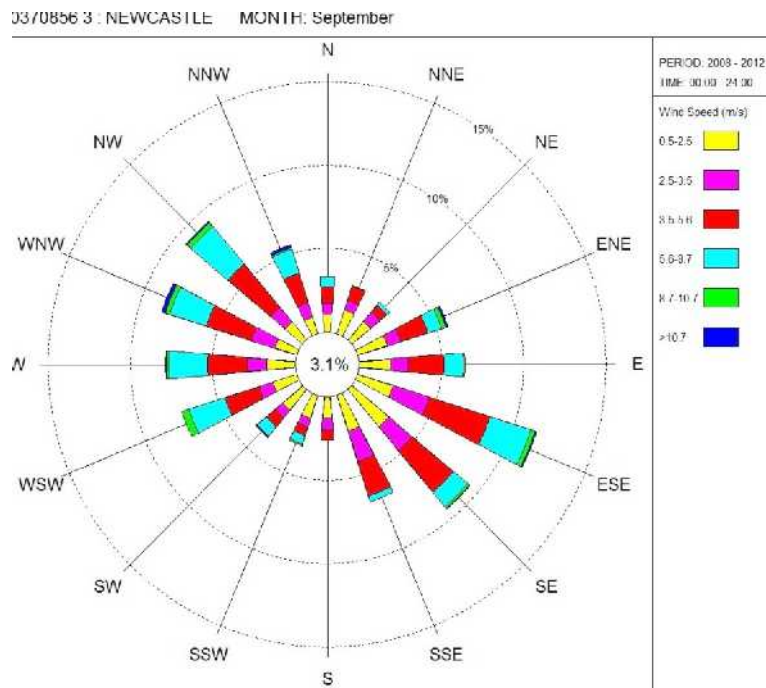


Figure 3.4 Indicating the wind speed and direction that has occurred in month September between 2008 and 2012.

The latter are very important in respect of wind erosion because they coincide with the end of the dry season, i.e. period when the soils and tailings are at their driest, making them vulnerable to wind erosion (see Figure 3.4).

### 3.2.2 Site history

The area became zoned for low cost residential settlements on the 25 November 2002. There are currently more than 2000 houses in the area. Some of the houses in this applicable study area are built on river bands. From the look of things it's clear that the houses that are built in close range to the water belt are subject to floods. The soil is sandy and loamy, severely impacted by the movement of people and vehicles. Evidence of some gulling along the river banks suggests that run-off could be severe during rain storms. The cemetery is about 429.0 m away from the closest houses, just

separated by a river. The WWTP is located at about 240.0 m from the nearest house. There's minimum vegetation in the area, only a few houses have trees in the yards.



Figure 3.5 The locality of the study area in relation to the distance between the river, the cemetery and the WWTP (GE, 2013).

### 3.3 Research design

The research design is the researchers overall plan for obtaining answers to the research questions guiding the study. Designing a study helps the researcher to plan and implement the study in a way that will help obtain the intended results, thus increasing the chances of obtaining information that could be associated with the real situation. The descriptive method of research was used for this study. To define the

descriptive type of research, Creswell (2009) stated that the descriptive method of research is to gather information about the present existing condition concerning the current status of the subject of the study. The emphasis is on describing rather than on judging or interpreting.

The survey method research is employed for this particular study, whereby participants answer the questions administered through interviews or questionnaires, the researcher then describe the responses given. In order for the survey to be both reliable and valid it is important that the questions are constructed properly, meaning that they should be clear and easy to comprehend. Another consideration is to include open ended, closed ended or rating scale questions which all have their set of advantages and disadvantages. Open ended questions allow for a greater variety of responses from participants but are difficult to analyse statistically because the data must be reduced in some manner. The closed ended questions on the other hand are easy to analyse statistically but they limit the responses of the participants. The Likert type scale on the other hand is easy to analyse statistically but also limits the respondent's response (Jackson, 2009).

Confidentiality is the primary weakness of descriptive research (Leahey, 2007). Often subjects are not truthful and will tell the researcher what they think the researcher would like to hear. This is particularly true for interviews. Some participants may also refuse to provide answers to questions they view to be too personal. One particular advantage with the use of descriptive research methodology is an opportunity and flexibility to fuse both quantitative and qualitative data giving the researcher greater options in selecting the instrument for data-gathering. The researcher used this kind of research to obtain first hand data from the respondents so as to formulate rational and sound conclusions and recommendations for the study.

### **3.3.1 Mixed method approach**

This study used a mixed method approach applying a qualitative and quantitative method. A mixed method approach was chosen because the researcher concurs with scholars (Creswell, 2009; Mnguni, 2012) who argue that mixing methods strengthen research findings, in that each approach is validated by the other when used together. The need to substantiate each approach is that each individual approach has its limitations that may be minimized by the other. Therefore to compensate for the misgivings of any one research approach, a mixed approach is preferred (Leahey, 2007). The researcher furthermore acknowledges that the study cannot be absolutely subjective or objective because of differences between reality and what the researcher perceives as reality (Leahey, 2007).

One limitation of using the mixed method is that the researcher requires expertise in both approaches (Merriam, 2009). While this may be viewed as a limitation, the researcher saw it as an opportunity to learn and develop as a scholar. Scholars also suggest that a mixed method approach requires extensive data collection and may be lengthy (Creswell, 2007 and Leahey, 2007). However the researcher was willing to collect extensive data as this would provide enough information to respond to the research question.

### **3.3.2 Quantitative method approach**

Quantitative data collection methods are centred on the quantification of relationships between variables. Quantitative data-gathering instruments establish relationship between measured variables (Stake, 2010). When these methods are used, the researcher is usually detached from the study and the final output is context free. Measurement, numerical data and statistics are the main substance of quantitative instruments. With these instruments, an explicit description of data collection and

analysis of procedures are necessary. An approach that is primarily deductive reasoning, it prefers the least complicated explanation and gives a statement of statistical probability. The quantitative approach is more on the detailed description of a phenomenon. It basically gives a generalization of the gathered data with tentative synthesized interpretations (Mnguni, 2012).

Quantitative approach in this study is useful as it helps the researcher to prevent bias in gathering and presenting research data. The purpose of the quantitative approach is to avoid subjectivity by means of collecting and exploring information which describes the phenomenon being studied. This phenomenon in turn should be discussed or explained by means of data analysis gathered through objective forms of measurement. Contrary to the quantitative method, qualitative approach generates verbal information rather than numerical values (Polgar and Thomas, 2008). Instead of using statistical analysis, the qualitative approach utilizes content or holistic analysis; to explain and comprehend the research findings, inductive and not deductive reasoning is used. The main point of the quantitative research method is that measurement is valid, reliable and can be generalized with its clear anticipation of cause and effect (Creswell, 2007). This means that the researcher's personal thoughts, subjective preferences and biases are not applicable to this type of research method.

### **3.3.3 Qualitative method approach**

The use of qualitative data gathering method is advantageous as they are more open to changes and refinement of research ideas as the study progresses; this implies that qualitative data gathering tools are highly flexible. Moreover, no manipulation of the research setting is necessary with this method; rather than employ various research controls such as in experimental approaches, the qualitative data gathering methods are only centered on understanding the occurring phenomena in their naturally occurring states. Aside from these advantages, researchers use qualitative data-gathering tools as some previous researchers believe that qualitative data are



particularly attractive as they provide rich and well-grounded descriptions and explanations as well as unforeseen findings for new theory construction. One of the notable strengths of the qualitative instruments is that they evoke a more realistic feeling of the research setting which cannot be obtained from statistical analysis and numerical data utilized through quantitative means (Creswell, 2007). These data collection methods allow flexibility in conducting data gathering, research analysis and interpretation of gathered information.

The current researcher shares the sentiment that the use of qualitative method alone would have been a disadvantage in that it focuses on the researcher's subjectivity (Creswell, 2009). That is due to the unavailability of rules governing analyzing or interpreting data when applying this method. To acclimatize for this limitation, a quantitative approach of data collection and analysis were employed. The quantitative approach has various other characteristics; it describes, examines relationships, and determines casuals among variables where possible. Reliability and validity of instruments is crucial to make sure that the respondent's answers are valid for constructive answers. This method provides an account of characteristics of particular individuals, situations, or groups. Furthermore statistical analysis is conducted to reduce and organize data, determine significant relationships and to identify differences and similarities between different categories of data. On the other hand qualitative approaches are not generalizable, if appropriately done they provide knowledge of context phenomena on a study opinions, behaviours and experiences of a particular individual (Merriam, 2009).

The use of a descriptive design to identify, analyze and describe if the gases released from the wastewater treatment facility have an impact on health of residents who reside adjacent to the study area, especially to find out if the EIA regulations were implemented to prevent health hazards in this area was applied. The study followed this design because it explored the factors that had not been previously described and attempts to identify new knowledge, new insights, new understandings and new

meanings (Stake, 2010). A descriptive design in this current study may be used for the purpose of developing theory, identifying problems with current practice, making judgments and determining what others in similar situations are doing.

### **3.4 Piloting**

In a quantitative study, a survey instrument that a researcher has designed needs a pilot study to validate the effectiveness of the instrument, and the value of the questions to elicit the right information to answer the primary research questions in. In a scientific study, a pilot study may precede the main observation to correct any problems with the instrumentation or other elements in the data collection technique. Mnguni (2012) lists some of the aspects that the researcher should ensure are considered pertaining to the validity of the questionnaire. This is in line with Taylor- Powell's (1998) views:

- a) The items in the questionnaire should measure what they are supposed to measure.
- b) All the words are understood by the respondent.
- c) All respondents interpret them in the same way.
- d) All response choices are appropriate.
- e) The respondents correctly follow the instructions.
- f) The questionnaire creates a positive impression that motivates students to respond.
- g) Length time taken to complete the questionnaire is adequate.

Taking all the above stated considerations the researcher sampled ten respondents. All the respondents were able to complete the questionnaire within 15minutes and understood the questions. The main apparent problem that a number of respondents encountered during completion of the questionnaire was the abbreviation WWTP which the researcher had to properly write in full for the actual study to avoid difficulties. The researcher revised the survey questionnaire based on the suggestion of the respondents. The researcher then excluded some irrelevant questions and changed

vague or difficult terminologies into simpler ones in order to ensure comprehension by respondents.

### **3.5 Development of the questionnaire or instrument**

The survey questionnaire was used as the main data-gathering instrument for this study (See Appendices, B and C). The researcher structured three different questionnaires meant for the residents in the study area and its surroundings (5.0 km away); the caregivers and municipality officials. The research questions were based on the knowledge obtained in the literature review. The researcher designed the research questions in a way that they follow a mixed method design (Creswell, 2009). For instance, in responding to the first research questions, a predominantly quantitative approach was used under section A. This made it efficient for data analysis to identify the frequencies among the calculated variables. The questions in section B, C and D had elements of qualitative methods to seek meaning in responses to questions that used the quantitative approach. However data was analyzed mainly from the quantitative approach to determine inferential statistics such as correlations. Methods that were used in each subsection are discussed in more detail in the next sections.

#### **3.5.1 Structure of the questionnaire**

The researcher constructed three main questionnaires given to different respondents for the various concepts related to the study. In application one questionnaire wouldn't have addressed all the various respondents nor would some of the questions been relevant to some respondents. The researcher structured the questionnaires for a) the residents in the study area and its surroundings (5.0 km away); b) the caregivers and c) municipality officials.

### **3.5.1.1 Methodology for research questionnaire A**

This questionnaire was devised for the residents in the study area and its surroundings (5.0 km away). The questionnaire consisted of the four sections:

Section A	Background information
Section B	General issues
Section C	Health aspects
Section D	EIA regulations

The research questions in section A ask about the respondents ethnic, gender, occupation, level of education, age group and the number of years one's been familiar with the area. This section was to indicate the ideology and trends that dominate in the study area and to gain a more specific understanding of the demographic differences between response groups. The first research question in Section B asks, "Have you ever smelt a bad odour that may be due to the wastewater treatment facility? This was a closed question that generates a lot of perceptions to the respondent. It is followed by an open questionnaire that allows a respondent to further elaborate his concepts on the phenomena. Section C and D; also follow the same order of questions (open and closed) in attempt to obtain as much information as possible based on health aspects and EIA regulations in terms of public participation in the area.

Section B of the questionnaire dealt primarily with air-quality issues that could be a nuisance to the residents, which is odour. A human receptor level of odour nuisance can be determined by using a questionnaire survey, whereby the receptor can describe the degree of odour nuisance based on his or her experience of the odour exposure. The degree to which a person reacts to a nuisance, such as odour, depends on five factors, the so called FIDOL factors (Nicell, 2009). These are frequency (F), intensity (I), duration (D), offensiveness (O), and location (L):

- Frequency: The more often an odour is detected, the more likely it will be annoying. Intensity: very high concentrations of odours can become nauseating.

- Duration: a very short duration odours is likely to be less annoying than one that persists for an extended period.
- Offensiveness: is a subjective rating of an odour's ability to cause annoyance.
- Location: some odours may be more acceptable in areas than others.

The researcher followed these factors in developing the questionnaire. For Section C, the researcher identified all possible health impacts that may be due to gases released. This was done through identifying each characteristic of the possible gases that are released in the WWTP. The section on EIA (Section D) was mainly based on continual engagement with communities to determine the impacts that they faced.

#### **3.5.1.2 Methodology for research questionnaire B**

This questionnaire was directed to respondents in clinics and hospitals, mainly the doctors and nurses. The questions mainly consisted of:

Section A	Background information
Section B	General issues
Section C	Health aspects

The researcher reduced the number of questions related to health caregivers to cater for their heavy workload and to make sure that they don't find it tiring to answer.

#### **3.5.1.3 Methodology for research questionnaire C**

This set of questions could mainly be answered by someone who works at the WWTP within the municipality.

Section A	Background information
Section B	Technical issues
Section C	Social issues
Section D	EIA regulations

The research questions in section B, were technical and the researcher attempted to ask such an array of questions to better understand the work that takes place in the facility as well as to know what technological systems were in place so that the researcher may compare these and provide necessary recommendations. The questions in Section C were coupled with further health aspects to ensure that the researcher has inputs from all participants in the study.

### **3.6 Validation and reliability of the questionnaires**

According to Dixon-Woods (2007), the usefulness of research relies heavily on reliability and validity of the research methods. Because of this, a number of statistical methods have been developed to measure validity and reliability in quantitative studies. Such a rigorous approach has fuelled the adaptation of various criteria for pursuing validity and reliability in qualitative research (Dixon-Woods, 2007). The variations in the nature of quantitative and qualitative research methods, requires that each paradigm have its own criteria for addressing reliability and validity.

Validation is a criterion to evaluate if a questionnaire is measuring what it is supposed to measure and is doing it reliably (Creswell, 2009). The idea behind validity is that any significant results must be more than a once-off finding and be inherently repeatable. The information obtained in a study should be valid, i.e. reflecting the true situation. A questionnaire being the instrument used is considered validated if it has been shown to have a high reliability and internal consistency. A questionnaire with a high reliability would elucidate the same answers if applied to the same population again. The internal consistency is measured by comparing the answers to questions measuring the same concepts.

### 3.6.1 Triangulation

Validity and reliability in research have propelled the subject of triangulation. Guion (2002) suggests that triangulation is a method used to pursue and ensure validity and reliability of a research study. Triangulation is a method used in analyzing a research question from multiple perspectives helpful in highlighting diverse viewpoints upon the topic. Hyrkäs *et al.*, (2003) defines triangulation as the use of multiple methods to validate data or research findings. A number of approaches can be followed in triangulation in an attempt to eliminate the bias that may be caused by the use of only one particular method (Hyrkäs *et al.*, 2003; Derry, 2000). In this respect, when a combination of qualitative and quantitative methods is used to explore the same phenomenon, data may be collected and analysed using both methodologies (Creswell, 2007). If the two methods reach a similar conclusion, data may be perceived as “valid” (Creswell, 2007).

Combining several approaches in studying one parameter may lead to overlaps, some may be complimentary, while others may contradict each other. This has the effect of balancing each method out and giving a richer and hopefully truer account. Triangulation validates the methodology by an examination of the results from several perspectives and this helps to prevent biasness. During the analysis stage, feedback from the stakeholder groups would be compared to determine areas of agreement as well as areas of divergence. Besides triangulation that involves a combination of qualitative and quantitative methods to validate research, Guion (2002) has highlighted four other triangulation methods. These are data triangulation, investigator triangulation, theory triangulation and environmental triangulation. In the data triangulation approach, different sources of information are used (Guion, 2002). In this instance, data may be collected at different times using different data-generating instruments i.e. interviews and questionnaires. In investigating triangulation, different researchers use the same method of data collection and analysis (Guion, 2002). For instance, different interviewers may interview the same set of students about a given phenomenon. With

theory triangulation, a single set of data is interpreted by different investigators (Guion, 2002). This method differs from investigator triangulation in that the focus is on interpreting the data or methods used by interpreters who may be outside of the field of the primary researcher. Finally, environmental triangulation relates to the use of different places, and other environmental settings e.g. culture, to collect data (Guion, 2002). Overall, by using such approaches, the researchers hope to minimize or eliminate any bias that may invalidate the research findings.

Reliability and validity are both important concepts, however validity is more important in qualitative approaches and reliability is more important in quantitative approaches (Creswell, 2007; Hyrkäs *et al.*, 2003 and Guion, 2002). As a result, reliability is well understood in the context of quantitative researches and validity is well defined under the qualitative context. Because of this, in the following section the current author discusses validity in detail under the qualitative context and reliability under the quantitative context.

### **3.6.2 Qualitative Validity**

In qualitative approaches of research validation, there are a number of methods that may be applied. Amongst others, the current author will outline two types of triangulation (namely, theory triangulation and data triangulation) and different types of validity namely, content validity, concurrent validity, face validity and criterion-related validity. As highlighted in section 3.6.1, theory triangulation relates to the use of “multiple professional perspectives to interpret a single set of data” (Guion, 2002). The professionals may be in the same field as the researcher or be in a different field. The latter is important when the researcher wants to make general inferences about the research findings. Data triangulation on the other hand refers to the use of different sources of data (Guion, 2002). In this instance, the data collected from the different sources is compared and consensus observations are made. Only if the results from the data show similar findings, will validity be pronounced.



In the case of qualitative research, a number of instruments are available to collect and or analyze data. Content validity refers to the instrument's ability to represent clearly and appropriately all of the content of a particular construct (Garson, 2007). In this regard, content experts define the content domain that the instrument is representing and then define how well it is able to cover such content domain. On the other hand, concurrent validity relates to the comparison of two different instruments that measure the same variable on two different occasions (Garson, 2007). For example, a sample of people may be given a test, which will be repeated at a different period. The differences between the tests are compared to determine how well the second test reflects the findings of the initial test. Should findings of the first and second tests be similar, then validity is achieved.

Another type of validity is face validity which is concerned with the appearance of the procedure or instrument. Face validity tells the researcher whether or not the instrument is well designed and is a reasonable tool for gaining information (Garson, 2007). Criterion-related validity is a measure used to demonstrate the precision of an instrument by way of comparison with other validated instruments (Garson, 2007). For example criterion-related validity can be gained by comparing a test under study with a well-established test such as a psychometric test. Finally, like criterion-related validity, concurrent validity tests the correlation of two instruments' results where one has been previously validated and the other is being tested (Geolog, 2006). Such instruments may presumably be related. In all cases, validity may only be established if the results of the instrument under study are similar to those of the previously validated instrument.

### **3.6.3 Quantitative Reliability**

Reliability predicts the probability of obtaining the same results if the research method is repeated under same conditions on a different occasion. However, reliability does not answer whether the research or its method is valid, while it does not cater for changes

in humans over time. In order to have confidence in the research methodology and its findings, the measure of reliability is of importance. This refers to the estimated probability of consistency of given measurements over time (Creswell, 2009).

There are two basic processes of single administration and multiple administration that can be used to pursue reliability (Creswell, 2009). Single administration estimation of the reliability involves administering the investigation once and then estimating the reliability from findings thereof (Creswell, 2009). In this regard, there are two methods that can be followed to obtain single administration reliability, namely, split-half and internal consistency (Creswell, 2007). In split-half method, the sample of subjects or items is divided into two alternate forms, but the test is administered in the same way. Thereafter, the instrument reliability is estimated by comparing the total score from one half of the items to the total score from the other half by calculating reliability using the Spearman-Brown formula (Creswell, 2009). In multiple administrations, reliability can be estimated using the internal consistency method where Cronbach's alpha is measured (Creswell, 2007). Cronbach's alpha measures how well variables measure a single unidimensional (consistent) latent construct. Hence, if data have a multidimensional (inconsistent) structure, Cronbach's alpha will usually be low (below 0.8) and vice versa for unidimensional structure (Geolog, 2006; Creswell, 1994).

Another measure of reliability is internal consistency. Internal consistency is the degree to which different instruments assess the same skill or characteristic (Garson, 2007). In this regard, internal consistency determines the accuracy of an instrument used in a study by way of comparing scores through correlation determination. Instrument accuracy can also be measured through a measure called test – retest reliability. In this case, a single test may be performed by the same group of respondents at different times. If the correlation coefficient between such tests is close to 1.0, the tests are regarded as reliable (Geolog, 2006).

Often, quantitative research deals with relationships between multiple items or events. In this regard, a number of assumptions can be made about the data. For instance, in each event such as a test, each subject has a true score which is the actual degree of particular characteristics e.g. conceptual understanding (Libarkin and Kurdziel, 2002; Creswell, 2007). The second assumption is that while testing particular characteristics in a given event there are random measurement errors (Libarkin and Kurdziel, 2002; Creswell, 2007). In this regard, the actual true score is obtained by calculating the average scores (mean score), which in a way, considers all the measurement errors (standard deviation from the mean score). If the standard deviation is too high (close or equal to the mean score), the results are regarded as having a low reliability (Libarkin and Kurdziel, 2002; Creswell, 2007). Furthermore, statistical tools using the mean score and the standard deviation can calculate a component called the reliability coefficient which ranges from 0 to 1.0. If the coefficient is close to 1.0, the results are regarded as reliable (Libarkin and Kurdziel, 2002; Creswell, 2007).

### **3.7 The validation and reliability of the current study**

Instrument validation was pursued namely, by instrument piloting (see section 3.4). The revised set of instruments was piloted, and the results used to inform any further revisions of the instrument. Details of the method employed is provided and discussed below.

#### **3.7.1 Instrument validation employing piloting**

To ensure validity of the data in the current study, the instruments were validated by utilizing applying the face validity method which tells the researcher whether or not the instrument is well designed and is a reasonable tool for gaining information (as indicated in section 3.6.2 above). The researcher chose face validity method because it is not quantified using statistical methods, it is a simple form of validity and helps the

researcher determine if the questionnaire measure what is intended to measure. The content validity method was also applied because face validity on its own can never be trusted. Content validity doesn't rely on people's perceptions for measuring constructs but it uses statistical tests. Therefore to strengthen validation the researcher applied both these methods.

In this regard, ten people were given a questionnaire to scrutinize each instrument and determine its legitimacy and appropriateness for the research. This enabled the face validity of the instrument to be measured. The questionnaire given to the panel of the group of ten people was designed to address two fundamental questions, through which the validity of the instruments would be established. These questions were:

- a) Does the instrument question what they ought to be? Given that each section of the instrument was meant to assess something specific skills (as given in section 3.5.1.1-3.5.1.3), the panel was meant to determine therefore whether the instrument meet the specified standards.
- b) Is the instrument suitable for the purpose it is designed for? In this instance the main focus was on the conceptual background of the instrument as per propositional knowledge given in Section 3.3.

Table 3.1: Questions used in the questionnaire given to the experts and reasons for their inclusion

<b>Question</b>	<i>a) The questions are easy to understand</i>
<b>Reason for inclusion</b>	Here the panel had to determine whether the overall language used in the probes was suitable for the respondents.
<b>Question</b>	<i>b) The time allocated to each question is appropriate</i>
<b>Reason for inclusion</b>	Since each question was to be performed over a specified period of time, the panel had to give their opinion as to whether the time allocated for each instrument was adequate.
<b>Question</b>	<i>c) The test is appropriate for the envisaged respondent</i>
<b>Reason for inclusion</b>	The panel also had to assess the content of the instrument and suggest in their experience whether they thought that a typical individual would have enough conceptual knowledge to respond to the instruments.

<b>Question</b>	<i>d) Other positive comments</i>
	<i>e) Other negative comments</i>
<b>Reason for inclusion</b>	The panel of experts was also asked to forward any other inputs by critiquing the probes. This was to cover any loop-holes that the questions in the questionnaire were not covering.

Table 3.1 lists the questions (in *italics*) used in the questionnaire given to the panel of experts and motivate for their inclusion. For each question, the panel had to give a closed response on a 4-point Likert scale (i.e. strongly agree, agree, disagree and strongly disagree), as well as an open response where they had to justify their choice in the closed responses.

Concerning the panel of experts, the author especially chose a wide range of different expertise in order to minimize any biasness amongst panel members due to knowledge backgrounds. In combination, the responses from the different experts were intended to give the researcher confidence about the validity of the instrument as suitable tools for the research under study.

The four-point rating scale stated above i.e. strongly agree = 3, agree = 2, disagree = 1 and strongly disagree = 0 (Hyrkäs *et al.*, 2003) was used to calculate an inter-item correlation, t-test as well as content validity index (CVI) (Hyrkäs *et al.*, 2003). The inter-item correlation was calculated using the *Statistical Programme for Social Sciences* (SPSS) to determine the correlation between each panel member's overall score in relation to the next member's.

The CVI's were calculated for each question according to the following formula:

$$\text{CVI} = \frac{\text{number of raters giving a rating of '2' or '3'}}{\text{Total number of raters}}$$

Where raters are the panel members and ratings '2' or '3' are generated from four-point rating scale. As suggested by Hyrkäs *et al.* (2003), for the CVI's obtained, those questions in relation to the questionnaire that scored above 0.79 were regarded as acceptable, those between 0.7 and 0.78 as in need of attention and those below 0.69 as

requiring revision or elimination. As a result, some instruments were reviewed and some were substituted and/or adjusted.

Following the instrument validation process, it was decided that the instrument were suitable for the research. At this stage, the researcher had obtained instrument validity through quantitative and qualitative methods.

Concerning the quantitative methods, the CVI's were determined. This particular method showed that the instrument was valid and reliable provided some minor adjustments were made. The piloting of the instrument further gave confidence that the instrument was valid and reliable for the research. Therefore, at the end of this process the researcher was confident that the instrument was valid and suitable for the research. The researcher agrees with the notion of validating the instrument as it provides the researcher with ideas, approaches that may not been foreseen before conducting the pilot study which is particularly helpful in face validity method. Such findings increase getting clearer answers for the study, thus the credibility of the study increases. Furthermore it allows the researcher to redesign parts of the study to overcome difficulties that the pilot study reveals.

### **3.7.2 Reliability**

Reliability is more important in quantitative approaches. The closed questions in the questionnaire are the most suitable to calculate internal consistency using the method where Cronbach's alpha is measured. The main thing that the researcher should look for when employing this method is that all questions are answered in order to establish proper interpretation. The results on reliability will be presented in chapter 4 to determine the consistency of the scores. Given the fact that the pilot study was administered twice and the results were then after found to be constant. The researcher can confidently state that the instrument was valid and reliable.

### 3.8 Sampling

A sample is a subset of a population being studied. It represents the larger population and is used to draw inferences about that population (Garson, 2007). It is a research technique that is broadly used to gather information without having to measure the entire population (Geolog, 2006). Given the number of houses present in the area and the limited resources at the researcher's disposal it would have been impossible to sample for each and every household in the study area. A non-probability sampling was used because not everyone in the area had an equal chance of being included in the study (Geolog, 2006). Consequently the researcher applied convenience sampling which is probably the most common of all sampling techniques. With convenience sampling, the samples are selected because they are accessible to the researcher. Participants are chosen simply because they are easy to recruit. This technique is considered easiest, cheapest and least time consuming. The researcher further used the probability sampling after identifying the population and applying a random process to decide on each individual's probability (Garson, 2007).

A stratified sampling technique was used by the researcher to divide the entire target population into different subgroups, or strata, and then randomly selected the final participants proportionally from the different strata (Garson, 2007). This type of sampling is used when the researcher wants an adequate amount of participants from each class in the final sample. The researcher only used this method with the questionnaires that were meant to be administered to residents in KwaMathukuza area as the expected sample size was larger. This method quite greatly improved the efficiency of the sample plan. This is due to that the selection of participants is random, not first available therefore it doesn't put any pressure on a researcher. In order to conduct this sampling strategy, the researcher defined the population first, listed down all the members of the population and then selected members to make the sample (see Figure.3.4). The two major reasons why the researcher chose to use it:

- a) Group comparison is the purpose of the study (disproportionate stratified sampling).
- b) Some elements are more important in determining outcome of research interest than are others.

The researcher's point of view for using this form of sampling was to extend the survey to the whole site and avoid a bias representativeness of the study.

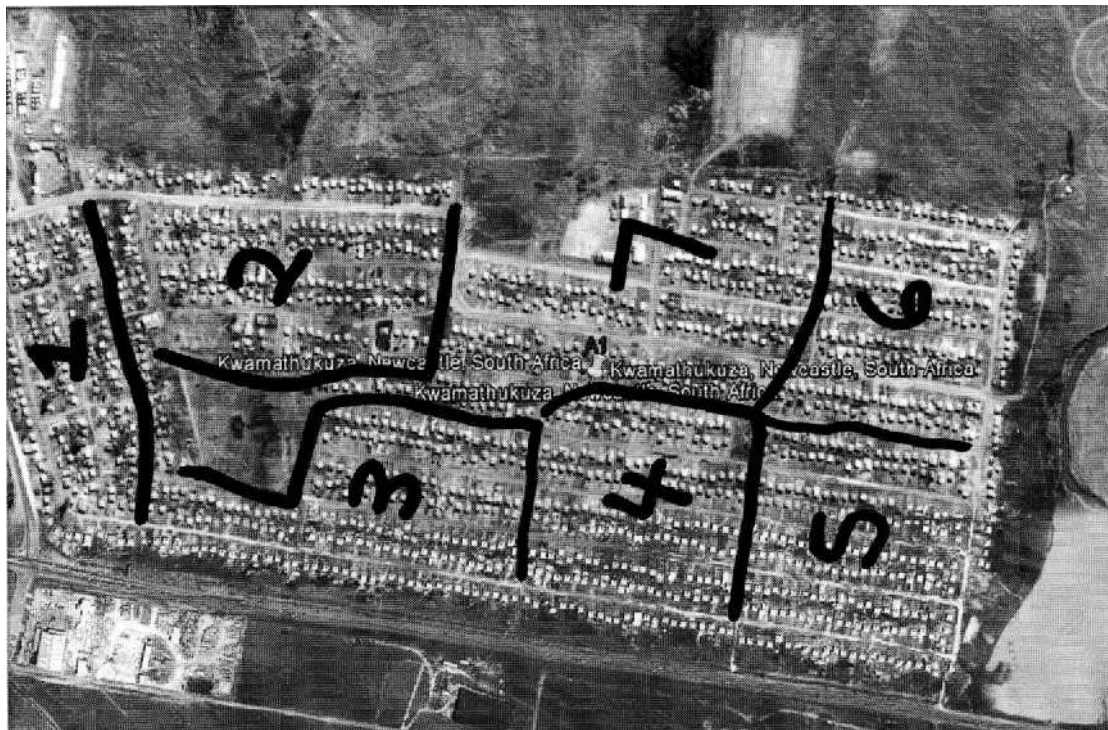


Figure 3.6 Shows the numbers which represent the groupings of populations in the study area. To ensure that the survey is extended to the whole site

The researcher recorded all the house numbers to avoid the same household being sampled more than once.



### **3.8.1 Participants**

The researcher systematically chose the respondent in the study area (as shown in Figure 3.4). The target was to survey more than 50 residents in the area, both genders between the age group 18.0 – 65.0 years. With regards to neighboring residents who reside more than 5.0 km from the WWTP, 15 people were surveyed. The researcher printed more questionnaires just to collect more data than envisaged.

A survey of the odour issues as perceived by residents in the neighbouring residential areas was conducted. The areas were selected, as it was felt that these residents would have been affected by any possible air-quality issues that may be related to the WWTP that is in close proximity to their residential area. The caregivers were involved in the study because the researcher believes they are there to oversee the health of people in the area, provide sound advice on rehabilitating their health and ensure that they administer appropriate treatment based on their health status and surrounding environment. The input from a municipality official who is involved with the WWTP was crucial as the researcher believed he/she may provide information on the technical aspects of the plant that may be manipulated in the future to reduce the impact of the odour to the surrounding community.

### **3.8.2 Mode of Administration**

Broadly speaking there are two modes of administering a questionnaire, a) self-administered and b) interviewer administered questionnaire. Self-administered questionnaire only requires questionnaire distribution; it is much cheaper and doesn't need trained staff. This mode is less susceptible to information bias and interviewer effect but has a greater chance of having no response items. The main advantages of

self-administered questionnaires is that it can reach a large sample size, cover wide geographical area, cover population which is sometimes difficult to reach, excellent for capturing sensitive topics and cheaper as compared to other modes of administration (Creswell, 2009). The main challenge that the current researcher discovered with this mode was that some respondents tend to leave some questions unanswered which affects the results. Therefore going through the questionnaire and identifying gaps helps even though it consumes time.

Common method of self-administered questionnaire distribution is either through mail or electronic distribution. Participants can complete mailed questionnaire at their convenience, in their homes and at their own pace. Major disadvantage of the mailed questionnaire is low response rate even after repeated mails, and queries of the participant cannot be clarified. Some effective techniques for improving the rate of response are; sending follow-up letters, enclosing some incentives, providing self-addressed stamped envelope and keeping the questionnaire brief. Electronic and web-based questionnaire, including data collected through personal digital apparatus (PDAs), smart phones and cell phones are latest techniques for questionnaire administration. Questionnaire can be designed to filter and screen participant's response, checks for input error, range and skip patterns can be incorporated preventing significant typing and data format error.

However electronic questionnaire is restricted to those participants who have access to a computer and internet and this can be a potential bias. In person or interview based administration is expensive if the researcher is from afar but provides direct interaction with the participant. The interviewer has the opportunity to introduce the research topic and motivate the participant to offer their frank answers and questions can be clarified at the spot. If the interviewer is motivated, it is the best method to collect data. The current researcher telephoned a number of officials including caregivers especially doctors to facilitate in covering a large number of participants. The advantage with this

is that the interviewer on the phone can directly talk to the participant, explain the study and clear any confusion or questions during the call.

The researcher aimed for a demographically representative sample. Therefore the researcher aimed at the different parts of town and around the study area to administer the questionnaires to the healthcare givers. To make the respondents aware that their inputs were required, the researcher telephonically contacted all the identified respondents and requested them to avail themselves in answering the questionnaire. The researcher further stated that the respondent was to get a maximum of 3 days to complete answering the questionnaire. The aim of the researcher was to administer 20 questionnaires to health caregivers. The questionnaires were formally integrated for three respondents, KwaMathukuza residents including those who reside 5km away, a minimum of 50 respondents and municipal employee's minimum of 10.

The semi structured interviews were directed to the municipal officials. The purpose of these interviews was to gain additional in-depth information on perceptions about the WWTP being in close proximity to the site and how the staff members in the vicinity deal with the odour related challenges. The officials from the Environmental Affairs Department and the municipality town planning office helped the researcher understand the dynamics that occurred before the houses in KwaMathukuza got built through document analysis and progressive storylines of legislation dynamics to help understand the perceptions and the researcher recorded everything. This was helpful to the researcher as the current study strives to provide new knowledge and give an opportunity to examine all aspects of the problem further giving suggestions of hypotheses for the future.

### **3.8.3 Ethics**

As this study required the participation of human respondents, certain ethical issues were addressed. The consideration of these ethical issues was necessary for the

purpose of ensuring the privacy as well as the safety of the participants. Among the significant ethical issues that were considered in the research process include consent and confidentiality. In order to secure the consent of the selected participants, the researcher relayed all important details of the study, including its aim and purpose. By explaining these important details, the respondents were able to understand the importance of their role in the completion of the research. The respondents were also advised that they could withdraw from the study even during the process. With this, the participants were not forced to participate in the research. The confidentiality of the participants was also ensured by not disclosing their names or personal information in the research. Only relevant details that helped in answering the research questions were included.

The researcher obtained ethical clearance to conduct the study from the University of South Africa (Ref. Nr: 2012/CAES/046) and a permission letter from the Newcastle municipality to conduct research in the study area. Furthermore the researcher made sure that every questionnaire had a consent form in order for participants to understand that they were answering the questions on a voluntary basis.

### **3.9 Data analysis**

Data collection took one week in January 2012. After gathering all the completed questionnaires from the respondents, total responses for each item were obtained and tabulated. The statistical analysis was performed using SPSS Statistics 17.0 Ink software where descriptive and inferential statistics were calculated. Results of data analysis will be presented in chapter 4.

### **3.10 Conclusion**

The experience drawn from field work is the advantage of using both the qualitative and quantitative methods to give the researcher full understanding of the concepts linked to the study. The researcher discovered more answers than initially bargained for by utilising different research methods.

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## CHAPTER 4: RESULTS

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### 4.1 Introduction

The purpose of this chapter is to present an analysis of the results from all the questions addressed in the questionnaires administered to various respondents in relation to the WWTP in KwaMathukuza area, Newcastle. This will be followed by a critical discussion of the findings and their linkages to the existing literature and research in order to ascertain whether this new data supports or contradicts the existing knowledge.

### 4.2 Results

In this section both qualitative and quantitative results will be presented. These are organized to address the research question and sub questions. As indicated in Chapter 1 these questions are:

- 1) How were the integrated environmental assessment (EIA) regulations applied and proper mitigation measures considered for people's safety?
- 2) What is the impact of gases released from the sewage treatment facility on health of residents living adjacent to such sites in Newcastle?
- 3) Should residential houses be built close the the WWTP?
- 4) Do families that reside close to the WWTP present common ailments such as deformities or early deaths within families?

#### 4.2.1 Meteorological factors

There appears to be a relationship between odour and meteorological conditions. Sakawi *et al.* (2011) indicates that weather is one of the environmental components which influence the frequency and the intensity of odour perceived by sensitive



receivers. The influence of weather such as wind direction and wind speed, temperature and rainfall can all affect the concentration of odour from the WWTP. Meteorological data in Figure 3.3 indicate that on average the maximum summer temperature in the area varies between 22°C and 30.8°C in summer, while in winter the minimum temperature varies between 5.6 °C to 18.6°C.

The results indicated that 55.0 % of respondents who reside in close proximity to the WWTP perceived that the strong odour usually lasts for up to an hour and 36.0 % of the respondents indicated that they could smell the odour for the whole day. About 40.0% respondents who are five kilometers away indicated that the strong odour lasts for the whole day and 40.0% also indicated that the odour lasts for up to an hour. A majority of respondents (56.1%) who live in close proximity to the WWTP further indicated that the odour is perceived more during the day, 12.1% respondents were more sensitive to the odour at night and 15.2% of respondents indicated their sensitivity towards the smell when it's windy, 10.6% indicated that they are more affected during the day whereas 3.0% are more sensitive to the odour when it rains, 1.5% in cold days and 1.5% did not give a valid response (Figure 4.1).

A high percentage of 70.0% respondents who reside five kilometers from the WWTP indicated that they also perceive most of the odour during the day whereas 20.0% indicated that they are more sensitive to the odour when it is windy and 10% were only sensitive to the odour at night. A majority of the respondents (i.e. 78.0%) indicated that they mainly respond to the odour by closing windows and doors if the odour becomes too invasive. The researcher further found that 3.0% of respondents in KwaMathukuza believe that the infestation of flies and mosquitoes in the area is related to the odour.

Figure 4.1: The time of the day in which most receivers are sensitive to odour

There is strong correlation that the odour blows from the WWTP wind direction to the North West of KwaMathukuza as indicated in chapter 3 section 3.2.2.3. This makes the WWTP a major source of odour in the neighborhood. The wind speeds recorded over a five year period are generally low, 3.0 – 4.0 m/s having a frequency of less than 15.0 % and occurring only in September (see Figure 3.4). It makes sense therefore to obtain only 20% response that the odour is smelt in such an instance. It is also important to note that the more the wind in the area, higher are the chances of soil erosion and if the rainfall increases considering the average rainfall of 55.56 mm occurring between January and December as indicated in Figure 3.2, the area may be more prone to floods from the nearby river.

#### **4.2.2 Background information of the respondents**

The results show that 99.0 % of the sampled community is black African except for 1% minority which is coloured people. The results further indicate that 55.0 % of the respondents were females and 45.0 % were males. The unemployed respondents amount to 73.0 %, whereas 13.0 % is self-employed, 3% did not give valid input and

12.0 % is employed. In terms of education, 53.0 % of the respondents have high school education (i.e. Grade 8 to 12), 12.1 % studied at Further Education and Training (FET) colleges, 4.5 % studied at university, 22.7 % have primary school education and 7.6 % never obtained any formal education.

Figure 4.2 Length of stay of sensitive receivers at the site

About 43.9% respondents have been residing in the area for 6.0-10.0 years, 21.3% have been in the area for 0-5.0 years. Those who have been in the area for 11 to 15 years make 19.7%, whereas 12.1% have been in the area for 16.0-20.0 years and 3% have resided in the area for 21 years and more (Figure 4.2 above).

#### **4.2.3 Compliance with EIA regulations**

One of the aims of the study was to investigate if the integrated environmental assessment (EIA) regulations were effectively implemented before building the (RDP) houses. The researcher discovered that an EIA study was conducted before houses were built KwaMathukuza in 2003. The municipality officials (i.e. respondent #5)

indicated to the researcher that “the approval for building houses in KwaMathukuza was received on the 25<sup>th</sup> November 2002” from the Development Tribunal. The Development Tribunal was established in terms of Section 15 (1) of the Development Facilitation Act, Act No 67 of 1995, with one of its primary functions being to consider and decide upon land development applications submitted in terms of the Act. A tribunal is established for each province in each case to be known as the development tribunal of the province concerned. A tribunal consists of a chairperson, a deputy chairperson and approximately 50 other member appointed by the Premier with the approval of the provincial legislature.

The researcher couldn't get hold of the written decision which calls for either an Environmental Authorization or Environmental Refusal and is listed in a Record of Decision (RoD). The researcher only took the word from the Department of Environmental Affairs (DEA) officials. The official (from the DEA, respondent #20) indicated that EIA was done and some of the concerns which exist today were brought into light by that study however nothing was done to stop the building progress from the site. These concerns included the close proximity of the WWTP to the site, the cemetery and the river. Respondent #5 (a municipality official) argued that “it doesn't take a rocket scientist to see that the area was and is unsuitable for human habitation” even though houses were build there. This finding suggests that while the EIA was conducted by the DEA, its recommendations were not implemented. As a consequence, it emerged (from a municipality official, respondent # 9) that the “Provincial Department of Environmental Affairs has made a court application accusing the municipality, specifically the Town Planning division, of being indecorous in allowing such a site to be occupied”. The court case is still pending. The researcher could not obtain relevant documents due to the sensitivity of the matter.

The researcher further investigated how the houses were built against the recommendations of the EIA. The division of Town Planning in the municipality, through respondent #11, indicated to the researcher that the reason why the establishment

continued was due to “the policies and Acts of that time”. He indicated that they “complied mainly with the Development Facilitation Act 67 of 1995 which was enacted after 1994 from a transition of apartheid”. He indicated that they interpreted the Act as one of:

“extraordinary measures to facilitate and speed up the implementation of reconstruction and development programmes and projects in relation to land; and in so doing to lay down general principles governing land development throughout the Republic. The Act further suggests that a development that benefits the environment [more than the society] should not be used to stop development, instead there must have mitigation measures to address the loop holes. This Act was less formal and applied mainly to the township establishments”.

The respondent (#11) openly indicated that the other aspect that led to the establishment of that site was the availability of land that solely belonged to the municipality and wasn't privately owned.

The Town Planning division (through respondent #11) went on further to point out that the system on how they handle developmental issues especially with regards to RDP houses has “improved since the new Planning and Development Act 2010 which introduces provisions regarding development plans, changes to the planning code and has made significant amendments to the Planning and Development Act 2000 (“the 2000 Act”)”. These changes are relevant to developers, local authorities and all future applicants for planning permissions.

Given the finding that EIA recommendations were not implemented, the researcher went on to investigate whether follow-up audits have been done to determine the impact of building houses in an unsuitable area. Environmental auditing is an important tool for providing an account of post-development environmental impact assessment (EIA) activities. In the past much EIA auditing focused on predictive techniques and prediction accuracy, which provide little information on the actual environmental outcomes.

However, of central interest in determining the effectiveness of EIA is the extent to which the environment and communities are managed and protected as a result of the EIA process as it is intended. The audit methodology for determining EIA effectiveness focuses on several distinct EIA components: impact prediction; occurrence of actual impacts; and the management of potential and actual environmental impacts. These are examined with particular attention to impact and environmental management outcomes. With regards to communities, auditing would include regular meetings between environmental management officials, municipalities and communities to determine if certain projects (such as the WWTP) are causing harm to the community. One would expect that, since the EIA recommendations were not implemented KwaMathukuza, regular meetings would be held between the relevant authorities and the community to ensure that the livelihood of the society is not compromised.

Fifty one percent of the respondents indicated that they have not attended any meetings with the municipality in general, while 46.0 % have. To this effect, 62.0 % of the respondents indicated that they report environmental problems to their local council (not the municipality), 15.0 % report to municipality and 3.0 % choose not to report. In this regard, 60.0 % of the respondents indicated having reported odour related complaints while 21.0 % have not. Sadly 36.0 % of the respondents indicated that their complaints and request are never resolved. To this end, 68.2 % of the respondents believe that the WWTP has negative effects on their lives while 36.0 % said the WWTP has negative effects on the environment. A critical observation in this instance is that there appears to exist poor communication between the municipality which administers the WWTP and the community at KwaMathukuza. This means the EIA measures to address environmental and social hazards such as proper and efficient auditing do not take place properly. In the following subsections the researcher presents results related to whether or not the WWTP has negative effects on the society KwaMathukuza.

#### **4.2.4 Odorous gases released by the WWTP**

Data revealed that there are unusual gases released probably from the WWTP. A survey of the area (kwaMathukuza) showed no other possible source of these gases except the WWTP. These gases lead to an unpleasant odour which probably affects the health of the residents as well as the environment in general. The odour in this regard was described by the respondents as a skunk or rotten eggs. In the following paragraphs the researcher presents detailed description of the odour trends as revealed by the data.

Figure 4.3 Strength of the odour according to respondents.

The results indicate that 97.0 % of respondents have smelt the bad odour that is probably released from the WWTP. This includes all respondents (n=10) who reside more than five kilometers from the WWTP. A majority of the respondents described the odour as strong to very strong (Figure 4.3).

Data also revealed that a majority of respondents 59.1% perceived the frequency of the odour at least once a day; some 18.2% indicated that the smell is there once every hour

whereas some 15.1% indicated that it's only once a week that they smell the odour. Data shows that only 7.6% indicated that they experience the odour only once a month. (Figure 4.4).

Figure 4.4 Frequency of the odour as perceived by the respondents.

#### **4.2.5 Effect of the gases on the community housing**

The researcher investigated the effect of the gases released from the WWTP on the community housing of KwaMathukuza. Qualitative data collected from officials in Newcastle municipality suggests that they have received complaints regarding the odour at least once every year and they also perceive the smell as unbearable. It must be mentioned that the community may be reporting an “odour” and not “gases” because they experience an odour and may not have a scientific understanding of the relationship between the gases and the odour.

Data also revealed that some officials believe that KwaMathukuza site is unsuitable for occupancy not only due to the WWTP but also due to its close proximity to the river and



the cemetery. They raised a concern about possible flooding in the area and that some of the houses have been built much closer to the river belt. The possible flooding may lead to leakage at the WWTP which may spill over to the houses. In this regard, the researcher found that most of the houses in the site have visible structural defects which may be due to chemicals released from the WWTP or simple water. The researcher did not have necessary equipment to test for this with certainty.

The current researcher made the following observations on houses which are within five kilometers from the WWTP:

- That most of the houses had cracking and crumbling walls (Figure 4.5);
- Poor drainage which also results in flooding (Figure 4.6);
- Some houses had banned asbestos as the roofing material (Figure 4.7)



Figure 4.5 Showing the waterlogged houses-note how water affects the structure.



Figure 4.6 The mud from untarred roads- usually waterlogged after brief rain spell.



Figure 4.7 The asbestos used as a roof cover in some of the houses

#### **4.2.6 Effect of the gases released from the WWTP on the community health**

The researcher also investigated the potential effect of gases released from the WWTP on the health of the community. According to the healthcare givers who participated in the study people who are exposed to gases (odours) were “most likely to suffer from allergens, sinusitis, nausea and lung diseases” (e.g. Respondent #16). The researcher then investigated whether these symptoms had been observed.

To start with, the researcher asked the respondents (residents) if they perceive the WWTP and the gases released as hazardous. Seventy two percent of respondents indicated that the odour (gases released from the WWTP) possibly causes health problems to humans. A further 74.0% indicated that they believe the gases probably affect their lungs. This was based on the fact that at least 57.0% of the respondents indicated that they visit the health facilities at least once in a month. About 40.0% of the respondents that reside five kilometers away from the site visited the health facility on a monthly basis. About 50.0% of respondents from five kilometers away indicated that they consult the public clinic the most and 40.0% go to the public hospital whereas 10% can afford to visit private doctors. In KwaMathukuza 51.5% people indicated that they consult mainly the clinics when they are sick and 39.4% visit hospitals whereas a minor shortfall of 6.1% visits the doctors and 3% never gave clear indication to the institution they consult (Figure 4.8).

Figure 4.8 Health institutions consulted the most by residents in the area

Previous research has identified common ailments related to gases released from WWTP (Zarra *et al.*, 2008). As indicated in Chapter 3, the researcher investigated whether some of these ailments are common in KwaMathukuza, in which case the researcher would infer that the WWTP is possibly affecting the health of the residents. Data revealed that 10.0% of the respondents indicated to have suffered a miscarriage. However there was no evidence suggesting that residing in close proximity to the WWTP increases the chances of miscarriages. Results did however indicate that a significant number of people suffer from headaches, vision, olfactory and breathing problems. Furthermore, it emerged that there is a significant correlation between the shortness of breath, regular cough, asthma, wheezing of chest, redness of eyes and the tightness of chest (Table 4.1a). There was also significant correlation between shortness of breath, burning sensation in the eyes, redness of the eyes and asthma (see Table 4.1b) below.

About 71.2% of the respondents indicated that they regularly suffer from blocked nose when their at home, whereas 3.0% observed that their nose get blocked when they are at work and 25.8% did not observe this olfactory impact. This was in line with an

observed significant correlation between shortness of breath, regular sore throat, regular cough, tightness of chest, redness of eyes and the blocked nose (Table 4.1c). The researcher further discovered that there was a significant correlation between trouble of concentrating with numbness of hands and/feet and tingling of hands and/feet (Table 4.1d). About 40.0% respondents indicated that they experience numbness of hands and/feet when at home, 10.0% experience this numbness when at work and 50.0% do not have any of such symptoms (Figure 4.9). Memory problems also had a significant correlation between the numbness of hands and/feet; the tingling of hands and/feet and swelling of feet and ankles (Table 4.1d).

Figure 4.9 Respondents who experience numbness of hands and/feet

The researcher also found qualitative data which shows that many of the children in the area had teary looking, discoloured not very red eyes (Figure 4.10).



Figure 4.10 Some of the children's eyes appeared to be teary and discolored in the sclera

Table 4.1a: A summary of correlations between symptoms presented by respondents

		Distance from WTPP	Miscarriages	Shortness of breath	Regular cough	Tightness of chest	Asthma	Wheezing of chest	Sudden fatigue when walking	Sudden fatigue when climbing light stairs	Sudden fatigue when bathing
Distance from WTPP	Pearson Correlation	1	-0.008	0.011	0	0.078	-0.196	0.136	-0.032	0.094	0.032
	Sig. (2-tailed)		0.947	0.929	1	0.536	0.115	0.277	0.8	0.452	0.797
	N	66	66	66	66	66	66	66	66	66	66
Miscarriages	Pearson Correlation	-0.008	1	0.135	-0.178	-0.191	-0.049	0.124	0.198	.463**	0.23
	Sig. (2-tailed)	0.947		0.281	0.153	0.124	0.695	0.322	0.11	0	0.063
	N	66	66	66	66	66	66	66	66	66	66
Shortness of breath	Pearson Correlation	0.011	0.135	1	0.169	.370**	.270*	.443**	-0.007	0.026	0.104
	Sig. (2-tailed)	0.929	0.281		0.174	0.002	0.028	0	0.954	0.837	0.405
	N	66	66	66	66	66	66	66	66	66	66
Regular cough	Pearson Correlation	0	-0.178	0.169	1	.493**	0.193	.263*	0.082	-0.117	0.116
	Sig. (2-tailed)	1	0.153	0.174		0	0.121	0.033	0.514	0.35	0.354
	N	66	66	66	66	66	66	66	66	66	66
Tightness of chest	Pearson Correlation	0.078	-0.191	.370**	.493**	1	.376**	.488**	0.003	0.016	0.082
	Sig. (2-tailed)	0.536	0.124	0.002	0		0.002	0	0.983	0.901	0.512
	N	66	66	66	66	66	66	66	66	66	66
Asthma	Pearson Correlation	-0.196	-0.049	.270*	0.193	.376**	1	.325**	0.165	0.032	-0.03
	Sig. (2-tailed)	0.115	0.695	0.028	0.121	0.002		0.008	0.187	0.798	0.813
	N	66	66	66	66	66	66	66	66	66	66

\*\*Correlation is significant at the 0.01 level (2-tailed). \*Correlation is significant at the 0.05 level (2-tailed).

Table 4.1b: A summary of correlations between symptoms presented by respondents

		Distance from WTPP	Miscarriages	Shortness of breath	Regular cough	Tightness of chest	Asthma	Wheezing of chest	Sudden fatigue when walking	Sudden fatigue when climbing light stairs	Sudden fatigue when bathing
Wheezing of chest	Pearson Correlation	0.136	0.124	.443**	.263*	.488**	.325**	1	0.122	0.217	0.134
	Sig. (2-tailed)	0.277	0.322	0	0.033	0	0.008		0.328	0.081	0.284
	N	66	66	66	66	66	66	66	66	66	66
Sudden fatigue when walking	Pearson Correlation	-0.032	0.198	-0.007	0.082	0.003	0.165	0.122	1	.629**	.402**
	Sig. (2-tailed)	0.8	0.11	0.954	0.514	0.983	0.187	0.328		0	0.001
	N	66	66	66	66	66	66	66	66	66	66
Sudden fatigue when climbing light stairs	Pearson Correlation	0.094	.463**	0.026	-0.117	0.016	0.032	0.217	.629**	1	.301*
	Sig. (2-tailed)	0.452	0	0.837	0.35	0.901	0.798	0.081	0		0.014
	N	66	66	66	66	66	66	66	66	66	66
Sudden fatigue when bathing	Pearson Correlation	0.032	0.23	0.104	0.116	0.082	-0.03	0.134	.402**	.301*	1
	Sig. (2-tailed)	0.797	0.063	0.405	0.354	0.512	0.813	0.284	0.001	0.014	
	N	66	66	66	66	66	66	66	66	66	66
Sudden fatigue when dressing	Pearson Correlation	-0.157	0.023	0.078	0.168	.277*	0.115	-0.048	.434**	0.236	.497**
	Sig. (2-tailed)	0.208	0.856	0.531	0.178	0.024	0.359	0.703	0	0.057	0
	N	66	66	66	66	66	66	66	66	66	66
Burning sensation in the eyes	Pearson Correlation	-0.034	-0.107	.364**	0.199	.304*	.263*	0.199	0.022	0.1	0.11
	Sig. (2-tailed)	0.789	0.394	0.003	0.109	0.013	0.033	0.109	0.862	0.425	0.38
	N	66	66	66	66	66	66	66	66	66	66

\*\*Correlation is significant at the 0.01 level (2-tailed). \*Correlation is significant at the 0.05 level (2-tailed).



Table 4.1c: A summary of correlations between symptoms presented by respondents

		Distance from WTPP	Miscarriages	Shortness of breath	Regular cough	Tightness of chest	Asthma	Wheezing of chest	Sudden fatigue when walking	Sudden fatigue when climbing light stairs	Sudden fatigue when bathing
Redness of the eyes	Pearson Correlation	-0.017	-0.01	.284*	.284*	.418**	.435**	.352**	.398**	.295*	.317**
	Sig. (2-tailed)	0.895	0.935	0.021	0.021	0	0	0.004	0.001	0.016	0.01
	N	66	66	66	66	66	66	66	66	66	66
Swelling of the eyelids	Pearson Correlation	-0.097	-0.187	.374**	0.161	.437**	.320**	.303*	0.231	0.181	0.035
	Sig. (2-tailed)	0.44	0.132	0.002	0.196	0	0.009	0.013	0.062	0.146	0.778
	N	66	66	66	66	66	66	66	66	66	66
Regular tearing	Pearson Correlation	0.034	-0.092	.436**	.265*	.361**	.402**	.473**	.307*	.255*	0.213
	Sig. (2-tailed)	0.789	0.464	0	0.031	0.003	0.001	0	0.012	0.039	0.086
	N	66	66	66	66	66	66	66	66	66	66
Regular sore throat	Pearson Correlation	-0.081	0.024	.342**	0.135	.258*	0.183	0.201	.325**	0.174	.384**
	Sig. (2-tailed)	0.517	0.846	0.005	0.281	0.037	0.14	0.105	0.008	0.163	0.001
	N	66	66	66	66	66	66	66	66	66	66
Dryness of the nose	Pearson Correlation	-0.093	-0.013	.291*	0.186	.330**	0.191	0.229	0.014	0.144	0.006
	Sig. (2-tailed)	0.46	0.92	0.018	0.134	0.007	0.124	0.065	0.913	0.25	0.965
	N	66	66	66	66	66	66	66	66	66	66
Blocked nose	Pearson Correlation	-0.096	0.061	.388**	.361**	.341**	0.189	.285*	0.08	0.055	-0.018
	Sig. (2-tailed)	0.443	0.626	0.001	0.003	0.005	0.128	0.02	0.523	0.661	0.888
	N	66	66	66	66	66	66	66	66	66	66

\*\*Correlation is significant at the 0.01 level (2-tailed). \*Correlation is significant at the 0.05 level (2-tailed).

Table 4.1d: A summary of correlations between symptoms presented by respondents

		Distance from WTPP	Miscarriages	Shortness of breath	Regular cough	Tightness of chest	Asthma	Wheezing of chest	Sudden fatigue when walking	Sudden fatigue when climbing light stairs	Sudden fatigue when bathing
Regular headache	Pearson Correlation	-0.131	-0.104	0.184	0.186	-0.009	0.035	0.056	0.151	0.035	-0.035
	Sig. (2-tailed)	0.293	0.408	0.139	0.134	0.94	0.777	0.657	0.226	0.78	0.78
	N	66	66	66	66	66	66	66	66	66	66
Trouble concentrating	Pearson Correlation	-0.057	0.047	.269*	-0.069	0.013	0.08	0.221	.366**	.363**	.402**
	Sig. (2-tailed)	0.651	0.707	0.029	0.58	0.916	0.525	0.075	0.002	0.003	0.001
	N	66	66	66	66	66	66	66	66	66	66
Memory problems	Pearson Correlation	0.003	0.201	0.018	-0.055	-0.049	0.032	0.174	.547**	.402**	.314*
	Sig. (2-tailed)	0.98	0.106	0.885	0.66	0.695	0.796	0.161	0	0.001	0.01
	N	66	66	66	66	66	66	66	66	66	66
Numbness of hands and/or feet	Pearson Correlation	.274*	0.068	0.119	0.046	0.157	0.12	.352**	.415**	.424**	0.084
	Sig. (2-tailed)	0.026	0.59	0.343	0.716	0.209	0.339	0.004	0.001	0	0.505
	N	66	66	66	66	66	66	66	66	66	66
Tingling of hands and/or feet	Pearson Correlation	0.205	0.044	0.026	0.088	0.063	0.07	0.19	.463**	.359**	0.229
	Sig. (2-tailed)	0.099	0.723	0.834	0.481	0.615	0.575	0.126	0	0.003	0.064
	N	66	66	66	66	66	66	66	66	66	66
Swelling of feet and ankles	Pearson Correlation	0.179	0.13	0.165	0.081	0.238	0.133	.254*	0.22	.311*	0.169
	Sig. (2-tailed)	0.149	0.298	0.186	0.519	0.055	0.286	0.04	0.075	0.011	0.175
	N	66	66	66	66	66	66	66	66	66	66
Burning sensation of the hands	Pearson Correlation	0.046	0.173	0.151	-0.009	0.089	0.089	0.164	.438**	.372**	.273*
	Sig. (2-tailed)	0.716	0.166	0.226	0.944	0.477	0.477	0.189	0	0.002	0.027
	N	66	66	66	66	66	66	66	66	66	66

\*\*Correlation is significant at the 0.01 level (2-tailed). \*Correlation is significant at the 0.05 level (2-tailed).

The researcher could not obtain any evidence to suggest the existence of handicapped babies and early deaths in families in relation to the WWTP.

The researcher went on to find out whether the municipality officials perceive the WWTP and the gases from it as hazardous to the community. An official at WWTP (i.e. respondent #2) indicated that they work at a risk for occupational exposure to blood or blood-contaminated body fluids. He further indicated that their workers receive annual immune boost to help prevent them from contracting hepatitis diseases. Municipality officials (i.e. respondent # 7) also indicated that they strongly believe that “the health of people who reside at the site is severely compromised not only due to odours and gases which are harmful to people's health but also due to possible contamination of aquifer by pathogens (microorganisms)” that are released in the cemetery bed. (A cemetery is located within five kilometers from the research site). Respondent #7 also highlighted that the lack of a border fence between the houses and the WWTP puts local children and livestock at risk. Another municipality official (respondent #8) further indicated that they had officially “planted approximately 1800 trees” in KwaMathukuza to try and “mitigate air pollution in the area and to provide people with access to a cleaner environment however those trees were not looked after and many of them died”. By inference, the official acknowledged that the WWTP was causing air pollution which could affect the environment and the health of local communities.

### **4.3 Conclusion**

The results indicate that people who reside in KwaMathukuza experience the same effects due to odour as people who are 5.0 km away from the site. People in KwaMathukuza are however more prone to health risks and are facing serious challenges in that particular site.

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## **CHAPTER 5: FINDINGS**

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### **5.1 Introduction**

In this chapter the researcher reflected on the research questions in order to articulate the knowledge contribution of the study. To do this it is crucial to first put forward what is already known in the literature in relation to the research questions. The researcher will further present the new findings of the study, including that which contradicts existing literature. The researcher will also highlight the limitations of the study and make recommendations on policy implementation in relation to EIA and research for other scholars to pursue.

### **5.2 The research questions and the major findings**

The first question asked: “how were the integrated environmental assessment (EIA) regulations applied and proper mitigation measures considered for resident’s safety”? The researcher found that EIA was conducted in the study area before building commenced. The initial plan for the housing process was based on the “fast-tracking” method, which translated into external contractors coming in and building houses speedily. The responses from the officials from the local office of Department of Environmental Affairs (DEA) signify that recommendations promulgated from the EIA were not in favour of building from that site. This means officially that site should not have been zoned for residential development.

It seems as though power was intimately used in disconcerting the EIA policy and applying other policies as indicated (in section 4.2.2) to develop the area. It is pleasing to see government being committed to sheltering people; however it is also disturbing that future implications of the consequences of building in that area were not properly looked. It must be noted that the local municipality still bears the burden in their limited

budget to set aside funds for reconstruction of houses that were built in the unsuitable terrain. Rebuilding those houses may seem proper but it doesn't look like a sustainable solution.

The researcher found poor follow up at the site, residents were succumbing to atrocious living conditions and from their report "the municipality was doing little to attend to the residents' needs". The municipality had decided to plant trees to curb the odour only in 2011 which is 9 years later since the houses were built. Sadly many of the trees died because the local municipality expected the people to take care of the trees which didn't happen. Overall there is little evidence that clearly indicated that EIA was adequately integrated in the housing projects. Based on the researcher's analysis, there is no evidence that policies and laws that relate to EIA contributed at promoting cognizant environmental management to evaluate potential environmental social, economic, cultural, natural impacts, socioeconomic impacts which include an assessment of land use, visual and aesthetic impacts on neighbours.

There is clear indication from the results that the community constitutes mainly of black people and that the rate of unemployment is high in this community. Furthermore a significant number of people mainly reached high school without obtaining tertiary education. This indicates that these people are vulnerable and prone to environmental injustice which is unfair treatment with respect to the development, implementation and enforcement of environmental laws, regulations, and policies in a sense that they just accept whatever that is put on their plate due to lack of information or prejudice.

Worldwide the greatest effects on the health of individuals and populations results from environmental degradation and social injustice, operating in consort (Donohue, 2008; Givens and Jorgenson, 2013). The majority of people affected are poor communities as they are most likely to bear the disproportionate burden of negative externalities linked to questions of development, human rights and democratic accountability. The results presented in this study illustrate how poor communities bear the brunt of environmental

injustice and include not only race but also gender, age and educational level. This could be linked to a known fact that poorer communities are less likely to cause disputes or oppose any flaws that are linked to the environmental regulatory systems.

There is high frequency of consultation to the public hospitals and clinics this serves as a clear sign that something is not right within their environment that compromises the immune systems of the community members. One possibility why these people visit mainly the public health institutions than private doctors may be linked to the issues of free services as opposed to payments when visiting a private doctor due to the high unemployment rate in the area.

The second sub-question was: “what is the impact of gases released from the sewage treatment facility on health of residents living adjacent to such sites in Newcastle”? Findings of the study point out that a majority of the respondents who were part of the sample are clearly not pleased with the odours that are released from the WWTP. One of the measure indicators that something is clearly wrong at that site is that most local people have sight (vision), nasal (olfactory), breathing and contact (tingling fingers and/toes) problems. The situation is worsened by the emissions of fugitive volatile gases from the WWTP that are carried by wind directly towards the residential area, which are located downwind from the plant. Wind direction is towards the residential area in the NW direction. The close proximity to the WWTP makes residents in the site more susceptible to the effects of gases released and the primary routes of targets include inhalation, eye and skin contact.

The hazardous chemicals released from the WWTP are not safe. It was noted that the WWTP plant offers vaccination shots to its employees to strengthen their immune systems from communicable diseases, but the same was not done for those residents who are a mere 290.0 m away from the facility. This situation indicates a contradiction between a residential development which is supposed to improve the lives of locals and a WWTP which offers employment, but also contribute to the decline of their health.

There may be other reasons why the sampled respondents have those symptoms but most likely they are due to the gases released from the WWTP.

The third question is: “should residential houses be built close to the WWTP”? Since the findings indicate that respondents who reside 5.0 km from the site are still negatively impacted by the gases released from the site, it makes sense to conclude that 5.0 km is still a susceptible distance when it comes to zoning a residential area. Houses should never be built close to the WWTP especially because the released gases could also be having a negative impact on resident’s houses.

The WWTP is also a hazard to resident’s lives especially when there is a sewage spill perhaps due to flooding or burst of pipes. Raw sewage spills pose serious threats to public and waterway health. Furthermore wastewater from WWTP contains dangerous pathogens that threaten public health. According to CCA (2013) discharges can also include toxic pollutants such as mercury and industrial chemicals. The proximity of a CWT to houses in this instance becomes a disadvantage as a DWT which can threaten waterways by leaching pollutants such as nitrates and pathogens into groundwater and surface water. This presents a clear indication that houses should not be built close to the WWTP.

The last question the researcher intended to get the answer for was: “do families that reside close to the WWTP present common ailments such as deformities or early deaths within families”? There was no evidence to suggest the existence of handicapped babies and early deaths in families in relation to the WWTP. This could mean that the levels of the gases are not in very high concentrations to cause acute effects but prolonged exposure may cause chronic effects such as those indicated in section 2.7. However there are an alarming number of respondents who indicated that they experience numbness of hands and/or feet (Figure 4.10). Literature indicates that mercury is a potent neurotoxin that affects peripheral nerve function (Wang *et al.*, 2012). The numbness of hands and/or feet including the tingling of hands and/or feet could be



an indication that the respondents are subject to contamination by Hg or any other chemical which have similar effects. While at the same time H<sub>2</sub>S could likely be the threat as it also affects the central nervous system. This could not be verified since the research did not have the appropriate tools to measure the gases released at the WWTP.

### **5.3 New knowledge revealed by the study**

A number of studies have been done worldwide regarding the implementation of EIA regulations as well with regards to WWTP and related gases that are emitted from such facilities. Researchers have also explored how these hazardous gases affect communities, particularly in relation to health. However, there has been a gap in literature regarding the implementation of EIA in South African township development, especially given the evolution of regulations from those set up by the apartheid government to those of the democratic government. In particular it was necessary to investigate this area given the urgent need for service delivery such as housing and sanitation to communities that were previously disadvantaged. This knowledge is also critical for other developing countries that may face the same conflict of interest as South Africa.

The critical finding in this regard is that the wellbeing of communities is put at risk when service delivery outweighs proper implementation of EIA regulations. It does not matter how good regulations are, if they are not properly implemented, then their existence is pointless. The researcher posits that South Africa may be faced with challenges when it comes to implementing EIA policies. In particular this study has revealed that there exists a gap between policy and practice in the area of EIA. While the study was based on a small community in South Africa, the author believes that the same trends could be found in other places around the country. As a consequence, there is urgent need to explore and perhaps revise the role of EIA in South Africa against the backdrop of demand of service delivery.

## 5.4 Findings that are echoed by literature

One of the challenges in explaining why EIA has not been effective involves civil, corporate corruption and mismanagement of the EIA process. Morrison-Saunders (2007) observed that monitoring and evaluating the impacts of a project are essential for determining the outcomes of EIA. By incorporating feedback into the EIA process, follow-up enables learning from experience to occur. It can and should occur in any EIA system to prevent EIA being just a *pro forma* exercise. However other African countries such as Nigeria are experiencing corruption and infraction of the EIA Act. This is due to the regulatory authority, which is the Ministry of Environment, Housing and Urban Development, being not fully transparent in terms of providing relevant information and data (Yusuf, 2008). This is similar to what the researcher found in the study area whereby data referring to the EIA being conducted before the site was developed had been said to be kept in another office of the state due to sensitivity of those records.

The observed lack of progress in EIA is not entirely unexpected given that applications of EIA are still being improved even today. The results also indicate that EIA cannot achieve the original vision set out in the world's first legislation adopted in 1970 unless a learning-organization approach is taken whereby, the critical role of informal knowledge is recognized; informal knowledge is properly managed by EIA teams to engender a common understanding of sustainable development goals; interdisciplinary and trans-disciplinary working practices are adopted as indicated by Bond *et al.* (2010). The researcher further agrees with Kakonge (2013) who indicated that lack of transparency on how to mitigate and monitor the environmental impact of projects has resulted in widespread frustration, thus also causing inconsistencies in EIA quality and an EIA process that can be difficult to understand or reproduce.

## **5.5 Findings that contradict literature**

The current researcher discovered that residents who are at a distance of over 5.0 km from the WWTP are still negatively impacted by the gases as the residents who are within 5.0 km. Therefore the approved distance of which as indicated in section 2.5 will not be effective in this area. Thus WWTP should be zoned at a negligible distance of more than 5.0 km away from any residential area. These findings contradict those of Maddock (2011) which recommend a buffer distance of 400.0 m to the nearest residential dwelling, there seemed to be a great impact of the odour annoyance besides the presented health issues at this particular distance.

## **5.6 Limitations of the study**

Although this research was carefully prepared, the researcher is still aware some unavoidable limitations. First of all, due to financial constraints the sample size was made small. The sample was only a very small proportion of the entire population of approximately 2000 residents. Therefore, research studies with much larger sample size would be required to ensure appropriate generalization of the findings of the study. Second, there was limited data collected from healthcare givers as many wanted to be paid a consultation fee which the researcher found unethical. Third, the present study has relied largely on quantitative methodology of data collection (though qualitative methodology was used to a limited extent) and is therefore restrictive. Therefore, more of qualitative methodology of data collection should be undertaken in future to provide wider perspective to the present study. For instance, the research design can employ case study methodology or content analysis to provide a holistic picture to the given subject. Fourth, there were no employed instruments to measure gases released by the WWTP. Fifth, most questions were focused on health effects and the current researcher acknowledges that she studied Life Sciences but has limited knowledge on Medical Science therefore interpretation of some of the causal symptoms needed to be done with caution.

## **5.7 Recommendations**

This study focused on to what extent the EIA regulations were implemented to prevent health hazards in KwaMathukuza. Future explorations should focus on ensuring that the EIA practice improves. The researcher proposes more use of planning and obligations use including the expansion of the use of formalised Environmental Management Plans to deliver them. Furthermore the researcher believes that there should be a body or professional institute that drives and monitors the implementation of EIA by various members in the practice.

This study highlighted a large gap between legislation and practice. The current researcher found that there is still a gap for much research in the sphere of HIA and how improvements can be made in order to improve the legal and administration system, a sustainable development strategy and public participation in environmental governance. Furthermore this researcher would like to challenge other scholars to explore what can be done if EIA was not properly implemented. The researcher suggests that more research is done to determine why international countries have a reduced buffer zone distance of less than 1000.0 m. From the researchers point of view it is possible that South Africa may be currently using the less improved systems that hardly reduce odour problems from the source.

## **5.8 Conclusion**

The researcher believes that there's a need of improvement in EIA administration system to ensure sustainable development. Findings indicate that there may be lack of proper implementation of EIA following main steps, in line with international practice. This could be due to lack of enforcement from Environmental Management bodies. All the above factors indicate that EIA is mandatory in South Africa however developers may struggle to understand the authenticity of the process if it lacks proper

implementation. The researcher finds it crucial that developers look at an example that was portrayed by the study to see how lack of EIA practice can result to economic, social other significant morbidity and mortality risks, cumulative and intergenerational effects, and broader determinants of health which could have been avoided if things were done in the appropriate way.

In conclusion, the researcher agrees with the quote that says “character is doing the right thing when nobody’s watching”. Basically in relation to this study, this says there are too many people who think the only thing that’s right is to get by (find convenient ways) and forget that what they allow they encourage because improper things have a way of being revealed.

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## APPENDICES

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### Consent form for participants

#### TITLE OF RESEARCH PROJECT

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**An investigation of the extent of implementation of Environmental Impact Assessment (EIA) regulations towards health hazard prevention at KwaMathukuza, Newcastle**

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#### NATURE AND PURPOSE OF THE STUDY

The aim of the study is to investigate if the proximity of a wastewater treatment plant (WWTP) to a residential area leads to health problems.

This study intends:

- To investigate if the integrated environmental assessment (EIA) regulations were effectively implemented before building the (RDP) houses
- To evaluate whether residential areas should ever be built close to such sites.
- To investigate if the gases released from the WWTP have any impact on the health of people who reside close to the site
- To establish if the families staying close to the WWTP have any common ailments such as handicapped babies, early deaths in families

The study involves administering questionnaires to get views of various people, observations and secondary information through reviewing documents.

#### PARTICIPATION TERMS AND CONDITIONS

1. If you wish you may not write your real name in the test and/or questionnaire as related to this research.



2. Real names will not be used in any report(s); instead, pseudonyms (unreal names and codes) will be used in all spoken and written records and reports.
3. Your responses will be treated in a confidential manner and will only be accessed by you (the participant), the researcher (Ms Simphiwe Mnguni) and the supervisor (Professor Moja).
4. Nothing that you say or write in relation to this study will be revealed to other persons in a manner that will reveal your identity.
5. Participation in this research is voluntary; you have the right to withdraw at any point of the study, for any reason, and without any prejudice, and the information collected and records and reports written will be discarded.
6. At your request, the summary of the findings will be made available to you.
7. No direct benefits will be given to you or your community.
8. The research requires your individual participation in answering this questionnaire on the environmental impacts of health problems in the community.
9. The questionnaire will offer you an opportunity to express your opinion on the effects of continuous odours in your area.
10. There is no right or wrong answer but just give your opinion which is valuable to the research.
11. The researcher will visit you at home or office, so no advance preparation or transport costs you will incur.
12. If you cannot write and fluent in English, the researcher will interpret to translate the questions into Zulu then fill in the answers for you.

### **INFORMATION (contact information of your supervisor)**

If you have any queries concerning the study, you may contact the researcher or the study supervisors:

- Mrs Simphiwe Mnguni, Department of Environmental Science; Unisa  
Email: snemiya1@yahoo.com; Tel: +27123196269/+27798013754

- Professor S J Moja; Department of Environmental Science; Unisa Florida Campus  
Unisa, South Africa; Email:mojasj@unisa.ac.za; Tel:+27114713878
- Dr Phokele Maponya , Department of Environmental Science; Unisa Florida Campus  
Unisa, South Africa; Email:maponpi@unisa.ac.za; Tel:+27114712285

## CONSENT

I, the undersigned,.....(full name) have read the above information relating to the project and have also heard the verbal version, and declare that I understand it. I have been afforded the opportunity to discuss relevant aspects of the project with the project leader, and hereby declare that I agree voluntarily to participate in the project.

I indemnify the university and any employee or student of the university against any liability that I may incur during the course of the project.

I further undertake to make no claim against the university in respect of damages to my person or reputation that may be incurred as a result of the project/trial or through the fault of other participants, unless resulting from negligence on the part of the university, its employees or students.

I have received a signed copy of this consent form.

Signed: .....

Date: .....

**WITNESSES**

1. ....

2. ....

## APPENDIX A FORM (residents)

### A. Background information

1. What is your ethnic? Choose from the list below.

White	Black	Asian	Indian	Coloured	Other
-------	-------	-------	--------	----------	-------

2. What is your gender?

	Male	Female
--	------	--------

3. What is your occupation?

Employed	Self-employed	Unemployed
----------	---------------	------------

4. What is your highest completed level of education? Choose from the list below.

None (no formal education)	Primary school (Grade 1 to 7)	High school (Grade 8 to 12)	FET college	University	other
----------------------------	-------------------------------	-----------------------------	-------------	------------	-------

5. Which age group do you fall under? Choose from the list below.

0 to 18 years	19 to 25 years	26 to 35 years	36 to 50 years	51 to 65 years	Over 65 years
---------------	----------------	----------------	----------------	----------------	---------------

6. How long have you been staying in this area? Choose from the list below.

0 to 5 years	6 to 10 years	11 to 15 years	15 to 20 years	Over 20 years
--------------	---------------	----------------	----------------	---------------

## B. General Issues

7. Have you ever smelt a bad odour that may be due to the water treatment facility?

7. Have you ever smelt a bad odour that may be due to the water treatment facility?	
Yes	No

8. If yes, can you fully describe the odour?

.....

.....

.....

.....

.....

9. How do you respond to the odour? E.g. spray anti-odour agent; close windows, etc.

.....

10. How strong is the odour?

Very strong	Strong	Neutral	Weak	Very weak
-------------	--------	---------	------	-----------

11. How often do you get the odour?

Once every hour	Once every day	Once every week	Once every month	Once every six months	Once a year
-----------------	----------------	-----------------	------------------	-----------------------	-------------

12. For how long does the odour last for?

About a minute	About an hour	About a day
----------------	---------------	-------------

13. Which time of the day do you get the odour most often?

Night	Day	When it rains	When it's windy	Hot days	Cold days
-------	-----	---------------	-----------------	----------	-----------

14. Which health facility do you and your family consult the most? (chosed for the list below)

Public hospital	Clinic	Doctor	Traditional healer	Other (please specify) .....
-----------------	--------	--------	--------------------	---------------------------------

15. How often do you use the above stated health facility?

Weekly	Monthly	Once every three months	Once every six months	Once a year	Never
--------	---------	-------------------------	-----------------------	-------------	-------

### C. Health Aspects

16. Do you think the "odour" could cause health problems to humans? Explain your reasoning.

<p>.....</p> <p>.....</p> <p>....</p>
---------------------------------------

17. Do you or anyone in your family suffer (has suffered) from the following? Indicate when do you get these:

a) Miscarriages	Yes	No	When at home	When at work	When at school
b) Shortness of breath	Yes	No	When at home	When at work	When at school
c) Regular cough	Yes	No	When at home	When at work	When at school
d) Tightness of the chest	Yes	No	When at home	When at work	When at school
e) Asthma	Yes	No	When at home	When at work	When at school
f) Wheezing of the chest	Yes	No	When at home	When at work	When at school
g) Sudden fatigue when walking	Yes	No	When at home	When at work	When at school

h)	Sudden fatigue when climbing light stairs	Yes	No	When at home	When at work	When at school
i)	Sudden fatigue when bathing	Yes	No	When at home	When at work	When at school
j)	Sudden fatigue when dressing	Yes	No	When at home	When at work	When at school
k)	Burning sensation in the eyes	Yes	No	When at home	When at work	When at school
l)	Redness of the eyes	Yes	No	When at home	When at work	When at school
m)	Swelling of the eyelids	Yes	No	When at home	When at work	When at school
n)	Regular tearing	Yes	No	When at home	When at work	When at school
o)	Regular sore throat	Yes	No	When at home	When at work	When at school
p)	Dryness of the nose	Yes	No	When at home	When at work	When at school
q)	Blocked nose	Yes	No	When at home	When at work	When at school
r)	Regular headache	Yes	No	When at home	When at work	When at school
s)	Trouble concentrating	Yes	No	When at home	When at work	When at school
t)	Memory problems	Yes	No	When at home	When at work	When at school
u)	Numbness of the hands and/or feet	Yes	No	When at home	When at work	When at school
v)	Tingling of the hands and/or feet	Yes	No	When at home	When at work	When at school
w)	Swelling of the feet and ankles	Yes	No	When at home	When at work	When at school
x)	Burning sensation of the hands	Yes	No	When at home	When at work	When at school

18. Have you observed any other health related problems in your area that may be related to the water treatment facility?

.....
.....
.....

#### D. EIA Regulations

19. Have you ever been to a meeting with municipality authorities and local community to discuss the water treatment facility?

Yes	No	Don't remember

20. If yes, when was the last meeting?

.....
-------

21. How often do these meetings take place?

Never	At least once a month	Once every six months	Once a year
-------	-----------------------	-----------------------	-------------

22. What was discussed in the meeting?

.....
.....
.....

23. Has there ever been a meeting between the entire community and municipality authorities to discuss the water treatment facility?

Yes	No	Don't know
-----	----	------------

24. If yes, when was the last meeting?

.....
-------

25. How often do these meetings take place?

Never	At least once a month	Once every six months	Once a year
-------	-----------------------	-----------------------	-------------

26. What was discussed in the meeting?

.....
.....
.....

27. Has there ever been a meeting between community leaders and municipality authorities to discuss the water treatment facility?

Yes	No	Don't know
-----	----	------------

28. If yes, when was the last meeting?

.....
-------

29. How often do these meetings take place?

.....
-------

Never	At least once a month	Once every six months	Once a year
-------	-----------------------	-----------------------	-------------

30. What was discussed in the meeting?

.....
.....
.....

31. If the community has a problem with the water treatment facility, to whom do they report?

Municipality authorities	Local council	They do not report	Other (please specify)
			.....
		Yes	No
			Don't know

32. Has the community ever report a problem with the water treatment facility?

33. If you answered yes in 32 above, what was the problem?

.....
.....
.....

34. If you answered yes in 32 above, explain how did the municipality authorities respond to the community's concerns?

.....
.....
.....

35. How long did it take for the municipality to respond to the community's concerns mentioned in 32 and 33 above?

They were never	Resolved within a week	Resolved within a month	Resolved after three
-----------------	------------------------	-------------------------	----------------------



resolved			months
		Yes	No
			Don't know

36. In your opinion, does this water treatment facility negatively affect the community's quality of life?

37. If you answered yes in 36 above, explain how.

		Yes	No
			Don't know

38. Do you think the water treatment facility benefits the local community?

39. If you answered yes in 38 above, explain how.

		Yes	No
			Don't know

40. In your opinion, does this water treatment facility negatively affect the environment?

41. If you answered yes in 40 above, explain how.

THANK YOU FOR YOUR TIME

## APPENDIX B FORM (Municipal employee in WWTP)

### A. Background information

1. What is your ethnic group? Choose from the list below.

White	Black	Asian	Indian	Coloured	Other
-------	-------	-------	--------	----------	-------

2. What is your gender?

Male	Female
------	--------

3. What is your occupation?

.....
-------

4. What is your highest completed level of education? Choose from the list below.

None (no formal education)	Primary school (Grade 1 to 7)	High school (Grade 8 to 12)	FET college	University	other
----------------------------	-------------------------------	-----------------------------	-------------	------------	-------

5. Which age group do you fall under?

0 to 18 years	19 to 25 years	26 to 35 years	36 to 50 years	51 to 65 years	Over 65 years
---------------	----------------	----------------	----------------	----------------	---------------

### B. Technical Issues

6. Which technology is used by the municipality for waste water treatment?

.....
-------

7. Which technology is used by the municipality for the redamation process in waste water treatment?

.....
-------

8. What is the performance capacity of this system?

The designed capacity (m <sup>3</sup> /d)	.....	The occupied area (m <sup>2</sup> )	.....
---	-------	-------------------------------------	-------

9. What kind of standards does the effluent reclaimed water comply with?

.....
-------

.....
.....

10. What is the reclaimed water used for? (Choose from the options below).

Toilet water	Landscaping	Fire-fighting	Car washing	Industrial processes	agriculture
Other (please specify)	..... .....				

11. How is this system operated? (Choose from the options below).

Automatic and just need periodically maintenance	
Need technical operators and periodically maintenance	
Can be operated by normal workers and need periodically maintenance	

### C. Social issues

12. How often do you get technical complaints about the water treatment system?

Never	At least once a week	At least once a month	At least once every six months	At least once a year
-------	----------------------	-----------------------	--------------------------------	----------------------

13. How often do you get/hear about health related complaints related to the water treatment system

Never	At least once a week	At least once a month	At least once every six months	At least once a year
-------	----------------------	-----------------------	--------------------------------	----------------------

14. How often do you get/hear about odour related complaints related to the water treatment system

Never	At least once a week	At least once a month	At least once every six months	At least once a year
-------	----------------------	-----------------------	--------------------------------	----------------------

15. How often do you get/hear about water purity related complaints related to the water treatment system

Never	At least once a week	At least once a month	At least once every six months	At least once a year
-------	----------------------	-----------------------	--------------------------------	----------------------

16. How often do you get/hear about environmental related complaints related to the water treatment system

Never	At least once a week	At least once a month	At least once every six months	At least once a year
-------	----------------------	-----------------------	--------------------------------	----------------------

17. How often do you get/hear about the colour of the water that has been reclaimed by the water treatment system?

Never	At least once a week	At least once a month	At least once every six months	At least once a year
-------	----------------------	-----------------------	--------------------------------	----------------------

18. How often do you get/hear about the price of water that has been reclaimed by the water treatment system?

Never	At least once a week	At least once a month	At least once every six months	At least once a year
-------	----------------------	-----------------------	--------------------------------	----------------------

19. Have you ever had some kind of illness that may be due to your regular work at the water treatment facility?

Yes	No
If yes, which illness?	..... .....

20. Do your colleagues have some kind of illness that may be due to your regular work at the water treatment facility?

Yes	No
If yes, which illness?	..... .....

21. What are your concerns about this water treatment facility? For example, proximity to residential areas.

..... ..... .....
-------------------------

22. How often do health inspectors visit the water treatment facility?

Never	At least once a week	At least once a month	At least once every six months	At least once a year
-------	----------------------	-----------------------	--------------------------------	----------------------

23. How often do environment inspectors visit the water treatment facility?

Never	At least once a week	At least once a month	At least once every six months	At least once a year
-------	----------------------	-----------------------	--------------------------------	----------------------

#### D. EIA Regulations

24. Have you ever been to a meeting with municipality authorities and local community to discuss the water treatment facility?

Yes	No	Don't remember
-----	----	----------------

25. If yes, when was the last meeting?

..... .....
----------------

26. How often do these meetings take place?

Never	At least once a month	Once every six months	Once a year
-------	-----------------------	-----------------------	-------------

27. What was discussed in the meeting?

<p>.....</p> <p>.....</p> <p>.....</p>
--

28. Has there ever been a meeting between the entire community and municipality authorities to discuss the water treatment facility?

Yes	No	Don't know
-----	----	------------

29. If yes, when was the last meeting?

<p>.....</p>
--------------

30. How often do these meetings take place?

Never	At least once a month	Once every six months	Once a year
-------	-----------------------	-----------------------	-------------

31. What was discussed in the meeting?

<p>.....</p> <p>.....</p> <p>.....</p>
--

32. Has there ever been a meeting between community leaders and municipality authorities to discuss the water treatment facility?

Yes	No	Don't know
-----	----	------------

33. If yes, when was the last meeting?

<p>.....</p>
--------------

34. How often do these meetings take place?

Never	At least once a month	Once every six months	Once a year
-------	-----------------------	-----------------------	-------------

35. What was discussed in the meeting?

.....
.....
.....

36. If the community has a problem with the water treatment facility, to whom do they report?

Municipality authorities	Local council	They do not report	Other (please specify)	
			Yes	No
				Don't know

37. Has the community ever report a problem with the water treatment facility?

38. If you answered yes in 37 above, what was the problem?

.....
.....
.....

39. If you answered yes in 37 above, explain how did the municipality authorities respond to the community's concerns?

.....
.....
.....

40. How long did it take for the municipality to respond to the community's concerns mentioned in 37 and 38 above?

They were never resolved	Resolved within a week	Resolved within a month	Resolved after three months
		Yes	No
			Don't

41. In your opinion, does this water treatment facility negatively affect the community's quality of life?

		know
--	--	------

42. If you answered yes in 41 above, explain how.

<p>.....</p> <p>.....</p> <p>.....</p>
--

43. Do you think the water treatment facility benefits the local community?

Yes	No	Don't know
-----	----	------------

44. If you answered yes in 43 above, explain how.

<p>.....</p> <p>.....</p> <p>.....</p>
--

45. In your opinion, does this water treatment facility negatively affect the environment?

Yes	No	Don't know
-----	----	------------

46. If you answered yes in 45 above, explain how.

<p>.....</p> <p>.....</p> <p>.....</p>
--

THANK YOU FOR YOUR TIME.

## APPENDIX C FORM (Care givers)

### A. Background information

1. What is your ethnic? Choose from the list below.

White	Black	Asian	Indian	Coloured	Other
-------	-------	-------	--------	----------	-------

2. What is your gender?

Male	Female
------	--------

3. What is your occupation?

<p>.....</p> <p>.....</p>
---------------------------

4. What is your highest completed level of education? Choose from the list below.

None (no formal education)	Primary school (Grade 1 to 7)	High school (Grade 8 to 12)	FET college	University	other
----------------------------	-------------------------------	-----------------------------	-------------	------------	-------

5. Which age group do you fall under? Choose from the list below.

0 to 18 years	19 to 25 years	26 to 35 years	36 to 50 years	51 to 65 years	Over 65 years
---------------	----------------	----------------	----------------	----------------	---------------

6. How long have you been working in this area? Choose from the list below.

0 to 5 years	6 to 10 years	11 to 15 years	15 to 20 years	Over 20 years
--------------	---------------	----------------	----------------	---------------

### B. General Issues

7. Do you ever receive patients who have reported fallen ill due to air pollution?

Yes	No
-----	----

8. If yes, how do they describe the air pollution?

<p>.....</p> <p>.....</p> <p>.....</p>
--

9. How do you advise such patients as mentioned in 7 and 8 above? E.g. they must spray anti-odour agent; close windows, etc.

<p>.....</p> <p>.....</p> <p>.....</p>
--



.....
.....
.....
.....

10. If you responded yes in 7 above, indicate how often do you get such patients?

Once every hour	Once every day	Once every week	Once every month	Once every six months	Once a year
-----------------	----------------	-----------------	------------------	-----------------------	-------------

### C. Health Aspects

11. Do you think the odorous gases released from water treatment facilities could cause health problems to humans? Explain your reasoning.

.....
.....
.....
.....

12. Do your patients from KwaMathukuza report suffering from the following conditions? Indicate the how often do you receive these cases in the space provided.

a) Miscarriages	Yes	No	At least once a week	At least once a month	At least once every 6 months
b) Shortness of breath	Yes	No	At least once a week	At least once a month	At least once every 6 months
c) Regular cough	Yes	No	At least once a week	At least once a month	At least once every 6 months
d) Tightness of the chest	Yes	No	At least once a week	At least once a month	At least once every 6 months
e) Asthma	Yes	No	At least once a week	At least once a month	At least once every 6 months
f) Wheezing of the chest	Yes	No	At least once a week	At least once a month	At least once every 6 months
g) Sudden fatigue when walking	Yes	No	At least once a week	At least once a month	At least once every 6 months
h) Sudden fatigue when climbing light stairs	Yes	No	At least once a week	At least once a month	At least once every 6 months
i) Sudden fatigue when bathing	Yes	No	At least once a week	At least once a month	At least once every 6 months
j) Sudden fatigue when dressing	Yes	No	At least once a week	At least once a month	At least once every 6 months
k) Burning sensation in the eyes	Yes	No	At least once a week	At least once a month	At least once every 6 months
l) Redness of the eyes	Yes	No	At least once a week	At least once a month	At least once every 6 months
m) Swelling of the eyelids	Yes	No	At least once a week	At least once a month	At least once every 6 months
n) Regular tearing	Yes	No	At least once a week	At least once a month	At least once every 6 months

o) Regular sore throat	Yes	No	At least once a week	At least once a month	At least once every 6 months
p) Dryness of the nose	Yes	No	At least once a week	At least once a month	At least once every 6 months
q) Blocked nose	Yes	No	At least once a week	At least once a month	At least once every 6 months
r) Regular headache	Yes	No	At least once a week	At least once a month	At least once every 6 months
s) Trouble concentrating	Yes	No	At least once a week	At least once a month	At least once every 6 months
t) Memory problems	Yes	No	At least once a week	At least once a month	At least once every 6 months
u) Numbness of the hands and/or feet	Yes	No	At least once a week	At least once a month	At least once every 6 months
v) Tingling of the hands and/or feet	Yes	No	At least once a week	At least once a month	At least once every 6 months
w) Swelling of the feet and ankles	Yes	No	At least once a week	At least once a month	At least once every 6 months
x) Burning sensation of the hands	Yes	No	At least once a week	At least once a month	At least once every 6 months

13. Have you observed any other health related problems from patients from KwaMathukuza that may be related to the water treatment facility?

.....
.....
.....
.....
.....
.....

THANK YOU FOR YOUR TIME.

## Consent form for pilot study

### TITLE OF RESEARCH PROJECT

---

An investigation of the extent of implementation of Environmental Impact Assessment (EIA) regulations towards health hazard prevention at KwaMathukuza, Newcastle

---

### NATURE AND PURPOSE OF THE STUDY

The aim of the study is to investigate if the proximity of a wastewater treatment plant (WWTP) to a residential area leads to health problems.

This study intends:

- To investigate if the integrated environmental assessment (EIA) regulations were effectively implemented before building the (RDP) houses
- To evaluate whether the (RDP) houses should ever be built close to such sites.
- To investigate the impact the (WWTP) has on the health of people who reside close to the site
- To establish if the families staying close to the WWTP have any common ailments such as handicapped babies, early deaths in family

The study involves administering questionnaires to get views of various people, observations and secondary information through reviewing documents.

### RESEARCH PROCESS

1. The research requires your individual participation in answering this questionnaire on the environmental impacts of health problems in the community.
2. The questionnaire will offer you an opportunity to express your opinion on the effects of continuous odours in your area.
3. You do not need to write your name, but remain anonymous.

4. There is no right or wrong answer but just give your opinion which is valuable to the research.
5. The researcher will visit you at home or office, so no advance preparation or transport costs you will incur.
6. If you cannot write and fluent in English, the researcher will interpret to translate the questions into Zulu then fill in the answers for you.

#### NOTIFICATION THAT PHOTOGRAPHIC MATERIAL, TAPE RECORDINGS, ETC WILL BE REQUIRED

No video recording of the interview or answering session of the questionnaire but the researcher will take photographs of the study area as the study will be in progress.

#### CONFIDENTIALITY

The views of every participant will be treated as confidential and only the researcher and college will have access to the information provided. No names will be published in dissertations. Your anonymity is therefore assured.

#### WITHDRAWAL CLAUSE

I understand that I may withdraw from being part of the questionnaire anytime. I therefore participate voluntarily until such time as I request otherwise.

#### POTENTIAL BENEFITS OF THE STUDY

This current study therefore provides enormous opportunity for further developing modifications in the environmental exposures that contribute to diseases. Research is needed to address these problems and judge from scientific evidence that this particular problem does not limit human population and further more make recommendations on to minimize the negative impacts.

#### INFORMATION (contact information of your supervisor)

If I have any queries concerning the study, I may contact the Supervisor:

Professor S J Moja; Department of Environmental Science; Unisa Florida Campus

Unisa, South Africa; Email:mojasj@unisa.ac.za; Tel:+27114713878

Mr Phokele Maponya , Department of Environmental Science; Unisa Florida Campus

Unisa, South Africa; Email:maponpi@unisa.ac.za; Tel:+27114712285

#### CONSENT

I, the undersigned, ..... (full name) have read the above information relating to the project and have also heard the verbal version, and declare that I understand it. I have been afforded the opportunity to discuss relevant aspects of the project with the project leader, and hereby declare that I agree voluntarily to participate in the project.

I indemnify the university and any employee or student of the university against any liability that I may incur during the course of the project.

I further undertake to make no claim against the university in respect of damages to my person or reputation that may be incurred as a result of the project/trial or through the fault of other participants, unless resulting from negligence on the part of the university, its employees or students.

I have received a signed copy of this consent form.

Signature of participant: .....

Signed at ..... on .....

#### WITNESSES

1 .....

2 .....

## APPENDIX D FORM (residents including those who reside >5km away)

### A. Background information

1. What is your ethnic? Choose from the list below.

White	Black	Asian	Indian	Coloured	Other
-------	-------	-------	--------	----------	-------

2. What is your gender?

Male	Female
------	--------

3. What is your occupation?

Employed	Self-employed	Unemployed
----------	---------------	------------

4. What is your highest completed level of education? Choose from the list below.

None (no formal education)	Primary school (Grade 1 to 7)	High school (Grade 8 to 12)	FET college	University	other
----------------------------	-------------------------------	-----------------------------	-------------	------------	-------

5. Which age group do you fall under? Choose from the list below.

0 to 18 years	19 to 25 years	26 to 35 years	36 to 50 years	51 to 65 years	Over 65 years
---------------	----------------	----------------	----------------	----------------	---------------

6. How long have you been staying in this area? Choose from the list below.

0 to 5 years	6 to 10 years	11 to 15 years	15 to 20 years	Over 20 years
--------------	---------------	----------------	----------------	---------------

### B. General Issues

7. Have you ever smelt a bad odour that may be due to the water treatment facility?

Yes	No
-----	----

---

8. If yes, can you fully describe the odour?

.....
.....
.....

9. How do you respond to the odour? E.g. spray anti-odour agent; close windows, etc.

.....
.....

10. How strong is the odour?

Very strong	Strong	Neutral	Weak	Very weak
-------------	--------	---------	------	-----------

11. How often do you get the odour?

Once every hour	Once every day	Once every week	Once every month	Once every six months	Once a year
-----------------	----------------	-----------------	------------------	-----------------------	-------------

12. For how long does the odour last for?

About a minute	About an hour	About a day
----------------	---------------	-------------

13. Which time of the day do you get the odour most often?

Night	Day	When it rains	When it's windy	Hot days	Cold days
-------	-----	---------------	-----------------	----------	-----------

14. Which health facility do you and your family consult the most? (choose from the list below)

Public hospital	Clinic	Doctor	Traditional healer	Other (please specify) .....
-----------------	--------	--------	--------------------	---------------------------------

15. How often do you use the above stated health facility?

Weekly	Monthly	Once every three months	Once every six months	Once a year	Never
--------	---------	-------------------------	-----------------------	-------------	-------

### C. Health Aspects

16. Do you think the "odour" could cause health problems to humans? Explain your reasoning.

....

17. Do you or anyone in your family suffer (has suffered) from the following? Indicate when do you get these:

y) Miscarriages	Yes	No	When at home	When at work	When at school
z) Shortness of breath	Yes	No	When at home	When at work	When at school
aa) Regular cough	Yes	No	When at home	When at work	When at school
bb) Tightness of the chest	Yes	No	When at home	When at work	When at school
cc) Asthma	Yes	No	When at home	When at work	When at school
dd) Wheezing of the chest	Yes	No	When at home	When at work	When at school
ee) Sudden fatigue when walking	Yes	No	When at home	When at work	When at school
ff) Sudden fatigue when climbing light stairs	Yes	No	When at home	When at work	When at school
gg) Sudden fatigue when bathing	Yes	No	When at home	When at work	When at school
hh) Sudden fatigue when dressing	Yes	No	When at home	When at work	When at school
ii) Burning sensation in the eyes	Yes	No	When at home	When at work	When at school
jj) Redness of the eyes	Yes	No	When at home	When at	When at



				work	school
kk) Swelling of the eyelids	Yes	No	When at home	When at work	When at school
ll) Regular tearing	Yes	No	When at home	When at work	When at school
mm) Regular sore throat	Yes	No	When at home	When at work	When at school
nn) Dryness of the nose	Yes	No	When at home	When at work	When at school
oo) Blocked nose	Yes	No	When at home	When at work	When at school
pp) Regular headache	Yes	No	When at home	When at work	When at school
qq) Trouble concentrating	Yes	No	When at home	When at work	When at school
rr) Memory problems	Yes	No	When at home	When at work	When at school
ss) Numbness of the hands and/or feet	Yes	No	When at home	When at work	When at school
tt) Tingling of the hands and/or feet	Yes	No	When at home	When at work	When at school
uu) Swelling of the feet and ankles	Yes	No	When at home	When at work	When at school
vv) Burning sensation of the hands	Yes	No	When at home	When at work	When at school

18. Have you observed any other health related problems in your area that may be related to the water treatment facility?

<p>.....</p> <p>.....</p> <p>....</p>
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# D. EIA Regulations

19. Have you ever been to a meeting with municipality authorities and local community to discuss the water treatment facility?

Yes	No	Don't remember
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20. If yes, when was the last meeting?

.....
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21. How often do these meetings take place?

Never	At least once a month	Once every six months	Once a year
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22. What was discussed in the meeting?

.....
.....
.....

23. Has there ever been a meeting between the entire community and municipality authorities to discuss the water treatment facility?

Yes	No	Don't know
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24. If yes, when was the last meeting?

.....
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25. How often do these meetings take place?

Never	At least once a month	Once every six months	Once a year
-------	-----------------------	-----------------------	-------------

26. What was discussed in the meeting?

.....
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.....
.....
.....

27. Has there ever been a meeting between community leaders and municipality authorities to discuss the water treatment facility?	Yes	No	Don't know
---	-----	----	------------

28. If yes, when was the last meeting?	.....
--	-------

29. How often do these meetings take place?			
Never	At least once a month	Once every six months	Once a year

30. What was discussed in the meeting?
.....
.....
.....

31. If the community has a problem with the water treatment facility, to whom do they report?			
Municipality authorities	Local council	They do not report	Other (please specify)
			.....

32. Has the community ever report a problem with the water	Yes	No	Don't
--	-----	----	-------

treatment facility?

		know
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33. If you answered yes in 32 above, what was the problem?

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34. If you answered yes in 32 above, explain how did the municipality authorities respond to the community's concerns?

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35. How long did it take for the municipality to respond to the community's concerns mentioned in 32 and 33 above?

They were never resolved	Resolved within a week	Resolved within a month	Resolved after three months	
		Yes	No	Don't know

36. In your opinion, does this water treatment facility negatively affect the community's quality of life?

Yes	No	Don't know
-----	----	------------

37. If you answered yes in 36 above, explain how.

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38. Do you think the water treatment facility benefits the local community?

Yes	No	Don't know
-----	----	------------

39. If you answered yes in 38 above, explain how.

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40. In your opinion, does this water treatment facility negatively affect the environment?

Yes	No	Don't know
-----	----	------------

41. If you answered yes in 40 above, explain how.

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THANK YOU FOR YOUR TIME