Water Quality Monitoring in the Eastern Cape: A Case Study of the Chris Hani District Municipality

Thesis in partial fulfilment of the requirements for the degree of MSc Eng

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Sarah N. Kiggundu

Declaration

I hereby, declare that the research, unless stated otherwise, is in entirety, my own work. All sources have been acknowledged and referenced and this thesis has not been previously submitted for a degree at any other tertiary educational institution.

Signed: ……

Date: ……

Executive Summary

Access to safe drinking water is a basic human right (Hodgson and Manus, 2006). Consequently, safe drinking-water that complies with national - and international standards and norms is of the utmost importance in order to prevent incidences of outbreaks of waterborne diseases.

Increases in the global population have placed increasing pressure on water resources. This in turn has resulted in high occurrences of waterborne disease outbreaks (Ford and Colwell, 1996). As a result, there is a need for effective water resource management in order to protect water resources as well as avoid preventable fatalities from water-related illnesses.

In order to maintain control over the spread of water-related illness and disease, education on a local, national and international level is needed to facilitate knowledge sharing. Waterborne diseases have the ability to affect different sectors of society, as well as hinder economic progress. As a result, importance should be placed on the overall benefits to be achieved, in order to prompt governments to invest in the water and sanitation sector (Ford and Colwell, 1996).

There are variations with regard to the progress towards achieving the MDG targets. According to UNICEF & WHO (2005), 83% of the world is on track to achieving the MDGS, yet other sources such as DEVALT (2004) estimate that only 20% of the world's countries are on track. Developing countries, in particular, are struggling to achieve sufficient progress to meet the deadline of the MDGs by 2015.

This dissertation investigates South African policy and legislation governing water quality, which forms part of water resource management. International guidelines governing how water resource management; with particular emphasis on water quality; is examined. A case study of the Eastern Cape will be presented, whereby

the aim is to understand the challenges facing local governmental institutions, as well as the stakeholders involved in water service provision.

Glossary

Basic sanitation: The recommended minimum standards of services necessary to ensure safe, clean, efficient collection or disposal of human excreta. This includes: domestic waste water (from formal and informal housing) and sewerage from households (formal and informal housing).

Basic water supply: The recommended minimum standards required for supporting human life and ensuring basic hygiene.

Borehole: An excavation which is used for the purpose of collecting and storing water that is obtained from the underground aquifer.

Capacity: This term is used in relation to municipalities. It relates to financial -, administrative -, human resources that a municipality may require in order to fulfil management responsibilities.

Catchment: The area onto which rainfall will drain into the water course via surface runoff.

Councillor: A member of the municipal council.

Consumer: The user of water provided for by the appointed water service authority.

Human Development Index (HDI): An index measuring human progress and development. HDI combines 3 aspects: (i) life expectancy at birth, which is indicative of population health and prolonged existence; (ii) education, which is measured through the adult literacy rate as well as primary, secondary and tertiary enrolment; and (iii) the standard of living.

Monitoring is described as a long-term, standardized assessment of the aquatic environment in order to establish the condition of a water source and its associated trends.

Residual Chlorine: A test, with regard to water quality monitoring, to test the concentration of chlorine 30 minutes after being added. High concentrations will result in changes to the taste and smell of water.

Surveillance: The continuous, detailed measurement and observation for the purpose of ensuring water quality management and operational activities.

Water Board: An organ of state established with the purpose of ensuring public safety.

Water Course: This may be a river, spring, natural channel, vlei, wetland, lake *etc.*

Water Quality: This is a term that is used to describe the characteristics of water, in relation to guideline values of what is acceptable, regarding its suitability for human consumption and general use. The components of water can be identified by the: biological, microbial, chemical and physical characteristics.

Water Resource Management: An umbrella term for the decision-making processes through which water is protected, allocated and developed. Water quality monitoring is one of the functions that are included within this practice.

Water Scarcity: Countries where domestic water useage is below 1000m^3/capita/yr. *E.g.* Iceland is a water-rich country with approximately 606 500 m^3/capita of water, which includes both surface runoff and groundwater replenishment and domestic water usage is 190 m^3/capita/yr.

Water Services: Incorporates both water services and sanitation services.

Water Service Authority: A municipality, whether on a district, local or rural level, whose primary goal is to ensure adequate access to water services.

Water Services Institution: This is a term used to describe Water Services Authorities, a Water Services Providers, Water Boards, or Water Service Committees.

Water Services Intermediary: A person or company that is contracted by the Water Services Authority to provide a service, which may be quality monitoring or ensuring provision.

Water Services Provider: An organization or company that is appointed to provide water services, either to the consumer, or a Water Services Institution.

Water Stress: Countries where domestic water usage is below 1700 m^3/capita/yr

Acronyms and Abbreviations

AFDB	African Development Bank
CBO	Community-based Organisation
DM	District Municipality
DOH	Department of Health
DPLG	Department of Provincial and Local Government
DWAF	Department of Water Affairs and Forestry
DWQ	Drinking-water quality
DWQG	Drinking Water Quality Guidelines
EHP	Environmental Health Practitioner/Professional
HPC	Heterotrophic Plate Counts
MDG	Millennium Development Goals
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational Scientific & Cultural Organisation
WHO	World Health Organisation
WSA	Water Service Authority
WSI	Water Service Institutions
WSP	Water Services Provider

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1 Chapter One: Background to the Study and Research Methodology

Water quality is a growing concern globally. Diarrhoea is a disease that is linked to unsafe drinking water conditions, *i.e.* it is a water-related illness. In 2000, 2 billion cases of diarrhoea were recorded, with a resulting annual death toll of 2.2 million people (Godfrey, 2005).

Owing to large numbers of people being affected by water-related illnesses, there is a need to examine the water and sanitation sectors and look at new ways to improve the efficiency of practices surrounding and involving water quality including the testing and assessment methods, regarding its quality.

The process of evaluating water quality monitoring encompasses more than the actual microbiological -, chemical – and physical testing. Factors such as sufficient water supply, adequate sanitation and hygiene awareness play a vital role in reducing and mitigating the instances of waterborne illnesses. Studies have shown that strategies focusing on the inclusion of these three factors together can have the greatest impact and reduce the burden of preventable disease by as much as 42% (UNDP, 2006 & Fewtrell *et* al, 2005).

It is estimated that 1.1 billion people throughout the globe do not have access to improved water sources (UNICEF, 2001); of which, the largest proportion is in Asia. Progress has been slowest in sub-Saharan Africa, where improvements between the period of 1990 and 2002, increased from 49% to 58% (Vlugman, 2007). There are a number of reasons for the slow progress, most of which can be attributed to political instability, high population growth rates and lack of sufficient investment in infrastructure (UN Water/Africa, AFBD, UNECA, unknown date).

On a regional scale, the proportion of people unserviced in Asia is approximately equivalent to the proportion of those unserviced in Africa, which is estimated to be 42% (WHO & UNICEF, 2004).

With regard to sanitation, an estimated 53% of sub-Saharan Africa has sanitation services compared to 38% in Central Asia (WHO, 2004). In general, access to sanitation in rural areas is worse compared to urban areas and there are also disparities with regard to the levels of access (Mutume, 2004, The Water Wheel, 2008). This can be attributed a number of factors, such as poverty.

Progress within Africa remains slow, especially within the poorest regions, where an estimated 300 million African's lack access to potable water (Mutume, 2004). Furthermore, 14 countries on the continent suffer from water stress (UNEP, 2000). By 2025, 11 more African countries are expected to be added to the list, thus resulting in approximately 50% of Africa's population facing either water stress or water scarcity (WWF, 2002).

Currently, domestic water use is below 55ℓ per capita per day in 55 countries, 35 of which are in Africa (WWF, 2002; UNEP, 2000). In addition to that, half all Africans suffer from at least one of the six major water-related illnesses (UN Water/Africa, AFBD, UNECA, unknown date). Africa's achievements of the MDG targets are currently off-track (DEVALT, 2004).

The poor pay the most for water and suffer the greatest with regard to their health, the most affected being children under the age of 5 (Hemler, 2001; Howard & Bartram, 2005). With target 10, Goal 7 of the Millennium Development Goals (MDG) aiming at *reducing half the proportion of people without sustainable access to safe drinking water and basic sanitation,* it is estimated that approximately 1.6 billion people will require access to improved sanitation between the periods of 2000-2015 (UN, 2007), the majority of which live in developing countries. According to Pruss *et al* (2003), an inadequate supply of water, inadequate access to sanitation and poor

hygiene practices are responsible for 4.0% of all deaths and 5.7% of the overall burden of disease globally. The death toll from diarrhoeal diseases, in the under-five age bracket, is higher than deaths occurring from pneumonia, malaria or HIV/AIDS combined (UNDP, 2006). Within South Africa, an estimated that 43 000 deaths occur per annum, from diarrhoeal diseases, 20% of which occur within the 1-5 year age bracket (Mackintosh & Colvin, 2003).

The process of measuring progress towards the MDGs, in South Africa, is complex, as little data exists for the baseline year of 1990. This can be attributed to the apartheid era, where black people were excluded from surveys involving social and economical status. As a result, the starting point for measuring progress for the MDGs, in South Africa, is 2000. Based on the international poverty line, at this particular point in time, it was estimated that 11.5% of the population lived in extreme poverty, on less than US$ 1 per day (R 7.50) and 35.8% lived in poverty (on less that US$ 2 per day) (World Bank, 2001).

Despite these setbacks, however, South Africa is classified as an upper middle-income country and is considered as one of the most-developed countries on the African continent (World Bank, 2001).

1.1 Importance of the Study

This thesis investigates South African policy and legislation governing water quality, which forms part of water resource management. International guidelines are discussed and a case study of the Eastern Cape is presented, whereby interviews with municipalities and stakeholders were conducted in order to understand the challenges facing governmental institutions, in light of the outbreaks of water-related illnesses.

An in-depth study of two rural communities and one peri-urban community in the Chris Hani District of the Eastern Cape is presented. The opinions and perceptions of these communities, regarding their water quality are highlighted. Within all 3 communities, small-scale water supplies are in place. The commonality is the reliance on non-piped water sources *i.e.* usage of borehole water, protected springs *etc*.

It is necessary to identify the **key issues** in the established system of water quality monitoring as well as Water Resource Management. This thesis seeks to establish if changes or improvements can be made in the structure and to include information obtained from the communities regarding their practices surrounding domestic water usage.

1.2 Objectives of the Thesis

The objectives of this research study, is to:

- Provide an overview of international practices regarding water quality, the assessment, and different testing procedures.

- Provide an overview of the South African guidelines, policies and regulations governing water resource management, with particular emphasis on water quality.

- Assess local conditions concerning water quality in the study area. This thesis investigates the *status quo* of the Eastern Cape with an in-depth study of 2 rural communities and 1 peri-urban community, in the Chris Hani District.

- Identify disease causation, patterns and prevention techniques used by communities.

- Obtain an understanding of the community's perception and opinions regarding their water quality.

- Identify the key issues in the established system of water quality monitoring.

1.3 Research methodology

Keeping with the objectives, mentioned in the previous section, the research involved the following aspects:

1.3.1 Literary investigation

All aspects directly and indirectly affecting water quality were researched from legislation, journals, dissertations, research reports, online news articles *etc*.

1.3.2 Interviews and questionnaires

A Participatory Action-based research procedure was adopted. This type of research involves the participants examining the problems (Kindon *et al*, 2007). On-site research began with interviews of municipal officials in the Eastern Cape. The information obtained was used to identify potential rural communities in which to conduct the community surveys.

The research is a cross-sectional study involving local governmental institutions and their management of water quality. The communities' domestic water practices are also examined, in order to identify the key issues.

1.3.3 Data Analysis

The data obtained from the community questionnaires is analyzed qualitatively. As a result, emphasis is placed on the validity of the data and not the reliability of the sample size (Welman *et al*, 2005). Using content analysis, the information is quantified into recurring themes that are discussed by the respondents.

1.3.4 Limitations of the Community-based Surveys:

- Cluster sampling within the communities proved to be more cost-effective as access to households proved difficult, owing to the harsh terrain and dispersal of households.

- 167 people were interviewed across all three communities. This numerical figure is not representative of the true number of people interviewed because during the interview process, 2 or more individuals may have responded to the questions. In such circumstances, the respondents were taken to represent 1 person.

1.4 Overview of the Chapters

This section provides a summary of the different topics that are discussed and investigated.

Chapter One: Background To The Study and Research Methodology

An overview of the proposed study is provided whereby the research processes as well as the research objectives are outlined.

Chapter Two: Legislation and Policies

An overview of the Legislation pertaining to Water Quality, in an international context and that of South Africa.

Chapter Three: Water Quality Parameters

This Chapter seeks to identify the most common pathogens associated with feacally polluted water, and evaluate the most common testing methods and procedures. Furthermore, the important parameters regarding water quality testing are examined.

Chapter Four: Community Surveys

An introduction to the Eastern Cape is presented along with the challenges with regards to water quality monitoring and management in the region. The project area is defined and information obtained from the questionnaires presented and the results analyzed.

Chapter Five: Recommendation and Conclusions

This chapter is the culmination of all the research that has been conducted for this dissertation. The author's findings, recommendations and conclusions are presented.

2 Legislation and Policies

International guidelines, due to their generic nature, are adapted to local circumstances, based on extensive research and expertise. This chapter reviews international guidelines and South African legislation governing water quality monitoring and its management.

One of the crucial objectives behind monitoring and managing water supplies is to minimize all pollution - whether it occurs through microbial or chemical contaminants. In section 2.5, further studies into current methods of water quality monitoring involving a reliance on testing procedures focussed on the end results, within selected parameters, rather than effective water quality management (Godfrey, 2005) is examined.

2.1 Risk Assessment and Characterization

Development of the WHO Drinking Water Quality Guidelines (DWQG) takes account of the analysis characterization, and the degree of waterborne risk involved. The inclusion of policies and scientific data is necessary and an attempt is made to quantify the extent of the associated consequences. This process involves an appraisal of any action required based on the risk characterization outputs (Haas and Eisenberg, 2001). For example, in the instance of micro-organisms, the end result may be infection, mortality or a combination of both.

[The] Limitations in science generate uncertainty in estimates of waterborne risk. As things currently stand, this uncertainty is of unknown (or unreported) extent and degree (WHO, 2001). There is an inherent need to understand and assess waterborne risks that are associated with quality.

The issue of acceptable risk is complex and as a result, does not form part of the international guidelines, *i.e.* cannot be fully quantified. According to Hunter and Fewtrell (2001), it is a topic that should play an important role in adapting the international guidelines to national conditions, with the involvement and participation of the relevant stakeholders.

Table 2-1 illustrates factors that should be considered when characterizing and assessing the level of risk.

Table 2-1: Considerations to be made when assessing and characterizing the level of risk (Adapted from WHO & Health Canada, 2006).

Factors	**Considerations**
Social/cultural	Identifying the vulnerable groups within communities (i.e. AIDS/HIV positive people) Establishing why these groups are vulnerable
Economic	Dominant economic sectors especially within rural areas Determining the infrastructure and support services Establishing the associated challenges within the management structures in place Determining the risk factors that result in contamination of water sources Identifying the types of systems in use in the communities Ascertaining the proportion of the community that has access to potable water
Behavioural characteristics	Use of pit latrines (common practice or not?) Establishing whether high-risk water sources are preferred as a drinking source
Health information	Average life expectancy Infant mortality (per 1000 births) Recent outbreaks in water-borne diseases (e.g. cholera)

Factors	Considerations
Structure	Defining the institutional set-up with regard to water services provision
Stakeholders	Identifying all stakeholders from national governmental level to community level (inclusion of non-governmental organisations and private companies that are outsourced by governmental institutions) Define the roles and responsibilities of all stakeholders (as defined through legislation) Establishing which agencies identify the community's needs, with regard to provision of water services Identifying whether groups within the community are excluded from the decision-making process
Enforcement	Determining whether mechanisms are in place to ensure adherence to guidelines and standards
Data collection	Identifying who collects and assesses data Ensuring representative data is collected from all communities Ensuring data is used to aid in decision-making
Support mechanisms	Capacity building to the communities, operators and all relevant stakeholders Ensuring funding to aid in capacity building Establishing the level of capacity building to be instituted
Success indicators	Keeping account of the number of outbreaks of waterborne diseases that are detected Estimate the reliability of the data, if any data is available Proportion of the population that has access to good-quality water

2.2 International Guidelines

The Drinking Water Quality Guidelines (DWQG) (WHO, 2001) covers aspects involving chemical, physical and microbiological factors. The aim of the water-related guidelines is to ensure the *protection of public health* (Havelaar *et al*, 2001). The guidelines serve as a basis for the development of national standards or norms and the development of risk management strategies which may include aspects from the domain of the environment, social, cultural and economic sectors.

The third edition of the DWQG; which were launched in 2004, outline a different approach towards the manner in which water is monitored. This shift involves a move away from placing sole emphasis on the testing methods and procedures, towards an approach that involves the inclusion of Water Safety Plans. This is essential to improve the overall safety of water supplies, involve preventative risk assessments and management that is rooted on health-based risk targets.

The DWQGs are grounded on five key components: (i) health-based targets which evaluate the associated health concerns; (ii) a system assessment which aims to determine whether drinking-water supply is able to deliver water of a quality that meets the health-based targets; (iii) operational monitoring of the control measures within the drinking-water supply; (iv) management plans which document the system of assessment as well as the monitoring plans in normal and emergency situations. Additional information that is required includes upgrades that will be made to the system; (v) an independent system of surveillance, whereby this component aims to ensure that the other four components are functioning properly.

(WHO, 2004)

2.2.1 Health-based Targets

National agencies are tasked with the responsibility of establishing targets for local municipalities regarding domestic drinking water quality and industrial water-quality. Health-based targets can be measured in quantifiable terms. For example, the burden of disease, in particular relation to waterborne disease, can be measured across a community or region. This target can be used to identify the level of tolerable or acceptable risk. The resulting water quality studies can be expressed as guideline values for microbiological parameters, physical parameters, or chemical parameters that are of particular concern.

2.2.2 System Assessments

Water Safety Plans encompass identifying hazards, along with occurrences that constitute a **hazardous event** occurring**.** Once the parameters defining such hazards been established, the risk or the likelihood of this event happening should be classified or quantified, if possible.

2.2.3 Operational Monitoring

Operational monitoring is an assessment of the performance of the control measures put in place.

If water quality is determined through the use of low-cost technology, it is important to ensure protective systems are in place to prevent pollution and ensure that the maintenance programme in effect is adequate enough to detect hazardous events. Given the evolution of testing methods and the availability of portable test kits, on-site testing is encouraged, where transporting of samples may affect the results. For example: with turbidity and pH levels testing, on-site testing is encouraged.

2.2.4 Management Plans

Management plans are formulated from the results of the Operational Monitoring system. The main objective of management plans is to oversee monitoring of water sources and distribution systems, through preventative management and on-going examination processes.

2.2.5 Independent System of Surveillance

There are two types of an independent system of surveillance. The first involves an audit of the system and the second part involves a direct assessment. In general, it is advisable to have a combination of both systems in place. *For information pertaining to the different characterized levels of surveillance, please refer to Appendix B.*

2.2.5.1 Audit

A review of Water Safety Plans should be conducted and the overall implementation, outlined in the Water Safety Plans examined. Response to incidences and advice on reports of hazardous incidences should be provided.

According to the WHO, periodic audits should be performed to ensure that the efficiency of the system is maintained and that operational monitoring guidelines are adhered to. The verification and assessment programmes must be in place in order to update and improve existing Water Safety Plans. In most instances, a sanitary inspection may cover the full range of activities from drinking-water quality to the distribution system. Despite this, however, preventative action must be taken to ensure that an incident does not occur.

2.2.5.2 Direct Assessment

Direct assessment assumes that the surveillance agency is able to assess findings and advise water institutions and communities. Specific approaches can be adopted, through information obtained from municipalities, community supplies *etc.*

Figure 2-2, below, shows the inter-related tasks and input factors that are needed in order to ensure public safety.

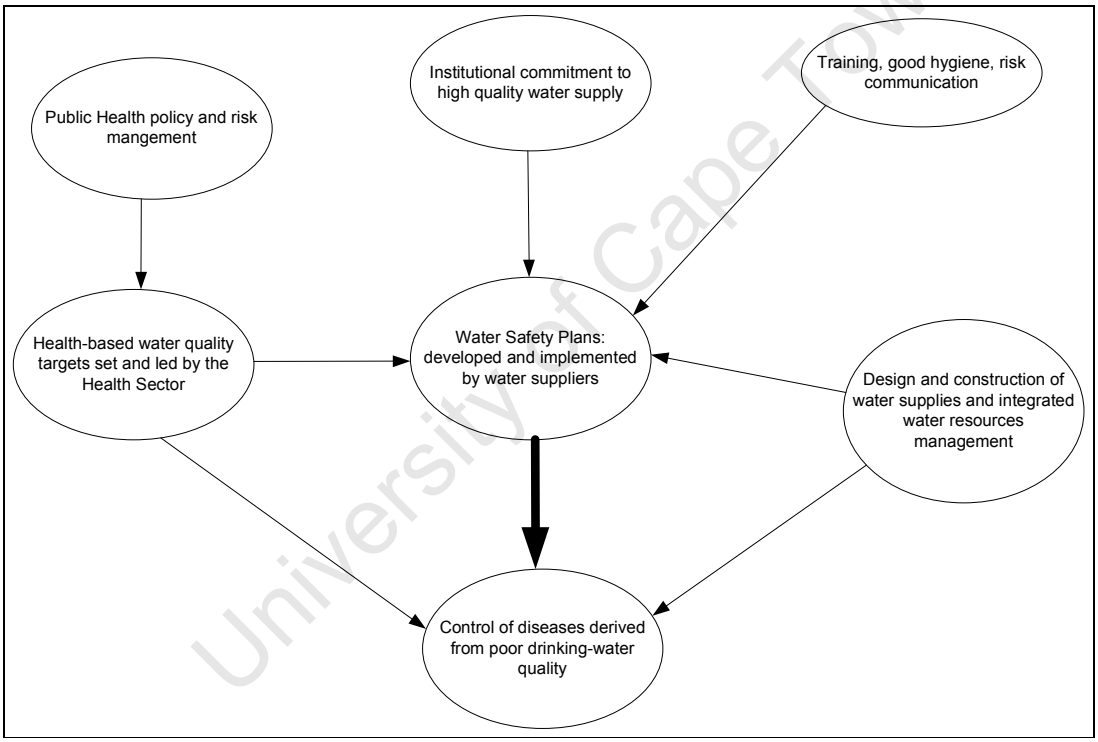

Figure 2-2: Graphical representation of the different input factors needed to ensure adequate water quality (Medema *et al*, 2003 – Original Source: Davidson *et al*, 2002).

2.2.6 Challenges with regard to Implementation of International Guidelines: Comparison between Developing- and Developed Countries

As mentioned previously, the guidelines are generic and it is the responsibility of individual countries to adapt the guidelines into legally-binding national standards, regulations and norms. This however, is dependent on the political structure, technological development, prevailing economic -, social -, cultural and environmental conditions.

Developing - and developed countries have a different set of issues to tackle. In the case of developing countries, there is pressure to follow international trends. In most developing countries, the increase in water and sanitation infrastructure cannot be matched with the rising population growth (WHO, 2001). The end result is the inefficient protection of public health and interests.

Figure 2-3, shown below, is a comparison between the developed – and developing countries. It is evident that developing countries struggle to adhere to the internationally recognized standards and norms, whereas developed countries may have brief periods of non-compliance.

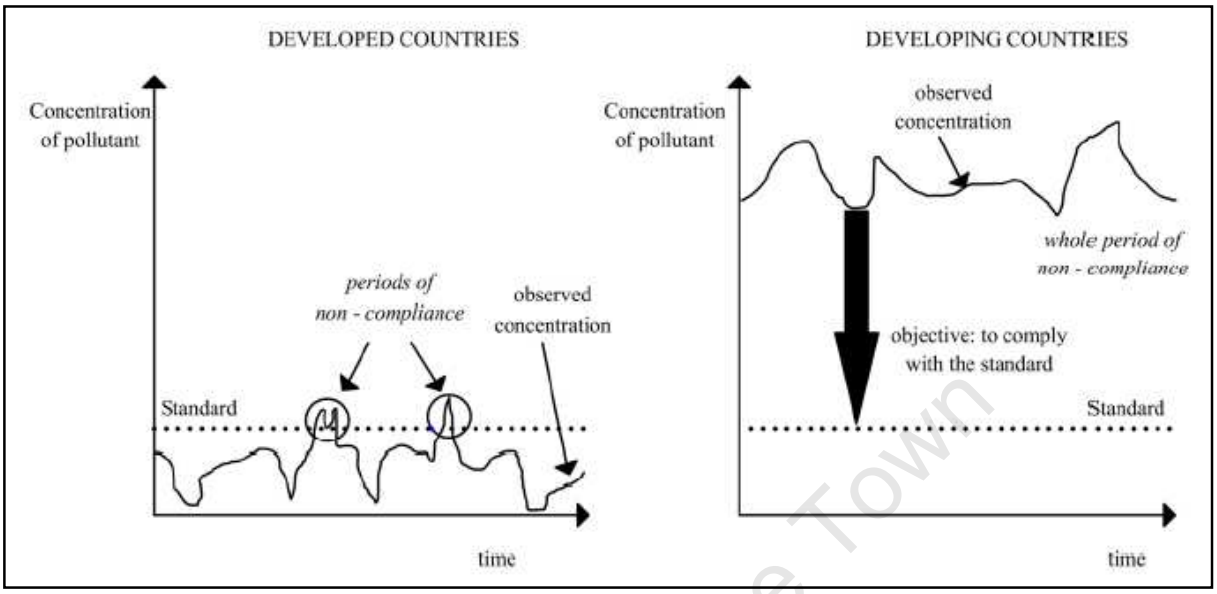

Figure 2-3: Comparison of developed - and developing countries (WHO, 2001)

Within Africa, few East African countries have had formal water service sector policies. Many of the East African nations have had fragmented institutions managing water and sanitation. Several countries in Eastern and Southern Africa have launched national water policies within the past ten years. Of these countries, it has been found that South Africa's national water policies are comprehensive, systematic and well-implemented (Seppala, 2002).

2.3 South African Policies and Legislation

The South African National Government is the custodian of all water resources within the boundaries of South Africa. All the Acts and Guidelines acknowledge that water is a basic human right that is necessary to sustain human life. Explanations of the different Acts governing Water Resource management, with particular emphasis on water quality, are examined in the following sections.

2.3.1 National Water Act (No 36 of 1998)

The central guiding principles within this Act are: **protection**, **sustainability,** and **equity**. The Act outlines how water resources should be managed. Emphasis is placed on the need to preserve water resources for present and future generations.

Chapter 14 of the National Water Act discusses the need for a National Monitoring System to ensure compliance to water quality objectives and to ensure that quantity and quality of water resources is managed effectively.

Part 2 of **Chapter 14**, outlines the establishment of mechanisms to co-ordinate monitoring water resources and the process requires the consultation and involvement of water service institutions, and the different water users.

The Act outlines the need for a national information monitoring system, which should be based on the quality and quantity of water resources and a register of all water user associations. The regulations, guidelines, standards, and methods for monitoring and assessment should be observed at all times. The aforementioned monitoring system is meant to aid in the development and implementation of a National Water Resource Strategy.

Data that is collected in the information system should be made available to the public. The task of making the data available is the responsibility of the Water Service Institutions (National Water Act (No 36), 1998).

2.3.2 Water Services Act (No 108 of 1997)

The Water Services Act seeks to establish national standards and norms for tariffs, Water Service Development Plans, Water Safety Plans; as well as a regulatory

framework, from which the water service institutions and water service intermediaries can benefit. The Act defines monitoring procedures and intervention mechanisms for water services.

Section 62 of the Water Services Act allocates the primary responsibility of monitoring to the Water Service Institutions. Compliance to national standards and the creation of development plans is mandatory and in the event of a Water Service Institution falling below expected performance levels, intervention is necessitated. Should the intervention process fail, the Minister has the right to intervene and assume the responsibilities of the functions of the Water Service Institution (Water Services Act (No 108): Section 64, 1997).

2.3.3 Strategic Framework for Water Services

This document outlines a comprehensive approach for water supply and sanitation. It provides information for rural schemes, urban and industrial schemes. Moreover, it is a working-manual for Water Service Institutions and Water Service Intermediaries and serves as an umbrella framework to meet established targets and it assesses the levels progress that has been made (DWAF, 2003).

2.3.4 South African Water Quality Management for Water Services Authorities: Drinking Water Quality Framework

This framework promotes an understanding of the entire water quality system, as well as the operational controls. The challenges facing Water Service Authorities in South Africa are acknowledged as well as the institutional roles between different sectors of government and the public (Hodgson and Manus, 2006).

The guidelines serve as a primary source of information in determining water quality and are updated and modified on a regular basis. Role players are encouraged to use these guides as a basis for developing mechanisms to inform water users about water quality. The information provided is aimed at improving the decision-making process, regarding the quality of water for domestic use, human consumption, bathing and other household tasks. Furthermore, consideration is given to the need to support hygiene awareness with water and sanitation practices (DWAF, 2005).

2.3.5 An Assessment of the Effectiveness of the Acts and Guidelines

Both the National Water Act and the Water Services Act outline the roles and responsibilities of stakeholders involved in drinking-water provision and quality monitoring, however, overlapping of responsibilities occurs within National Legislation. A clear separation of activities is needed, within legislation, so that conflict can be avoided between different independent spheres of government. Regardless of this, the Acts are explicit in their attempt to illustrate the needs of the public in terms of monitoring, assessment and the creation of an information system through which data of water resources can be stored and distributed for public benefit. It is the Strategic Framework for Water Services that calls for establishing a clearer set of guidelines for each of the stakeholders involved in Water Supply and Sanitation Provision in the country.

2.4 Role Players and Stakeholders

The role players and stakeholders participating in the processes and procedures required when assessing and evaluating water quality are of vital importance.

2.4.1 Department of Water Affairs and Forestry

The sector leader with regard to water and sanitation provision is the Department of Water Affairs and Forestry (DWAF). This Department is *the custodian of water resources* (DWAF, 2003) and is responsible for policy, regulation, monitoring Water Service Authorities and determining where intervention and support is needed (DPLG, 2005).

2.4.2 Department of Health

The Department of Health (DOH) has the function of collecting information on the incidences of waterborne diseases. This is essential to help facilitate interventions (DWAF, 2005; Hodgson and Manus, 2006).

2.4.3 Department of Provincial and Local Government

The Departments of Provincial and Local Government (DPLG) are responsible for ensuring co-ordination and monitoring national programmes such as water services within the area of their jurisdiction. Much like DWAF, but on a provincial scale, they are required to intervene when necessary and provide support (DPLG, 2005).

2.4.4 Water Services Authority

The Water Service Authority (WSA), which is better known as a municipality, has a duty to all consumers. The Water Services Act (No 108) (1997) stipulates that there is a need to ensure *efficient, affordable, and economically sustainable access to water services*.

WSA have the responsibility of managing local water resources infrastructure such as dams, boreholes, bulk water supply schemes, water treatment systems *etc.* WSAs that rely on the use of contracted Water Service Providers (WSP) or Water Service Intermediaries (WSI) have the added task of monitoring such bodies to ensure adherence to all standards and norms.

Table 2-2, shown represents the bottlenecks in the key areas that have been identified.

Table 2-2: Keys areas that need improvement with regard to water services provision and water resource management (DWAF, unknown date)

Key Areas that require improvement	**Description of challenges**
Strategy and planning	Aligning strategies & planning for water resource management and the provision of water services, especially with respect to the links between the catchment management strategies required by the Water Services Act & the water services development plans required by the WSA.
Implementation	Promoting partnerships for developing and managing water resources infrastructure, and implementing interventions in, for example, water quality management & water demand management.
Water Use Regulation	Coordinating common regulatory and audit functions for water resources management and water services, including monitoring and managing compliance with the conditions relating to specific water use.
Institutional support	Sharing capacity for empowering, coordinating & supporting water management and water services institutions, & transferring functions to them.

Key Areas that require improvement	Description of challenges
Information management and communications	Integrating or linking information systems & technology, & coordinating communication with external stakeholders and partners. The Water Services Act contains specific requirements for water resources management activities to support the provision of water services.

2.4.5 Water Boards

A water board is defined as a *body corporate* with the main purpose of providing water services to Water Service Institutions (Water Services Act (No 108), 1997). They have the duty of managing and overseeing water resource infrastructure and bulk water supply schemes. Formerly, water boards were restricted to urban areas; however, new policy aims to increase the representation of water boards (Abrams, 1996). Presently, within South Africa, there are only two established water boards (Nel, 2008).

2.4.6 Ward Committees

The ward committees are structures that are established to provide the needed link between the municipality, at a local level and the community (Lesabi, 2006). Only metropolitan and local municipalities may have ward committees. The main objective of such a committee is to *enhance the participatory democracy in local government* (Municipal Structures Act, 1998). If the municipality decides to establish a ward committee, it must establish a ward committee for each ward within the jurisdiction of the municipality. The Constitution of South Africa (Act 108 of 1996) mandates that communities should play a role in matters involving local government.

2.4.7 Community-based Organizations (CBO)

This type of association is geared towards the management of small rural water schemes. CBOs represent the needs and concerns of the community, owing to their close-knit ties. Through relevant skills provision and knowledge-sharing, a CBO can effectively respond to the needs of a community (Ngcobo, 2004).

Figure 2-5 is a simplified schematic diagram showing the relationship between different spheres of government, water users and community-based organisations.

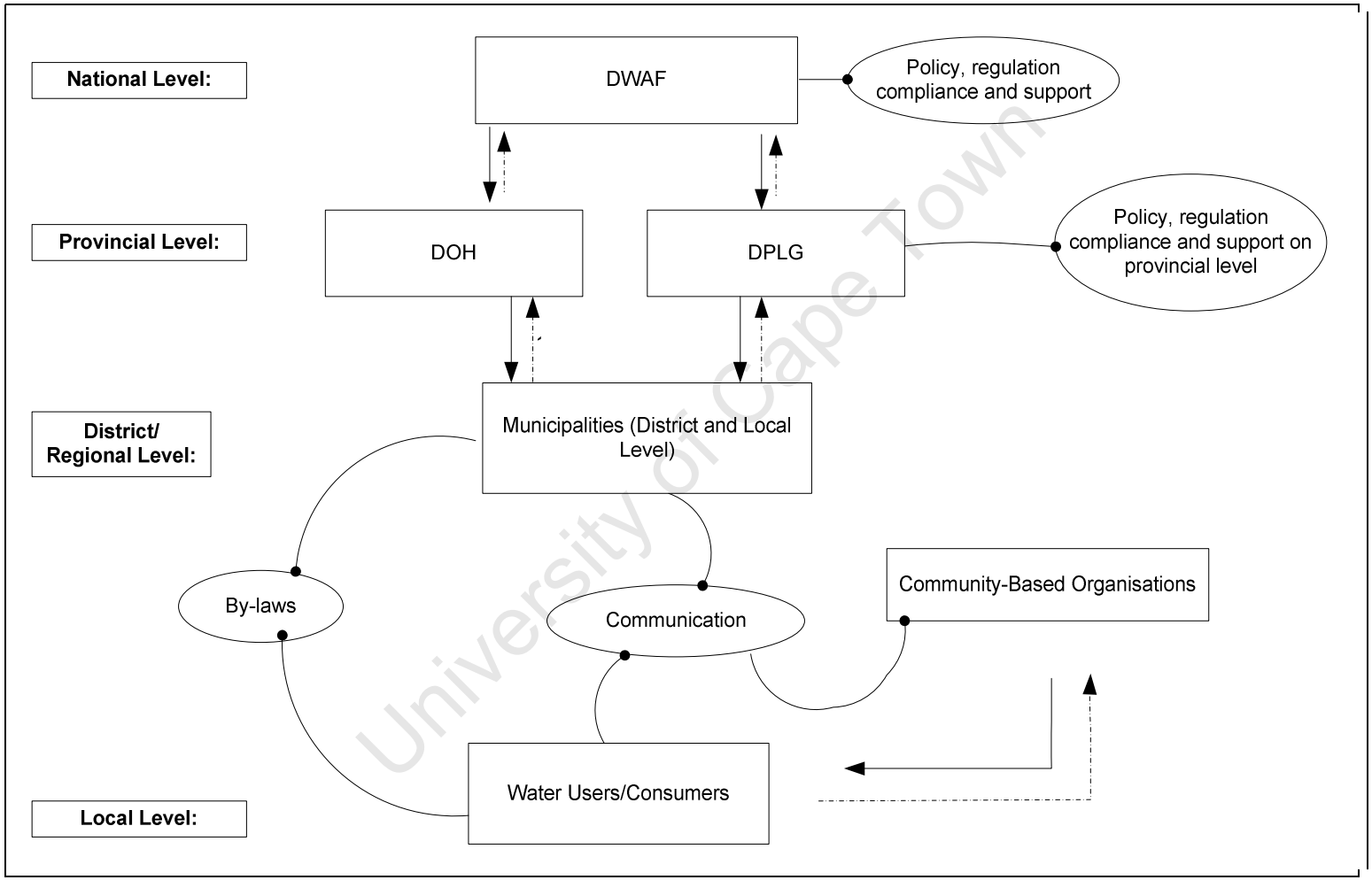

Figure 2-5: Simplified schematic flow-chart of the different spheres of government involved in water services provision.

2.5 Summary

The Drinking Water Quality Guidelines (DWQG) from the World health Organisation (WHO), cover chemical -, physical - and microbiological aspects. The five main key components of the DWQG are: (i) Health-based targets; (ii) a System of Assessment; (iii) Operational Monitoring; (iv) Management Plans and (v) an Independent System of Surveillance.

Developing - and developed countries have a different set of challenges. In the case of developing countries, there is pressure to follow international trends yet the increase in water and sanitation infrastructure cannot be matched with the increasing population.

Within Africa, few East African countries have had formal water service sector policies. Many of the East African nations have had fragmented institutions managing water and sanitation. Within the last decade, several countries in Eastern and Southern Africa have introduced new water policies. Overall, it has been found that South Africa's national water policies are comprehensive, systematic and well-implemented.

In the South African context, The National Water Act (No 36) of 1998 outlines how water resources should be managed, protected and conserved. The Water Services Act (No 108) of 1997 defines the roles and responsibilities of stakeholders and different spheres of government.

There is an overlap in the duties and functions of different governmental bodies in National Legislation regarding water quality monitoring and assessment. It is the Strategic Framework for Water Services that seeks to define the roles of different stakeholders as well as serve as a working-manual for water and sanitation provision.

3 Water Quality Parameters

According to Sundram *et al* (2002), there are over a 100 different types of pathogenic viruses and bacteria present in faecally polluted water, however, only a small proportion of these organisms can be detected by methods and techniques currently available. The surveillance of water supplies should not only involve determining the microbiological aspects, but should encompass taking remedial action to mitigate health hazards. Mitigation of health hazards can be achieved through hygiene and awareness education within communities and processes involving capacity building.

Microbial testing forms an integral part of water quality monitoring as it ensures that the quality of water is safe for use. Non-microbial parameters, such as the chemical- and physical compounds can also be examined. Monitoring and evaluation of these parameters on a regular basis provides data on the quality of water sources and enhances the decision-making process should samples not meet the recommended standards.

An evaluation of microbiological organisms that pose a potential health risk are discussed (Section 3.2) and an overall summary, of the most important parameters that indicate quality of water are presented (Table 3-1 on pp **43**). An examination into the different testing methods regarding water quality are performed and illustrated in Section 3.3. An explicit analysis of water quality parameters that are tested within the South African context is provided.

3.1 Sample Collection Procedures

The procedure for the collection and testing of water samples is defined and outlined by the WHO. Many questions arise with regards to the balance between the accuracy of laboratory testing *vis-à-vis* the convenience of on-site testing.

Transportation of water samples may and can affect the overall accuracy of the results. Nevertheless, owing to advances in testing methods and accessibility to portable test kits, in many instances, it is easier to conduct tests on-site. This section outlines the basic procedures that should be followed when collecting samples for testing.

Water samples should be representative of the area being examined. According to WHO/UNEP, in order to prevent changes to the microbial content of the sample, exposure to sunlight should be avoided. It is recommended that all samples should be cooled, between temperatures of: 4 ^{o}C – 10 ^{o}C, to preserve the original composition of the water sample. If, however, it is not possible to cool the samples, it is advisable that an examination occurs within 2 hours of the collection (Bartram & Balance, 1996).

Where the samples have been cooled, there is an interim period, whereby the samples must be inspected. After collection, 6 hours is the minimum recommended limit and 24 hours being the maximum allowable period before which testing of the samples must be done (Payment *et al,* 2003)

In piped networks, for instance, where samples may contain a disinfectant, such as chlorine, a neutralizing agent should be added to counterbalance the residual solution. Furthermore, the concentrations of residual disinfectants, along with the pH of the water sample should be recorded, at the time of collection.

3.2 The Total Coliform Group

These particular groups of organisms are bacteria, characterized by their growth rate and are directly linked to faecal contaminants. Generally, this group of organisms multiplies at a temperature of 37 ^{o}C.

Faecal indicator organisms are used as a basis for microbiological testing (WHO, 2001). The reason being, that it is *difficult to assess the risk of health presented by any particular level of pathogens in the water. The risk is dependent equally on the infectivity and invasiveness of the pathogens and on the innate and acquired immunity of the individuals who consume the water.... certain waterborne diseases can be detected reliably and easily in water, and some cannot be detected at all* (WHO, 1993).

Within the coliform group, there are also thermo-tolerant bacteria. These types of organisms multiply at higher temperatures. *Escherichia coli,* better known as *E.Coli,* for example, is a thermo-tolerant bacterium.

Thermo-tolerant coliforms, however, may also originate from organically enriched waters like industrial effluent and decaying material in plants and soils. Thus an indication of the presence of this type of organisms may not always represent the presence of faecal contamination. Evidence of their presence in treated is a serious matter as it may be an indication of the existence pathogens or inefficient treatment procedures.

In essence, thermo-tolerant coliforms are, therefore, not a reliable indicator of faecal contamination, other than *E.Coli*. *E.Coli* must **not** be present in any 100 mℓ sample that is tested.

The coliform group is also comprises of organisms of non-faecal origin. These may occur in natural waters and their presence can be accepted in unpiped or treated water. This assumption should be based on evidence that substantiates the origin to be not of a faecal nature. Attempts to remove of these organisms, is an unnecessary expenditure and detection techniques for evaluation of these organisms can be conducted by simple and inexpensive methods.

3.2.1 Bacteriophages

Bacteriophages, commonly referred to as “phages”, are viruses that infect bacteria, such as *E.Coli* and other closely related bacterial-like organisms. Phages mainly replicate within the gastro-intestinal tract of humans and warm-blooded animals. The process of detection is simple, inexpensive and results can be obtained rapidly. The functions required to carry out these processes can be performed by basic laboratories (Grabow, 2000).

3.2.2 Somatic coliphages

This type of organism may occur in natural, pristine or faecally polluted water (Montemayor *et al*, 2005). Coliphages differ from bacterial indices of faecal contamination and are usually detected in human and animal feaces. It is possible that somatic coliphages may occur within water sources, unrelated to faecal contamination; however, it is commonly believed that the chances are highly unlikely (Payment *et al*, 2003).

Even though these organisms can be utilized as a faecal pollution indicator, their presence is not necessarily indicative of the presence of *Enteric viruses.* This is due to the fact that somatic coliphages multiply in the environment (*i.e.* outside of the body) (Sundram *et al*, 2002).

3.2.3 Cytopathogenic viruses

This type of organism requires human hosts and is transmitted via faecally contaminated food or water. This group includes viruses such as the Polio virus, Hepatitis A and E viruses *etc* (Online Medical Dictionary, 2000).

3.2.4 Protozoan parasites (Giardia/ Cryptosporidium)

Protozoan parasites are pathogenic parasites usually found in river or lake systems and are associated with human and animal faeces. This particular species is capable of infecting humans and warm-blooded animals. Their population numbers, however, within faecal matter and pollution vary and they are able to survive for extended periods within the natural environment. These parasites exist within an egg-like protective shell which protects the organism; thus enabling its resistance to treatment.

Protozoan parasites can be found, usually in low quantities, in treated water. Their presence, however, in filtered water supplies implies inefficient filtration-coagulation processes (Payment *et al*, 2003), thus for short-term monitoring and assessments it is necessary to determine their existence within water supplies. Enumeration, however, is expensive and requires a well-equipped laboratory (Fewell, 2007).

Table 3-1 shown below, is a summary of the microbial parameters and the associated characteristics.

Table 3-1: Microbial Parameters and the associated characteristics (Payment *et al*, 2003)

Parameter	Association with faecal contamination	Speed of measurement	Cost	Technical difficulty	Survival in the environment	Resistance to treatment
Total coliforms	N/A	M	M	M	M	L
Thermo-tolerant coliforms	M	M	M	M	M	L
Escherichia coli	M	M	M	M	M	Insufficient data
Heterotrophic bacteria	N/A	M	M	M	H	H
Somatic coliphages	Insufficient data	H	M	M	H	M
Enteric viruses	N/A	L	H	H	H	H
Giardia cysts	N/A	L	H	H	H	H
Cryptosporidium oocysts	N/A	L	H	H	VH	VH

Key	
L	Low
M	Medium
H	High
VH	Very High

3.3 Different Testing Methods

Cultivation and enumeration of indicator bacteria is time-consuming. A balance, therefore, needs to be struck between rapid and time-consuming tests. For rapid result-yielding tests, a lack of sensitivity of the results will not usually indicate the number of microbial organisms present in a tested sample yet time-consuming tests offer a higher degree of sensitivity and enumeration (Ronchi, 2003).

This section assesses the different testing techniques that may be used for the assessment of water quality. Information pertaining to the effectiveness and the limitations of each of the testing methods is presented.

3.3.1 Presence/Absence Test

This test is an economical alternative to coliform analysis (Rice *et al*, 1989).

Advantages

- Negating errors associated with more complex testing procedures that enumerate coliform numbers.

- Has the ability to detect organisms such as: *Aeromona, Clostridium, E.Coli,* faecal streptococci, *Pseudomonas* and *Staphylococcus* (Payment *et al*, 2003).

Disadvantages

- This test should only be used as a screening device and not as an alternative to assess the fitness of water for human consumption.

- Does not enumerate coliform numbers.

3.3.2 Hydrogen Sulphide (H_2S) Test: The Paper-Strip Test

A simple test developed in 1982, based on the H_2S (Hydrogen Sulphide) produced by bacteria. Using a culture-medium where Thiosulphate is used as a source and Ferric Ammonium Citrate as an indicator, under these circumstances certain varieties of bacteria produce H_2S.

A paper strip, which if H_2S is present, will turn black. This test can also be used in a semi-quantitative manner, by using varying dilutions of a sample. It should be mentioned that a number of bacteria, not necessarily linked to faecal contamination, also produce H_2S. Furthermore, the presence of heavy metals (such as iron salts) may inhibit the ability of certain bacteria to produce H_2S.

Owing to the lack of standardization of this test and the inability to directly associate this method of testing to exclusively identify faecal-originating pathogens, a consensus has not been reached on the whether this test should be recommended for use by authorities.

The H_2S test is recommended for drinking water that is obtained from surface waters, boreholes, and rain water sources (Mosley and Sharp, 2005).

Advantages

- Useful screening tool or as an *early warning system* (Payment *et al,* 2003), particularly within small or rural communities without immediate access to testing laboratories.

- Can be used where in-depth testing is too expensive (Mosley and Sharp, 2005).

Disadvantages

- Has the ability to give a false positive, whereby the presence of H_2S may lead the evaluator to believe that there may be faecal contamination (Payment *et al,* 2003).

3.3.3 Heterotrophic Plate Counts (HPC)

Heterotrophs are broadly defined as micro-organisms that require carbon for growth. As a result, they include bacteria, yeasts and moulds (Bartram *et al*, 2003). The HPC test is a general assessment of bacterial content, not directly related to faecal contamination, in water. The assessment process only occurs after an incubation period, which can vary from a few hours to a few days or even weeks, at temperatures between 20 ^{o}C and 40 ^{o}C. Furthermore, the nutrient conditions will vary, depending on the type of micro-organisms being tested (WHO, 2003).

Advantages

- Assesses the efficiency of the treatment processes as well as the distribution system in piped water supplies (Allen *et al*, 2002).

- Can be used as an underlying marker for causes or failures in the aesthetic quality of water (Bartram *et al*, 2003).

Disadvantages

- There is no evidence to suggest that HPC values directly relate to the potential health risks (Bartram *et al,* 2003).

3.3.4 Ratios of counts

This method compares the ratios of thermo-tolerant coliforms to faecal streptococci. This method is used to differentiate between human and animal contamination. If the ratios are below 0.7, this indicates contamination of an animal nature.

Advantages

- Able to differentiate between animal and human feaces, thereby identifying the probable source of contamination.

Disadvantages

- The ratios have the ability to vary because it is site specific and also depends on the duration of contamination.

This method is not recommended as a means for determining faecal contamination (Payment *et al*, 2003).

3.3.5 Direct Total Counts and Activity Tests

This technique involves quantifying the microbial content of the water. This type of test has little sanitary significance owing to the fact that it aims to obtain general microbial numbers rather than faecal organisms (Payment *et al*, 2003).

Advantages

- Enumerating microbial content of water.

Disadvantages

- General quantification so no specification with regards to particular parasitic organisms.

3.4 The importance of a Chemical Assessment

The assessment of chemical components in water is considered a lower priority in relation to the microbial aspects because the negative effects are associated with long-term exposure whereas with microbial aspects, the effects become apparent immediately (Thompson *et al,* 2007).

Table 3-2, is a categorisation of chemical pollutants and the associated sources. *Please refer to Appendix C for further information on the chemicals components that can be present within water sources as well as information pertaining to chemicals that are derived from human activities.*

Table 3-2: Categorising sources of chemicals in drinking water (Thompson *et al*, 2007)

Sources of pollution	Examples
Natural occurring chemicals	Rocks and soils, cyanobacteria in surface water
Chemicals form agriculture	Manure, fertilizer and pesticides
Chemicals from human settlements	Sewage and waste disposal, urban runoff and fuel leakages
Chemicals from water treatment and distribution	Water treatment chemicals, corrosive and leeching from storage tanks and pipes

3.5 Non-Chemical Parameters

Non-chemical parameters are not directly related to coliform analysis, yet monitoring and evaluation of these factors is crucial to maintaining adequate water quality.

The non-chemical parameters are presented and the importance of the need for on-going monitoring established.

3.5.1 Rainfall/Runoff

Rainfall can have the effect of contaminating surface waters and ground water as it has the ability to move pathogens through water sources and soils and re-suspend sediments and contamination of groundwater through infiltration. Owing to this factor, forward planning with regard to rainfall monitoring is necessary as it will provide authorities with an early warning system, whereby provisions can be made for rainfall events that could potentially influence water quality in a negative manner.

Rainfall is not directly linked to faecal loading; however, this parameter can have an influence on predicting the expected levels of pollution of a water source as

well as aiding in taking necessary precautionary measures to safeguard overall water quality (WHO, 2004).

3.5.2 Turbidity

Turbidity is a measure of the suspended solids and provides the important data regarding the effectiveness of the treatment process (Payment *et al,* 2003). It is not associated with faecal matter but increases in turbidity can signal increases in pathogen numbers.

Measurements are conducted using a Nephalometer which measures the amount of light that is scattered by particulate material. The lowest recommended level is 0.02 NTU (Nephalometric Turbidity Units).

Most ground waters have stable turbidities and the test methods are inexpensive.

3.5.3 Flow

This parameter provides information regarding availability and production of water quality. Low flows in surface water can lead to contamination, whether biological contamination or higher concentrations of pollutants.

In the incidence of water being treated at water treatment works, changes in the flow can affect the flocculation and coagulation processes.

Flow is needed to improve the filtration process as well as maximize contact of water and the disinfectant. Changes to the flow rate in distribution systems can have the effect of suspending sediments and or deteriorating the quality of water supplies.

3.5.4 Colour

Colour in drinking water may be owing to the presence of organic compounds such as iron or manganese *etc.* In general, water should be colourless and any changes that are observed should serve as an early warning signal and imply possible changes in the quality.

Testing methods are cheap and can be conducted using a spectrometer or visual comparison from known standards or a colorimeter

3.5.5 pH

In the case of water at a treatment works, the pH can affect coagulation and disinfectant processes (using chlorine-based chemicals).

This parameter needs to be continuously monitored. To test the pH of water, simple paper strips or colorimetric tests can be used, though such methods are less precise. There is, however, equipment for continuous monitoring and data logging that can be used but such equipment for continual measurements, is expensive.

3.5.6 Disinfectant residual concentration

Measurement of the disinfectant dosage is important. Chlorine is the most widely used disinfectant in water treatment (Payment *et al*, 2003). In the treatment process, residual concentrations should be monitored continuously.

Table 3-3: Non-microbial parameters and the associated characteristics (adapted from Payment *et al,* 2003).

Parameter	Level of Technical Difficulty	Cost	Speed of Measure-ment
Rainfall	L	L	H
Turbidity	L	L	H
Flow	L	L	H
Colour	L	L	H
pH	L	L	H
Disinfectant residual concentration	L	L	H

Key	
L	Low
M	Medium
H	High
VH	Very High

Table 3-4, shown on page **53**, is a summary of the factors that are tested within the South African context, regarding water quality. The information presented in the table is a combination of the microbial and the physical factors that are taken into account as well as the alert level as governed by SAN241.

Table 3-4: Microbial and non-microbial parameters tested, regarding water quality, in the South African context (DWAF, 2005 and Emanti/WQMS, unknown date).

Operational Water Quality Alert Values			
Determinant	**Brief Description**	**Unit**	**SAN 241 Alert Level**
Turbidity	The turbidity is a measure of the suspended particles or degree of cloudiness of a water.	NTU	**5**
Residual chlorine	Free chlorine residual is an indication of the efficiency of the disinfection process and is thus a rapid indicator of the probable microbiological safety or otherwise of the treated water.	mg/ℓ	**<0.5**
Heterotrophic plate count	The Heterotrophic Plate Count detects a wide range of bacteria and is used to assess the general bacterial quality of water. Pollution can give rise to conditions conducive to bacterial growth leading to high heterotrophic plate counts.	count/mℓ	**5000**
[Total] coliform bacteria	The total coliform group includes bacteria of faecal origin and several other bacterial groups.	count/mℓ	**10**

Operational Water Quality Alert Values			
Determinant	**Brief Description**	**Unit**	**SAN 241 Alert Level**
Somatic coliphages	Somatic coliphages are a diverse group of phages which infect *E.Coli* and certain closely related bacteria. These phages occur in large numbers in sewage and therefore the presence of somatic coliphages indicates faecal pollution.	count/100 mℓ	**1**
Cytopathogenic viruses	Somatic coliphages are a diverse group of phages which infect *E.Coli* and certain closely related bacteria. These phages occur in large numbers in sewage and therefore the presence of somatic coliphages indicates faecal pollution.	count/100 mℓ	**1**
Protozoan parasites	*Giardia* and *Cryptosporidium* are pathogenic parasites that are commonly found in lakes and rivers, particularly those contaminated by sewage and animal wastes.	count/10 mℓ	**1**

(*Giardia*/*Cryptosporidium*)	They exist as a cyst; an egg-shell-like covering that protects the micro organism from hazards (e.g. conventional disinfection methods using chlorine may be ineffective). The cyst also protects the micro organism from destruction outside the host, leaving it viable. When this is ingested, viable cysts can infect their new hosts.		

3.6 Summary

There are many different types of viruses and bacteria that may be present in feacally polluted waters, of which, only a small proportion can be detected by methods currently available. Some of the organisms tested for in drinking water are: (i) Bacteriophages; (ii) Somatic Coliphages; (iii) Cytopathogenic Viruses and (iv) Protozoan Parasites.

Each of the methods for assessing water quality have associated advantages and disadvantages to their use.

There are different views with regards to on-site testing compared to laboratory testing. In testing water quality, there are key parameters in the physical -, chemical - and microbial aspects of water that should be examined. The non-chemical aspects, not directly linked to water quality, but affecting its overall quality or aesthetic appeal, must also be assessed. Examples of non-chemical parameters that should be monitored are: (i) Rainfall/runoff; (ii) Turbidity, (iii) Flow; (iv) Colour; (v) pH and (vi) The disinfectant residual concentration.

4 Community Surveys

An assessment of the issues regarding water quality in the Chris Hani District, of the Eastern Cape, is examined along with an organogram of the organisational structures in place in the region. Information from a municipal level is presented followed by an analysis of the opinions, concerns and practices of the communities that were studied.

4.1 The Eastern Cape

The Eastern Cape is located on the south-eastern seaboard of South Africa. The capital is Bhisho, which is located approximately 60km from East London. *The location map can be found in Appendix D (Fig D-1).* The main provincial languages, spoken in this province, are: IsiXhosa, Afrikaans, English and Sesotho, of which IsiXhosa-speaking people make up the largest percentage.

The Eastern Cape, which covers an area of 170 600 km² is the third largest province in South Africa and the 4th richest as the GDP accounts for 8.1% of the South African total. The GDP per capita, however, ranks 8th provincially in South Africa and the area is characterized by high poverty and unemployment rates. The population in this region is estimated to be 6.9 million (SSA, 2007).

In the Eastern Cape, there are 6 District Municipalities (DM) and one Metropolitan municipality. Under each of the DMs, there are local level municipalities. In total, in the region, there are 38 local municipalities. The 6 DMs are:

Alfred Nzo District Municipality
Chris Hani District Municipality
O.R Tambo District Municipality
Ukhahlamba District Municipality
Cacadu District Municipality

4.2 Challenges specific to the Eastern Cape: Historical setting and Socio-Economic Environment

The Eastern Cape, during the apartheid era, were self-governing homelands called the Ciskei and the Transkei. These homelands were regarded and acknowledged by the then government in Pretoria, as separate, independent entities from the rest of South Africa. Internationally, however, these homelands were not recognized as independent states. The former homelands were characterized by overcrowding and environmental collapse (Nel and Davies, unknown date).

Currently, the Eastern Cape faces a number of challenges. Its GDP per capita is far lower than the South African average. This is indicative of the extent of poverty in the region. It can be argued, however, that the poor performance within the Eastern Cape is linked to historical occurrences and neglect by government. Furthermore, unemployment throughout the region ranges from 16% to 85% in the rural areas (Nel and Davies, unknown date).

Despite the progress that has been made, there are a number of socio-economic factors that prevent this region from fully developing. The high incidences of poverty and unemployment are compounded by potentially unsafe drinking water (Provide Project, 2005). Within the Eastern Cape, approximately two thirds of the population reside in rural areas where borehole water, protected springs, or communal taps are the main source of water supply.

4.3 Water Quality Management in the Eastern Cape: An Overview

Access to water and adequate sanitation remains a problem in the Eastern Cape. In the rural setting, the residents rely mainly on borehole water; communal taps *etc* and utilize pit latrines.

In an evaluation of Eastern Cape Municipalities, conducted by and the DWAF Regional Office in the Eastern Cape (2006), municipalities had to assess their performance, and as a result, a number of factors were identified. The purpose of this evaluation was to recognize the gaps pertaining to provision of water services and assess the current status quo with regard to water quality management.

From the evaluation, it was found that 29% of all the municipalities in the Eastern Cape had copies of: The National Water Act and The Water Services Act. At the time that the survey was conducted, the SANS241 (of 2005) drinking guidelines were still to be acquired by many of the WSAs. Despite these obstacles, however, the WSAs felt that they were complying with their legal responsibilities as defined through legislation.

District Municipalities as well as the Nelson Mandela Metropolitan Municipality, perform the functions of WSAs with the exception of a few local municipalities. Water Service Providers (WSPs) play a big role in the functioning of the WSAs as many of the municipalities utilize them to manage the operational aspects involving water quality testing within the WSAs.

Figure 4-1, shown on pp **61**, represents the organisational structure with regard to water quality management in the Eastern Cape. The linkages and communication routes between different spheres of governmental bodies, authorised service providers and the water users will be shown.

The majority of municipalities make use of external laboratories as only 4 have in-house laboratories. Water Service Infrastructure is considered to be of average quality and is only monitored on a crisis management level as funding for preventative maintenance is lacking.

An example of the need for the inclusion and adherence to preventative maintenance programmes can be seen with the Ukhahlamba DM. In the In May of 2008, Ukhahlamba DM had an incident whereby 131 babies died of diarrhoea. Diarrhoea, especially in infants, often indicates water contamination. The areas that were affected within the Ukhahlamba District were Barkley East and Sterkspruit. Epidemiology reports concluded that the core causes were from microbiological water which did not meet the established standards and norms, as well as domestic storage practices within households. Overall, the report linked the core elements of the outbreak to unsafe water supply, poor sanitation, and hygiene practices. It is important to note that prior to the outbreaks tests conducted over a seven month period had shown a 68% failure rate of the legislative requirements, but this had not resulted in remedial action in the areas (Makhubu, 2008).

Rural areas of the Eastern Cape are not the only places to be affected by water quality issues. In May of 2008, Port Alfred, which is a coastal town, also had an episode whereby 9 babies died and approximately 100 people were treated for diarrhoeal infections. The reasons for the outbreaks, once again, where accredited to poor hygiene and unsafe drinking water (Macgregor, 2008).

Failure on such a magnitude is due, in part, to a lack in human resources, in WSAs where a delay in response can have disastrous consequences.

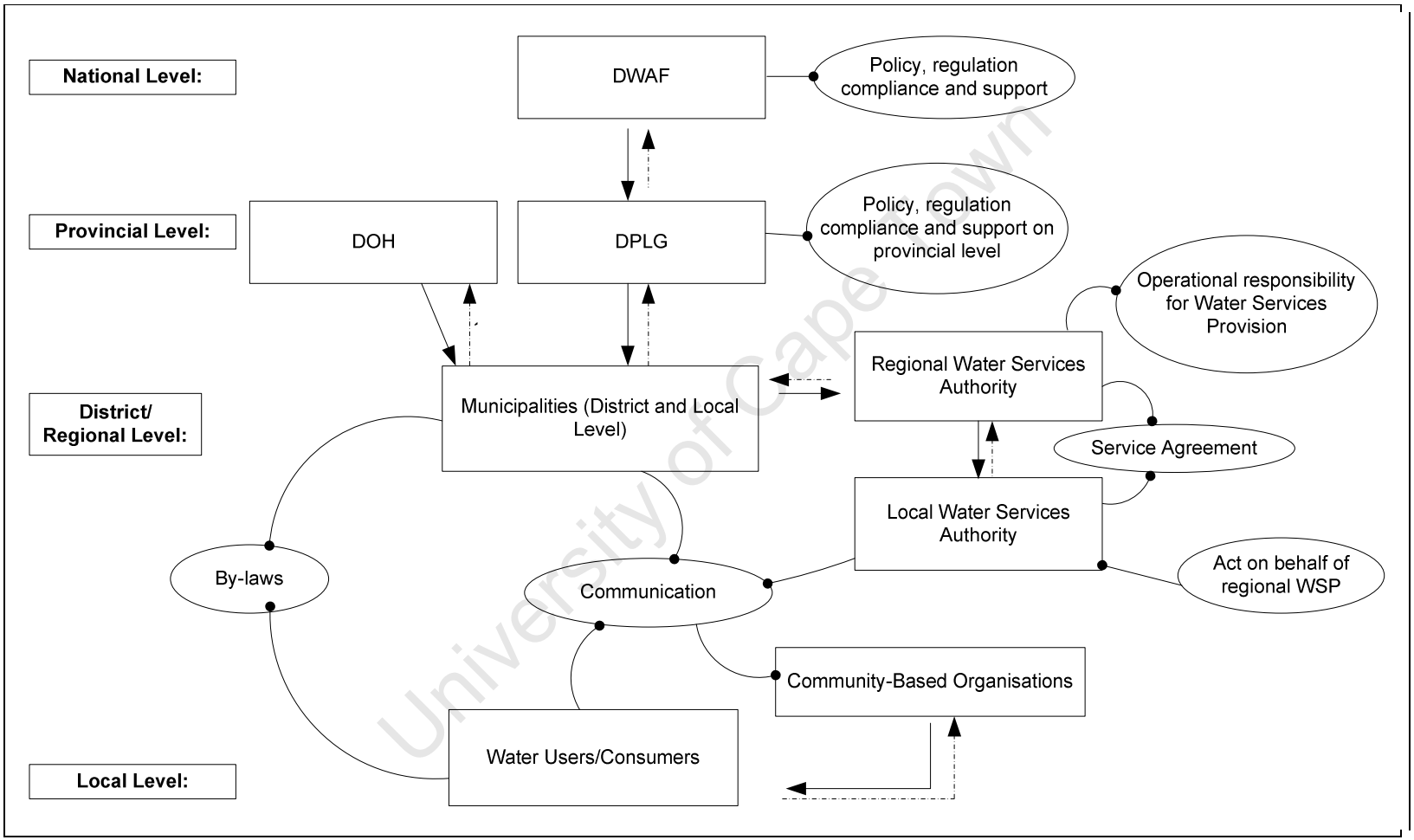

Figure 4-1: A simplified schematic diagram of the organisational structures in the Eastern Cape.

On a council level, the issue of water quality is a recurring topic. There is consensus amongst the WSAs that the management of data regarding water quality monitoring and its assessment is a difficult task, as budgetary constraints are to some extent a norm in the region (Nel, 2008). As a result, preventative maintenance, with regard to drinking water quality (DWQ), is not performed and in most cases there is not enough capital for routine monitoring of drinking water.

Only 36% of WSAs in the Eastern Cape reported having acceptable Drinking Water Quality Management and 34% of all WSAs in the region reported having acceptable levels of water services quality (DWAF, 2006). This means that there are serious gaps in the current system that need to be identified.

4.4 The Chris Hani District

The Chris Hani District Municipality (CHDM) covers an area of approximately 37 110 km² and is home to 800 000 people and 203 000 households (SSA, 2007). This DM consists of 8 local municipalities (SSA, 2007). Towns such as Cradock and Middelburg are located within the Inxuba Yethumba Municipality, Hofmeyer, Tarkastad and Sterkstroom are within the Tsolwana Municipality, Queenstown and Whittlesea are located in the Lukanji jurisdiction and Lady Frere, Indwe and Wodelhona are in the Emalahleni region. Cofimvaba and Tsomo fall in the Intsika Yethu region and Engcobo and Elliot and Cala are located within the Sakisiziwe region. The main towns in the district are Queenstown, Cradock, Middelburg, Elliot and Engcobo.

The population density is 22 people per km² as compared to 39 people per km² nationwide. The Intsika Yethu and Lukanji Municipalities have the highest population densities and the Tsolwana, has the lowest.

39% of the people within this region are below the age of 15 years and more

than 50% of the people are under the age of 20. This characterizes the economic under-development of the area. The core symptoms of economic under-development are: lack of access to employment opportunities, health care, potable water, food, education and housing (Wikipedia, 2008). In the case of the Eastern Cape, these challenges are a reality. In addition to that, the Human Development Index (HDI) is 0.49 and the poverty is estimated to be 75%.

The adult literacy rate is 47% and the unemployment rate is 55%. The biggest employer in the region is the Government or the Public sector.

The social services and infrastructure require further development as currently, 73% of the households in the region are either informal or traditional settlements that are, in most cases, not serviced. Only 28% of the households in the district have safe, potable water on-site and 50% have a sanitation facility (either a flushing toilet or a pit latrine).

Please refer to Appendix D, Figure D-2, to view the municipal boundaries and location of Chris Hani DM.

4.5 Challenges with regard to water services provision and water quality management in Chris Hani

Within the Chris Hani District, approximately 40% of people are not serviced. The reasons cited for this is the fact that the area is *deeply rural* (Nel, 2007) and in most cases rural communities are located too far away from water resources and thus remain unserviced (Gulwa *et al*, 2006) as the development of water infrastructure would be too costly, owing to financial constraints.

There are documented occurrences of rural communities living near rivers and factors such as these pose a water-quality risk to both the communities and

the riverine system. 82% of the water resources utilized are abstracted from surface water and the remaining 18% comes from ground water. Overall, within the province, 60% of the water is supplied in a formal distribution system and the remaining 40% is obtained from groundwater reserves, which is mainly used to supply local rural schemes (DWAF, 2006).

Water in rural areas is generally characterized by partial or minimal water treatment, where isolated communities and villages without access to electricity or other amenities make use of water directly from rivers or streams without any prior treatment. In this instance, both water quality and quantity may be affected by seasonal changes (DWAF, 1996, DWAF, 1998 & Nel, 2007).

There is an overlapping of roles and responsibilities between Environmental Health Practitioners (EHP) in the CHDM and the WSA, regarding water quality monitoring. The practice of water quality monitoring forms part of the WSA's core components and also encompasses one of the EHPs management perspectives. The EHP's main responsibility is to secure environmental health. This involves a range of activities, from the disposal of dead/decaying material to health aspects involving water quality monitoring (Nel, 2007).

WSAs in the district prefer to outsource operational and maintenance aspects of water supply schemes to WSPs (DWAF, 2006). All schemes are monitored on a monthly basis and in the case of rural schemes; drinking-water quality is managed at the water source (*i.e. borehole, protected spring, communal tap etc.)* Furthermore, monitoring occurs on a *crisis management basis* (Gcali, 2007; Nel, 2007).

A lack of human resources has prompted WSAs to rely on the use of WSPs. According to Nel (2007) within the Chris Hani District there is roughly 1 EHP for every 45 000 residents.

4.6 Questionnaire Design

In order to develop the community questionnaire, dialogue with municipal officials concerning the challenges facing water service institutions, were identified and evaluated to form the basis of the survey. From the 22nd – 25th May 2007, 6 municipalities and 1 Water Services Provider were interviewed as the first trial run. No distinction was made between municipalities servicing urban populations and municipalities servicing rural communities. This was required to establish if the challenges facing the local institutions in the region are generic.

In October 2007, a second round of trial-run interviews were conducted, however, in this instance; only 2 district municipalities were identified. These being: Chris Hani DM and Alfred Nzo DM. A trial-run of the community questionnaire was performed, whereby a total 40 households within both districts were interviewed.

From the trial-run interviews, the questionnaire proved to amass of great depth of knowledge. As a result, a qualitative questionnaire was developed, where room for the respondents to comment and provide further input was allowed. Using content analysis, the information has been quantified into recurring themes and topics that are discussed by the respondents.

Three communities were surveyed, one a peri-urban community (Ilinge) to represent households living near towns and two rural communities (Tsojana and Hoita) to represent households outlying from towns.

Please refer to Appendix E to view the community questionnaire.

4.6.1 Data Collection

The main interview process was carried out from the 25th - 30th of May 2008. With the aid of EHPs from local municipalities in the area, communities were mobilized and the interviews were conducted at local clinics, hospitals and where permitting, door-to-door interviews were conducted.

A total of **167** people were interviewed from all three communities within the Chris Hani District. The definitions regarding rural and peri-urban, in this thesis were based on the distance of the community from Queenstown (which is where the Chris Hani DM is located) and the level of sophistication of the water and sanitation facility in use in the communities.

Ilinge is located approximately 15 km outside of Queenstown and is a peri-urban community, located in the Lukanji Municipality. The Lukanji Municipality services approximately 208 000 people and has 49 680 households (SSA, 2007).

The communities of Tsojana and Hoita fall under the jurisdiction of Intsika Yethu Municipality. These communities are located within the locality of Cofimvaba, which is approximately 80km from Queenstown. This municipality services 185 340 people and 43 500 households (SSA, 2007).

4.6.2 Limitations of the Questionnaire

Though the questionnaire gathers information on the communities, their perceptions and water practices, observations and limitations of the questionnaire have been acknowledged. These being:

- Data collected from the communities is representative of the opinions of these rural communities. The total number of households in these vil-

lages/communities, however, can not be verified owing to a lack of data.

- The overall majority of interviews were conducted at clinics and hospitals owing to the dispersal of households within the communities and the limited time frame in which to conduct the interviews.

- Local EHPs conducted the questionnaires within the communities. Inexperience on their part with regard to performing interviews may have affected the quality of the responses provided by the respondents.

- Certain questions of the questionnaire called for a specification with regards to time, or frequency of monitoring. For example: If a distinction could not be made between terms such as “too long” or “too short”; as a result these responses are characterized as “No clear specification” in the results.

- Respondents declined to answer certain questions and these responses are classified as “No response” answers.

4.7 Discussion of Results: Hoita, Ilinge and Tsojana

The social networks of all the communities surveyed are well-established, as queries or issues regarding polluted water sources are directed towards either the local water operator (27%) within the community or the local councillor (38%), in the case of Ilinge.

The communities of Hoita and Tsojana have a variety of methods to direct their concerns over the quality of their water sources. In Hoita 19% rely on local councillors, 19% don’t tell anyone, 17% prefer to inform the local water operator or the municipality and 13% of the respondents rely on the water com-

mittees established within the community. 1.5% of the respondents commented that water concerns are directed towards the traditional leader (chief). This coincides with information obtained from municipal officials concerning the reliance on traditional leaders within small rural communities and the close-knit social ties.

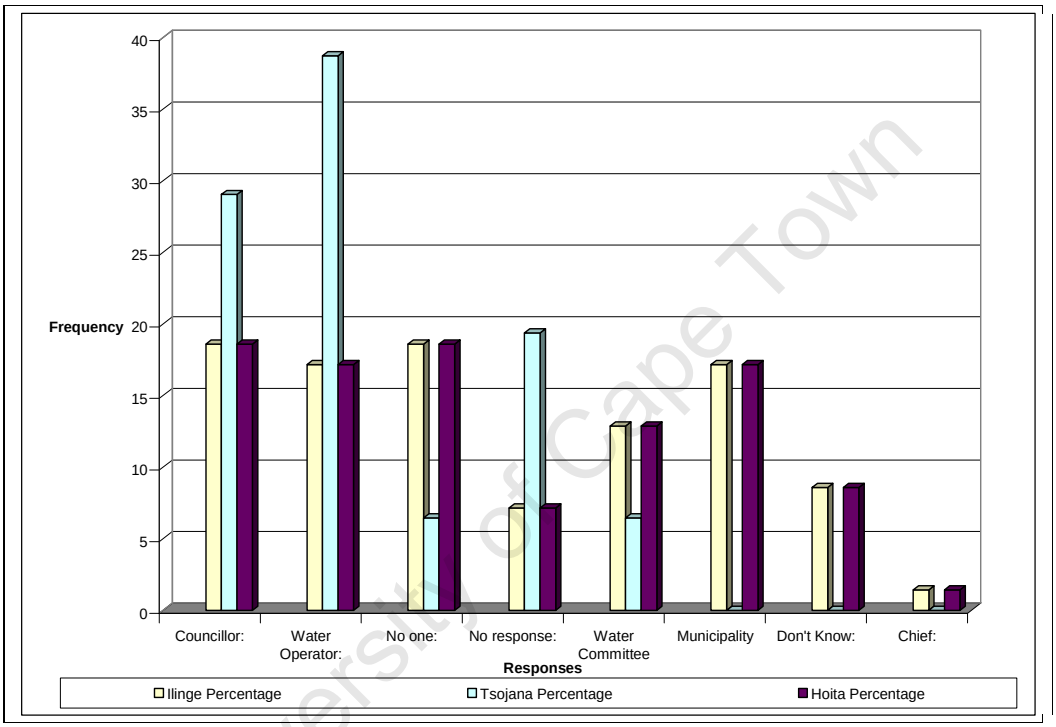

Figure 5-2: Communities response to notification on contaminated water (who they inform).

There are gross variations with regard to the waiting time-period before changes are made to the water source.

In Hoita, 11% of the respondents believe the waiting period to range between 12 hours and 3 days, yet another 11% of respondents put the waiting period between 1 - 2 weeks. Most surprisingly, 17% of the respondents believed that no changes (with regard to the quality of water) had ever occurred to their water sources after having reported the source being contaminated.

Within this community, overall, 61% of the respondents interviewed reported using only municipal-authorised water sources.

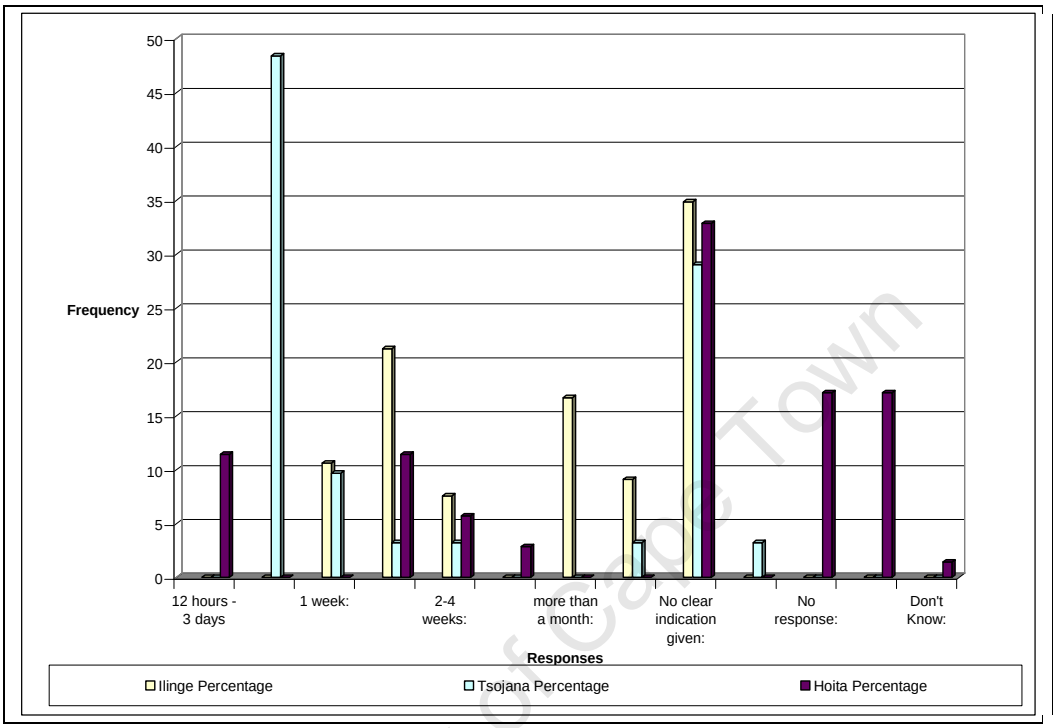

Figure 5-3: Waiting period before changes are made to contaminated water sources.

In Tsojana, the waiting period has been determined to be between 1 - 2 days (48%) and 10% of the respondents determined the waiting-period to be 1 - 2 weeks.

71% of the respondents reported that they **do not** use municipal-authorised water supplies. At the time that the interviews were conducted; the community of Tsojana did not have municipal-authorised water sources, as their bore-holes had depleted. The author is therefore not surprised that 71% of the re-spondents claim to not use municipal-authorised drinking water points.

In Ilinge, a large percentage of the respondents interviewed (21%) commented that the waiting period before water sources are fixed is: 1- 2 weeks. 10 % of those interviewed within the community believed the waiting period to be a

week, 7 % commented that the waiting period before contaminated water sources are “fixed” is 2-4 weeks and 17% of respondents believed water sources to be “fixed” after more than a month.

Of those interviewed in Ilinge, 68% reported only using municipal-authorised drinking facilities, whereas 29% use unauthorised drinking sources.

It is the opinion of the author, that within this community and with particular reference to this question, the respondents embellished on their answers as compared to the rural communities that were surveyed, Ilinge has better water service infrastructure. Furthermore, from interviews that were conducted with municipal officials through out the district, the author is aware that whenever water is contaminated in communities within a close proximity of the municipality, the residents are cautioned against using the facilities through use of the clinics, local water operators and local councillors and are provided with emergency water tanks until the issue is resolved.

The reasons cited, across all three communities, for not utilizing municipal-authorised water sources, are: (i) a shortage of water; (ii) a some respondents felt that the water was “clean” and “safe” (iii) one respondent cited that he/she had “no other choice” or alternatives; (iv) no taps/boreholes available; (v) a few respondents preferred to use river water; and (vi) one respondent remarked that there were no municipal-established water sources within his/her community.

Across all three communities, the colour of water is the biggest indicator of contamination, followed by the taste and then the odour. Within each of the communities, there are respondents who do not attempt to improve the quality of water before consumption. In Hoita, 21% do not improve the quality of water (from the water sources) followed by Tsojana with 19% and then Ilinge at 11%. These respondents cited that it is not necessary because the water is “safe”.

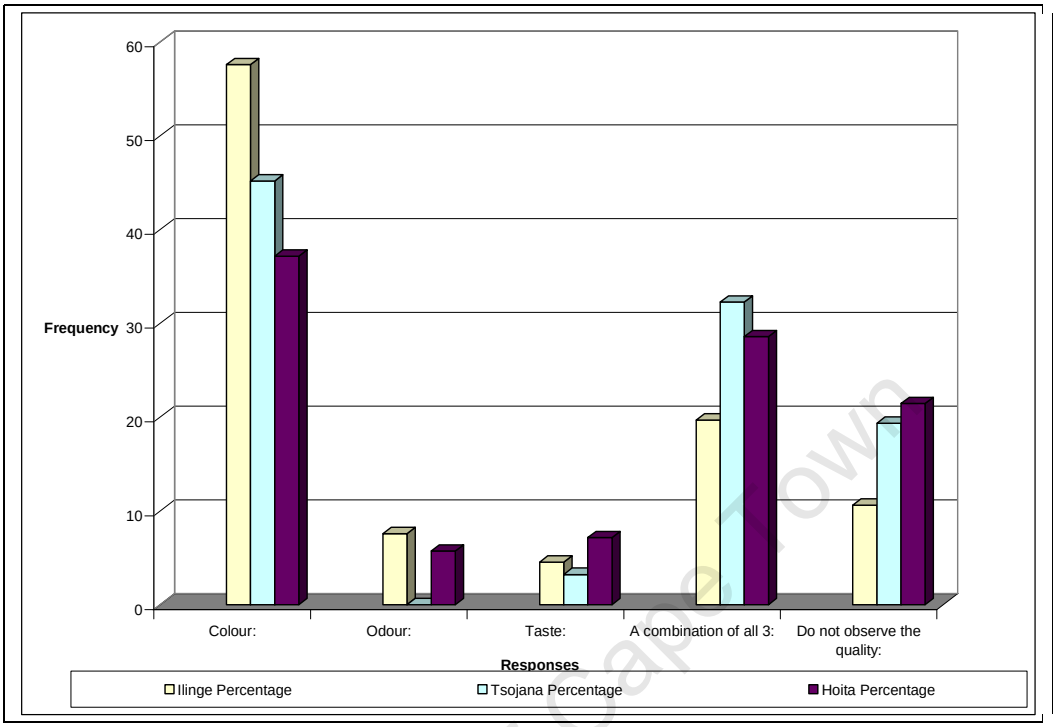

Figure 5-4: Methods of identifying a contaminated water source

The main method of improving the quality is either by boiling or by adding bleach. The respondents were aware of the required measurements of 1 tea-spoon of bleach per 20ℓ of water.

The respondents acknowledge: (i) usage of unprotected springs and/or rivers; (ii) usage of windmill water; (iii) provisions made by the municipality to supply water tanks and (iv) the need for the municipality to "improve the quality of water".

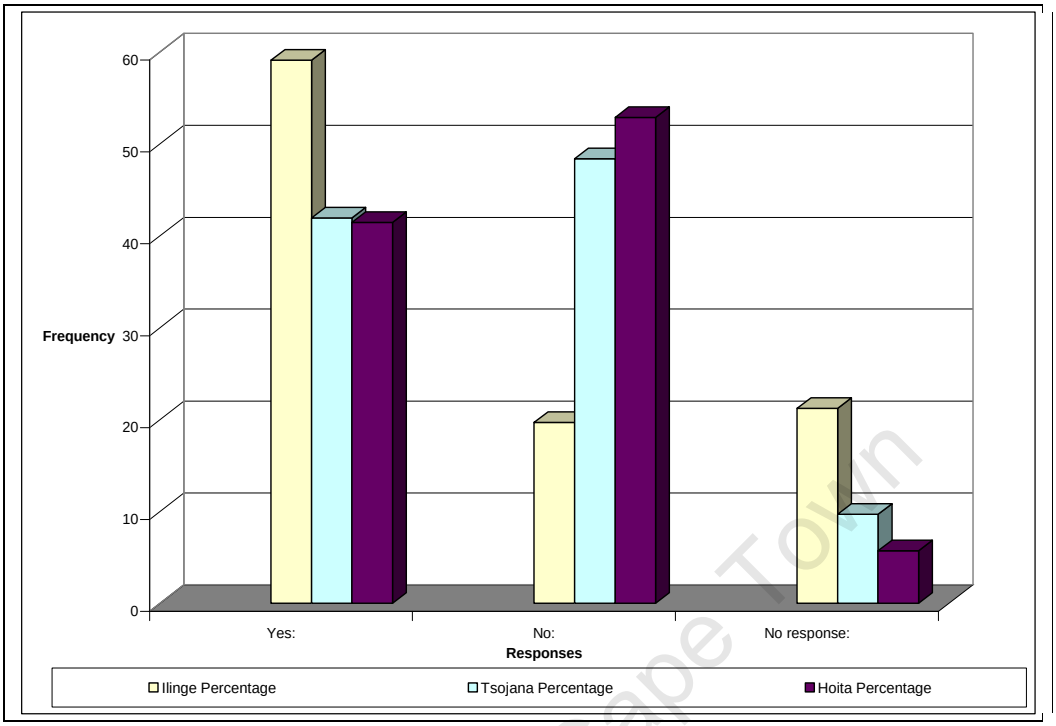

Figure 5-5: Respondents who try to improve water before consumption

Regarding drinking-water quality, in Ilinge, 67% perceive their water to be unsafe whereas in Hoita and Tsojana the majority of respondents perceive their water to be safe. One respondent commented that "the groundwater quality should be improved" and another commented that the water should be monitored more "frequently".

There is an overall willingness in all the communities for participation in a local monitoring scheme. Of those reluctant to participate in such an initiative, this can be attributed their feelings of neglect. In the case of Tsojana, respondents had commented about a water project that had been initiated but was never completed. In addition to this, discussions centering on the existence of water committees in their villages were explored. In some instances local water committees existed, but were "inactive", in the opinion of one respondent.

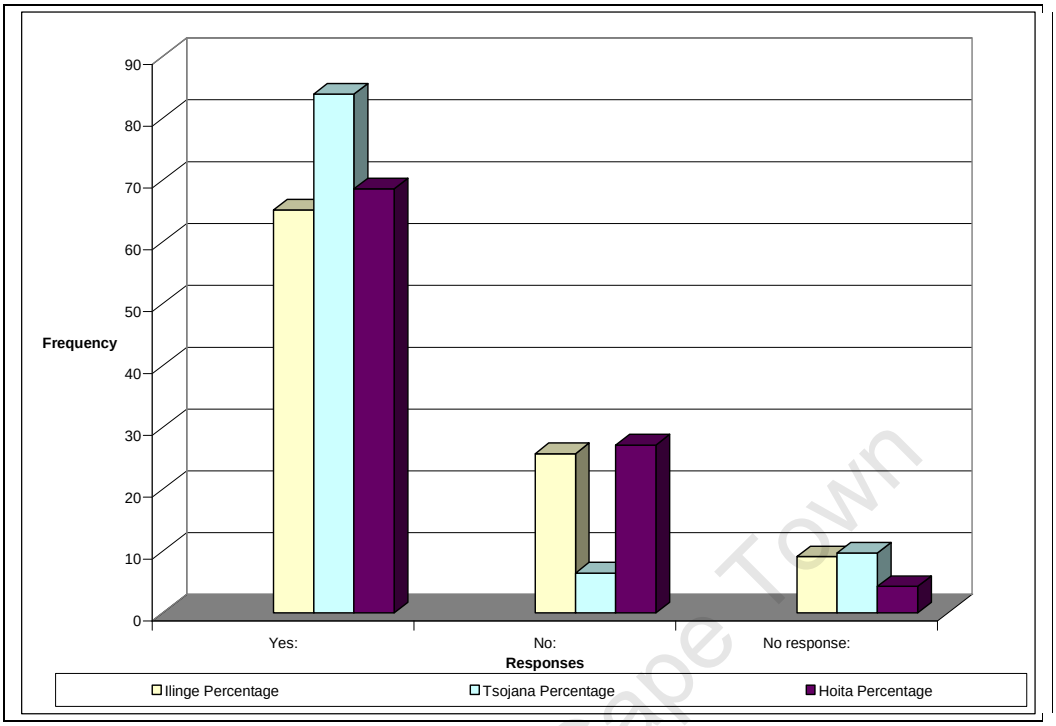

Figure 5-6: Willingness to participate in a local community-based monitoring programme.

Awareness surrounding the frequency of municipal testing of the communities' water sources is not known. The respondents either claim to have never seen EHPs testing the water, or are just have no idea about the frequency of testing.

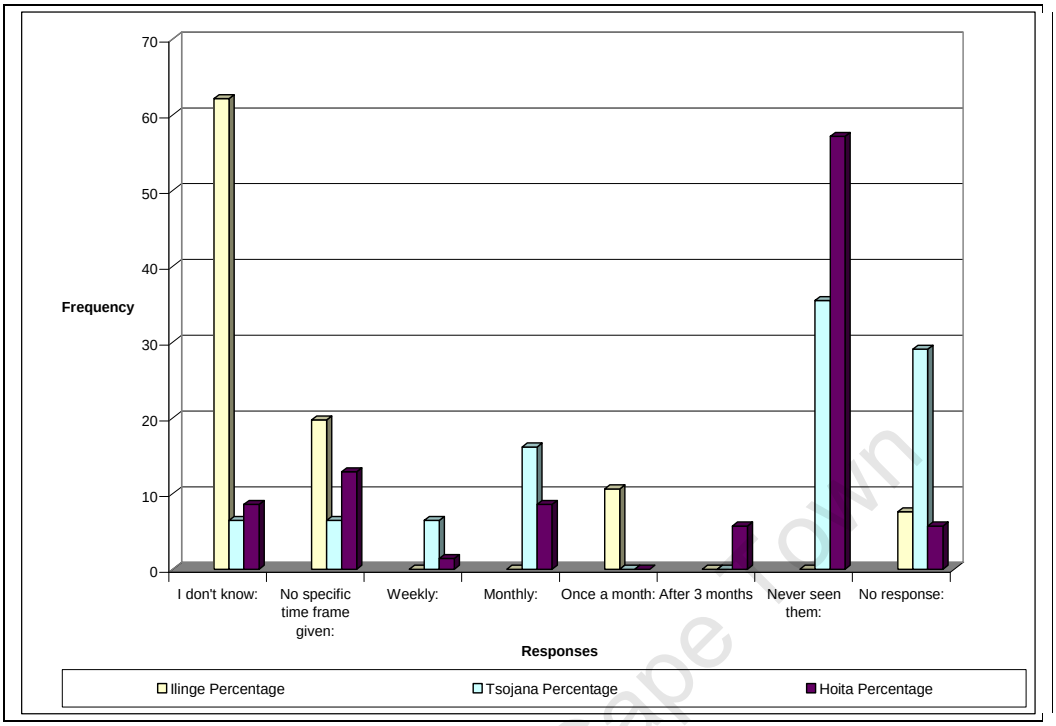

Figure 5-7: Frequency of testing water quality in the community

With regard to the frequency of children (under the age of five years) falling from water-related diarrhoeal infections, the majority of respondents in Hoita and Tsojana believe the occurrence of children falling ill never occurs within their community. 23% of respondents, in Hoita, cited the occurrence of infantile diarrhoeal infections being a common occurrence whereas in Tsojana, infantile diarrhoeal infections were cited as a seasonal occurrence. In Ilinge, however, the incidence of diarrhoea in children occurring is largely not known as 38% of the respondents could not respond to the question.

There is consensus amongst all three communities that the quality, with particular emphasis on the taste of water, varies with seasonal changes. This coincides with information obtained from municipal officials, who regarded changes to water quality, particularly after periods of heavy rain, to be a concern (Mzayiya, 2007). In Hoita, 51% of the interviewees agree that the quality of the water changes with the seasons compared to 52% in Tsojana. One respondent cited that in winter the water is “scarce” and “brown” in colour. An-

other commented that after the summer rain, the taste of the water changes. This alludes to the non-chemical parameters that affect water quality; *i.e.* the rainfall/runoff. Ilinge is the only community where the majority of respondents (58%) do not feel that the quality of the water changes with seasons.

4.8 General Observations within the communities

All rural schemes are supposed to be designed to Rural Development Plan (RDP) standards, which is 25ℓ per person per day and the walking distance to the facility should not be more that 200m (Gulwa, 2007 and Gcali *et al*, 2007). With the exception of Ilinge, which is peri-urban, the rural communities of Hoita and Tsojana often have water facilities further than 200m.

Please refer to Appendix F for pictures of the study area.

4.9 Summary of the Main Findings of the Study:

The Eastern Cape is located on the eastern seaboard of South Africa. The Eastern Cape faces a number of challenges. Firstly, its GDP per capita is far lower than the South African average. This is indicative of the extent of poverty throughout the region. Furthermore, unemployment in the region ranges from 16% to 85% in the rural areas. Approximately, 40% of people in the Chris Hani District are not serviced. This corresponds to information obtained from residents who claim to not have municipal infrastructure (*i.e.* water points) within their communities.

With regard, rural drinking-water quality schemes are monitored at the source. Within communities, however, there is little knowledge with regard to the frequency of such monitoring. Though there are water quality concerns within the communities of Hoita Ilinge and Tsojana, residents are still driven to use unsafe water sources because of: (i) a shortage of water, (ii) some respondents feel the water is “safe” and (iii) having “no other choice”.

There is consensus amongst all three communities that feedback regarding water quality of water sources is lacking. Furthermore, very little information is known about the occurrence of infantile diarrhoeal infections.

All three communities agree that the quality of water, especially its taste varies with seasons. This coincides with information obtained from municipal officials, who regarded changes to the water quality to be a concern especially after periods of heavy rain.

5 Conclusions and Recommendations

This chapter summarizes the information learned in this dissertation as well as provide recommendations.

5.1 Conclusions

Water quality is a growing concern globally. Owing to the numbers of people being affected by water-related illnesses, a need to examine the water and sanitation sectors and uncover innovative ways to improve the efficiency of practices surrounding and involving water quality including the testing and assessment methods, regarding its quality has arisen.

The process of evaluating water quality monitoring includes more than the actual microbiological -, chemical – and physical testing. Factors such as sufficient water supply, adequate sanitation and hygiene awareness play a vital role in reducing and mitigating the occurrences of waterborne illnesses. This dissertation has shown the importance and relevance to include these factors when assessing water quality.

OBJECTIVE 1: Overview of International Practices regarding water quality, the assessment and different testing procedures

The central purpose of monitoring and managing water supplies involves minimizing pollution which may be via microbial or chemical contaminants. Non-chemical parameters not directly linked to coliform analysis, such as rainfall or runoff, turbidity or pH should also be monitored as these factors can also affect the overall quality of water supplies. Although conventional methods of water quality monitoring involve a reliance on the end results of testing procedures, there are many varieties of pathogenic viruses and bacteria that

can be present in feacally polluted water. The surveillance of water supplies; therefore, should not only involve determining the microbiological and chemical aspects, but take into account actions to mitigate the associated health hazards.

The process to reducing the incidences of water-related illnesses can be achieved through hygiene and awareness education within communities along with effective procedures on a municipal level to ensure that monitoring and assessment of drinking-water quality meets the required standards.

The International guidelines provide information on the activities that should be carried out by local governmental authorities concerning microbiological, physical; and chemical parameters.

OBJECTIVE 2: Provide an overview of the South African guidelines, policies and regulations governing water resource management, with particular emphasis on water quality

Within South African legislation, such as the National Water Act and the Water Services Act, there is an overlapping of roles and responsibilities of stakeholders. A clear separation of activities is crucial to avoid conflict between different independent spheres of government. The Strategic Framework for Water Services acknowledges the overlap in the roles and responsibilities of different sphere of government. This document, however, is the working-manual for all stakeholders involved on water services and sanitation.

Though there is overlapping of duties, the national acts and legislation are explicit in their attempt to exemplify the needs of the public in terms of monitoring, assessment and the creation of an information system.

OBJECTIVE 3: Assess local conditions concerning water quality in the study area

The Eastern Cape is a province of South Africa that faces high levels of poverty and unemployment. These factors are compounded by unsafe drinking water. Approximately two thirds of the region is based in rural environments. Residents utilise borehole water, protected springs, or communal taps, which are the main source of water supply.

29% of all the municipalities in the province reported having copies of national legislation governing water quality monitoring, assessment and management. Despite these obstacles, however, the WSAs felt that they were complying with their legal responsibilities, as required through national legislation such as the National Water Act and the Water Services Act. Furthermore, Water Service Infrastructure is only monitored on a crisis management level as funding for preventative maintenance is lacking.

Within the Chris Hani District, 40% of their residents are not serviced. This can be attributed to outlying rural communities whereby financing of water infrastructure is too costly and not a feasible option.

82% of the water resources in the CHDM are abstracted from surface water and the remaining 16% comes from ground water (DWAF, 2006). Water in rural areas is generally characterized by partial or minimal water treatment, whereby isolated communities and villages without access to electricity or other amenities may make use of water directly from rivers or streams.

OBJECTIVE 4: Identify disease causation, patterns and prevention techniques used by communities

With regard to the three communities that were studied, there is little knowledge from the residents concerning the frequency of monitoring that occurs

within their community. Though there are water quality concerns in all three communities, residents are still driven to use unsafe water sources because of the circumstances they face, such as a shortage of water.

Across all three communities, it has been found that the majority of respondents, with the exception of Tsojana, improve the quality of their water, particularly, is they have concerns over its safety for domestic use. The main method of improving the quality is either by boiling or by adding bleach. Furthermore, the respondents were aware of the required measurements of 1 teaspoon of bleach per 20ℓ of water.

OBJECTIVE 5: Obtain an understanding of the community's perceptions and opinions regarding their water quality

There is overall willingness within all three communities to participate in local water quality monitoring schemes. Furthermore, there is consensus amongst the communities of Ilinge, Hoita and Tsojana that the quality of water, especially its taste, varies with seasons. This coincides with information obtained from municipal officials, who regarded changes to the water quality to be a concern especially after periods of heavy rain.

OBJECTIVE 6: Identify the key issues in the established system of water quality monitoring

All three communities believe feedback regarding the quality of their water sources is lacking. Though concerns over the quality of the water were raised, during the survey, residents are still driven to use municipal-authorised water sources. This is because: (i) they have "no other choice", (ii) the water is "safe" or (iii) there is a shortage of water within the community.

Very little information is known about infantile diarrhoeal infections. As a result, residents are unaware of the overall health of their communities or the conditions of their water supplies.

5.2 Recommendations

This section identifies key recommendations, based on research as well as the analysis of data obtained from the questionnaires that were carried out in the study area.

- Community-based monitoring is an important step that should be taken between the local authorities and the community. This is necessary and important to build capacity and strong relationships between both parties. Though residents may not be able to carry out the testing methods and assessments required, by legislation, their input and ownership regarding the water supplies needs to be initiated, in order to prevent occurrences of contaminated water. Furthermore, support from the overseeing authority is essential in order to make rural schemes sustainable.

- During the interview process, it was found that female respondents provided in-depth information regarding domestic practices and occurrences of illnesses. As a result, it is the opinion of the author that empowering and inclusion of women in monitoring schemes would prove most beneficial.

- Increased financing to local municipalities is vital to ensure water service infrastructure can be developed in unserviced rural areas and operation and maintenance functions can be conducted in areas where water supply schemes have already been implemented.

- Educational hygiene awareness campaigns should be conducted in the communities, as an on-going process to alert residents to potentially hazardous practices regarding collection, storage and usage of water that can affect their quality of health.

- More communication and regular feedback on a local level between local municipalities, clinics/ hospitals and the community is needed. The lack of communication between these groups serves to hinder progress to improving the current situation.

- Despite the National Water Act and the Water Services Act describing the information system by which to collect and distribute water quality information, obtaining water quality and health statistics on the region, even on the internet is difficult to achieve. Though various internet web-pages, showing the districts, regions and communities, were found on the DWAF website, information and statistics on the study are not available. It is therefore the opinion of the author that the "information" referred to in National Legislation is made public via all available media, such as the internet.

- Regular feedback regarding statistics with respects to water-related illnesses should be available to the community either via the councillors, water committees, village chief or water operators, due to the reliance on these individuals by the community.

- In-depth studies measuring the attitudes and perceptions of communities across the region of the Eastern Cape should be conducted, whereby a representative assessment can be made concerning the communities and their water supplies.

This thesis outlined the global challenges in meeting the MDGs, South African legislation regarding water quality monitoring and management, information on

the important water quality parameters that are tested, as well as the problems and challenges facing the Eastern Cape of South Africa.

Throughout the research process, it became evident that the most important component in water quality testing is the **people** that are being serviced. As a result, it is the opinion of the author that communication between municipalities and communities is crucial, as without their participation and co-operation, no project or study can ever be feasible or sustainable in the long-term.

In particular, rural water schemes should be more community-orientated, especially with regard to feedback on the quality and condition of water sources. The study showed that residents were not fully aware of the condition of their water sources or the frequency of diarrhoeal illnesses occurring in children under 5, owing to a lack of feedback from municipalities and clinics.

Though there are challenges and obstacles to be faced with water quality testing and the financial constraints of municipalities, emphasis should be placed on on-going educational awareness campaigns surrounding domestic water practises to help mitigate instances of outbreaks of preventable waterborne illnesses.

It is the hope of the author that this body of work serves to educate and inform the reader concerning the water quality issues facing the Eastern Cape.

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7 Appendices

Appendix A

The Millennium Development Goals (MDGs) are achieved by 2015. They are drawn from the actions and targets contained within the Millennium Declaration that was adopted by 189 nations-and signed by 147 heads of state and governments during the UN Millennium Summit in September 2000.

The MDGs break down into 21 quantifiable targets that are measured by 60 indicators.

Goal 1: Eradicate extreme poverty and hunger
Goal 2: Achieve universal primary education
Goal 3: Promote gender equality and empower women
Goal 4: Reduce child mortality
Goal 5: Improve maternal health
Goal 6: Combat HIV/AIDS, malaria and other diseases
Goal 7: Ensure environmental sustainability
Goal 8: Develop a Global Partnership for Development

Goal 7: Ensure Environmental Sustainability

The indicators

Target 7a: Integrate the principles of sustainable development into country policies and programmes; reverse loss of environmental resources Target 7b: Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss.
7.1 Proportion of land area covered by forest 7.2 CO2 emissions, total, per capita and per $1 GDP (PPP) 7.3 Consumption of ozone-depleting substances 7.4 Proportion of fish stocks within safe biological limits 7.5 Proportion of total water resources used 7.6 Proportion of terrestrial and marine areas protected 7.7 Proportion of species threatened with extinction
Target 7c: Reduce by half the proportion of people without sustainable access to safe drinking water
7.8 Proportion of population using an improved drinking water source 7.9 Proportion of population using an improved sanitation facility
Target 7d: Achieve significant improvement in lives of at least 100 million slum dwellers, by 2020
7.10 Proportion of urban population living in slums

(UNDP, unknown date)

Appendix B

Different levels of surveillance

Table B-1: Characterisation by levels of the level of activity with regard to surveillance development (WHO, 1976)

Level of surveillance	Description	Country situation
I	Initial	Proposed programme for use in developing countries where no formal surveillance programme exists
II	Basic	Proposed programme for adoption in developing countries that have nominal programmes with limitations with regard to the scope and effectiveness.
III	Interim	Proposed programme for use in developing countries that have established surveillance programmes only within major cities
IV	Intermediate	Proposed programme for use in developing countries that have nationwide surveillance programme and are seeking to increase the effectiveness.
V	Advanced	Programmes that are similar to established programmes within developed countries, where water-borne diseases have been eliminated.

Table B-2: The principle activities for the different levels of services provided by surveillance agencies (Adapted from WHO, 1976)

Activity of the surveillance agency	**Level of surveillance**			
	I	**II**	**III**	**IV**
Law, regulations and policies	Basic	Basic	Basic	Complete
Drinking-water standards	Bacterial testing only	Bacterial – and physical testing	Bacterial, physical and chemical testing	International equivalent
Technical assis-tance	Limited	Passive	Special cases	Active
Staff training	In-service training	In-service training and short courses	In-service training and short courses	In-service training and established technical institute
Waterworks	None	Seminars	Seminars and short courses	Seminars and established technical institute
Sanitary Inspec-tion	In major cities only	All cities	All cities, and some rural areas	All cities, and most rural areas
Sampling and monitoring	Major cities	All cities	Urban areas	Urban areas and special rural areas

Standard methods of analysis	Bacterial - and residual chlorine testing	Bacterial -, residual chlorine - and physical testing	Bacterial -, residual chlorine -, physical and chemical testing	International equivalent
Establishment of laboratories	Use of existing facilities	Central laboratory	Regional laboratories	Regional laboratories with fully equipped reference labs
Design standards criteria	Advisory		Informal	Formal approval

Appendix C

Table C-1: Chemical parameters that can have negative health effects on humans (DWAF, 1998).

Chemical Parameters	Description
Nitrates and nitrates	Common in groundwater (especially bore-hole water) – particularly in areas of in-tense agricultural activity or where pit la-trines are used. Negative effects – Toxic effects can be seen in infants.
Fluoride	Often raised in groundwater in hot and arid areas. Negative effects – Damage to skeleton and marking of teeth
Sulphate	Common in mining areas. Negative effects – Diarrhoea (especially in users no accustomed to water with high Sulphate concentrations).
Chloride	Often raised in groundwater in hot arid ar-eas. Negative effects – Nausea, vomiting (at very high concentrations)
Arsenic	May be present in groundwater especially in mining areas. Negative effects – Arsenic poisoning
Cadium	Usually occurs along with Zinc in acidic waters where it may have been dissolved from appliances
Copper	Affects the colour of water Negative effects – Can cause upset stom-achs
Manganese	Main cause for the discolouration of fix-tures. Can be common in bottom water of dams or mining areas.

Chemical Parameters	Description
Zinc	Usual cause is acidic water dissolving zinc from galvanized pipes. Negative effects -Affects the taste of water.
Iron	Affects the taste of water and may cause reddish-brown colouring. Negative effects – May cause growth of slimes of ironing-reducing bacteria that appear as black flecks in water.
Potassium	Affects the taste of water. Negative effects – Bitter at elevated concentrations
Sodium	Often raised in hot, arid areas especially in groundwater Negative effects - Affects the taste of water.
Calcium	Causes scaling and can reduce the lathering of soap.
Magnesium	Affects the taste of water. Negative effects – Bitter at high concentrations Common in areas in some areas it adds to the effects of calcium.
Total Hardness	Combination of Calcium and Magnesium Association with scaling and inhibition of soap lathering.

Table C-2: Chemicals derived from human settlement (Thompson *et al*, 2007).

Source Category	Activity	Source Description	Target Water Body	Chemicals of Concern	Comments
Point Source	On-site Sanitation and sewerage	Sanitation facilities – including sewerage plants	Surface waters and groundwater	Nitrates and Ammonia	Pit latrines of individual houses should be considered as diffused point sources
	Waste disposal sites	Waste disposal sites	Mainly groundwater	Nitrate, ammonia, and other chemicals associated (may possibly be industrial waste)	Past disposal sites can still be a concern, particularly industrial wastes. They are more of a concern compared to domestic wastes. Chemicals can affect surface waters as well as groundwaters.
Diffuse Point Source	Fuel Storage	Fuel stands, industries *etc.*	Mainly groundwater	Petroleum, hydrocarbons, benzene	Attention should be paid to past and current trends.
	Chlorinated Solvent Use	Industries, cleaning businesses *etc.*	Mainly groundwater	Trichloroethylene, trichloroethane, tetra-	Attention should be paid to past and cur-

				ethylene.	rent trends.
	Urban activities	Industries, public facilities and individual houses	Surface waters and groundwaters	Unspecified	These chemical contaminations are important where no adequate sewerage systems are in place
Non-point Source	Urban runoff	Roads, roofs, open spaces and other sources relating to urban activities	Surface waters and groundwaters	Nitrate, ammonia, heavy metals, pesticides and organic chemicals	Deposits from dry-weather periods are flushed out with rain-water runoff.

Appendix D

Figure D-1: The Eastern Cape Province of South Africa (www.places.co.za).

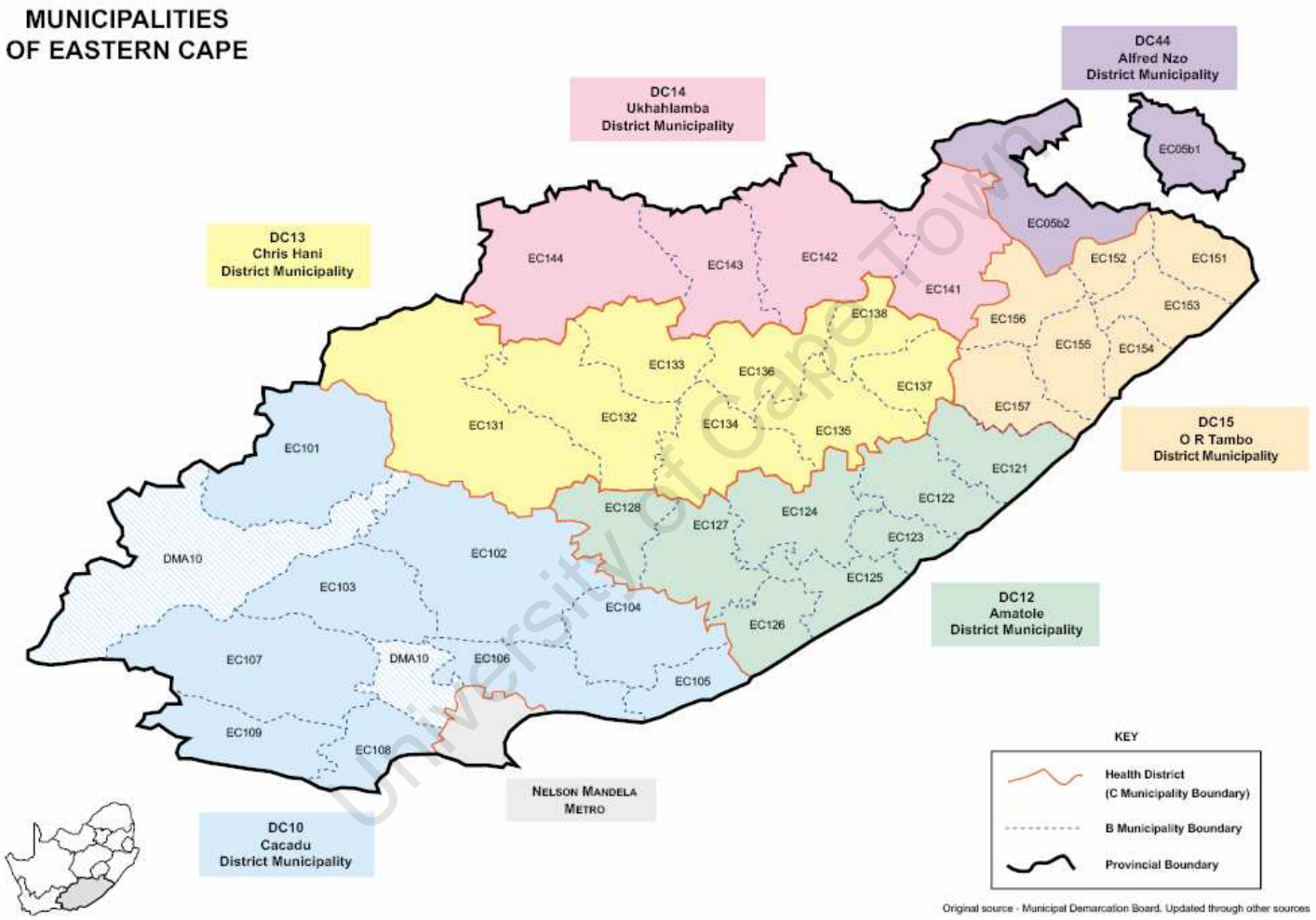

Figure D-2: The District Municipal boundaries of the Eastern Cape (SAHR, 2002)

Appendix E

Community Questionnaire

1. Who do you contact in your area, if your water sources are polluted?

2. If the water is polluted, how long before anything is done about it? What is the longest or shortest period before the relevant authorities acted?

3. Do you use water sources/points that are not authorized by the municipality?

Yes
No

If the answer is yes, what drives you to use these water sources?

4. How do you identify if a source is polluted?

Colour
Taste
Odour

Are there any other factors that alert to the possibility that the water source is polluted?

5. Do you try to improve the quality of the water, if you are using an unauthorized water source?

Yes
No

If the answer is yes, what do you do?

6. Do you feel the quality of the water you receive is safe?

Yes
No

If no, what do you think can be done to improve the situation?

7. Would you be willing to participate in a local community water monitoring scheme?

8. How often do the municipal officials test the quality of your water sources?

9. How often to children get ill as a result of contaminated water?

10. In your opinion, does the quality of your water change with the seasons, *e.g*. in summer and winter, are there any significant changes?

Appendix F

The photographs shown in this were taken within the rural communities.

Figure F-1: The rural communities within the Chris Hani District – displaying the dispersal of households in the area.

Figure F-2: Animals drinking water from the sewage ponds (Ilinge).

Figure F-3: A person collecting from a polluted and murky-looking water source (Del Rio; and Foyaca-Sibat, 2005).

Please Note: *This study (and the image) was conducted by Del Rio and Foyaca-Sibat, within a rural village of South Africa. Though the study area differs from that of the communities studied in the Eastern Cape, the conditions and challenges faced by the residents are the similar.*

Appendix G

Interview Transcripts: List of Interviews

Date	Organisation	Interviewees
22 May 2007	Amatola Water, East London	Noshipo Gulwa
23 May 2007	Makana Municipality, Grahamstown	Pinkie Hermanus
23 May 2007	Buffalo City Municipality, East London	Deanne Karshagen
24 May 2007	Chris Hani District Municipality	Francois Nel
24 May 2007	O. R. Tambo District Municipality (Service Provider)	Booi Malgas
25 May 2007	O. R. Tambo District Municipality	Eric Mzayiya
25 May 2007	Alfred Nzo District Municipality	Mthetheleli Gcali, Nowthando Chongo, C. M. Qomto.

These transcripts were conducted with Melissa Loudon, who was a fellow Masters student at UCT. The interviews were conducted together.

Interview with Noshipo Gulwa - Amatola Water

NG - Noshipo Gulwa

ML – Melissa Loudon

SK – Sarah Kiggundu

NG: You see in this area, which is like East London and around, there isn't really. Most of the places here have got potable water from the distribution system. Even in rural areas, even Amatola Water you know have got water works that they are managing, even in rural areas. So, there isn't that much problem here of water quality. But now, as you go to former Transkei – from East London, go to Butterworth – from Butterworth, then you will find there's lots of rural communities who doesn't really have water supplies. In East London you not gonna see people from the municipalities, besides Deanne? Because Deanne is just a laboratory manager. The people who work with communities are the people from – what's this name... Ey, they've changed all these names!

ML: We struggled with that too!

NG: Amatole. Amatole District Municipality.

SK: This is Amatola. The Amatole region is near to the coast.

NG: The head office is here in East London.

ML: Would you be able to give use a contact number by any chance? [To SK] Could you find a contact for them?

NG: Because my concern is that us at Amatola water, much as we are managing quality of water, we are managing the quality of the water that is produced from the water treatment works, and supplied to communities. Meaning we know about communities who have got water supply. Most of them have got water supply – I think 80% of the rural areas here have got water supply. But now, as you go, take this other direction and go to the former homelands you see, they don't.

SK: How do they get water? The ones who don't have water supply.

NG: They go to the rivers, or to natural sources like springs.

SK: Which is, clearly the water isn't tested

NG: Obviously, it's non-potable water.

SK: How come they haven't been supplied yet?

NG: I'm also asking that question.

ML: I'm sure they are, too.

NG: You see in South Africa now, water provision has become a political tool. But even then, I think the service delivery is too slow. We need to acknowledge that.

SK: Why do you think it is slow?

NG: If you go to the municipalities they will show you their IDPs and so on, all their plans. To do all this, provide water, sanitation, this and that. You will see that there, but it doesn't really happen for reasons I can't really understand. I don't know how municipalities spend their budget on services. But, we need to acknowledge that our current service delivery is too slow. And unfortunately, in the areas it's affecting the people.

ML: You said that in a lot of the municipalities, a lot of the communities in this area have their own water treatment works.

NG: In this area, these communities, Newlands and all, they are supplied by these water treatment works, so even if they have standpipes, they are getting treated water. An on the other side, the big township, Mthanzane, it's the second biggest township in South Africa, they've all got electricity, they've all got water supply. There are a few areas like squatter camps, but they've got standpipes as well. So, from my side and Amatola Water's side, as much as I would like to help.. So, I'm not saying that I can't help, but you see, my knowledge is quite limited...

ML: No, we understand. your opinion is still very valuable to us, you still know far more than we do about what might and might not work. Would you mind still having a look at the system?

NG: No, no fine.

ML: The system that we are demonstrating isn't necessarily targeted at the most rural areas either. If there were community-managed supplies, that maybe treat their own water – does that happen?

NG: Ah, I guess, yes.

ML: That might be someone who would use the system.

NG: You know, there are community organizations, which are called community-based organizations, and in some, they are called water committees, and those people there who serve in those committees, what they do they are there, they have been, I'm not sure if they are appointed through an election process or nomi-

nated or whatever, but they are there in the communities. If there is water supply in the communities, maybe there is a borehole, or there is a pump, even in some that are piped, pumps water to wherever, they are taught to go check the diesel, to do all the minor operation and maintenance of the whole system. and I think they are getting a, like a stipend from the municipalities. And also you see in the rural communities in some there is vandalism.

And in cases where there are no water supply sources and people use rivers, that's where some municipalities, they will provide them maybe with chlorine tablets, to say, go get your water, maybe in a 25 litre bucket or whatever. Or say there is gonna be a big function, like weddings or funerals, where they must cart these large volumes of water, say a 50 litre drum, either they supply them with those tablet or they offer some kind of a service to say, use Jik, maybe pour so much of Jik and leave it overnight, just to make it a form of treatment, because you know that if water is not treated it can cause problems. But I know it is happening in rural areas and in some where there are no water committees or CBOs, there are local chiefs, people who look after the functioning of the area and then those people there are the ones who go maybe, because people like you do some research they come and they get together with them and they supply them – 'just try this maybe, we doing research.' Or if they offer what's this, Aquatest, so do this maybe every 15 litre drum. So then people get to know about these things. other than that, there is old ways of boiling water and some, if they can't boil the water, they use a clean cloth just to try and sieve through the water – just those old traditional ways, and I must say that they are really happy to get any assistance, in whatever form, to help them improve their water quality, because they are aware of the water quality problem. There are the ignorant ones, that will say Ah, we drink this water for years, and nothing has happened. So I think going out there, you could get a very broad picture, and get different opinions from different people. Political, cos some will tell you, I remember when we went to some village, some people there, they will tell you – that other village on the other side has got water supply, but they don't have. And then people start yelling at you and voicing their concerns. When you come

and talk about water it's a political issue, it's a resource people need. Some voice their concerns, some are prepared to listen to what you have to say, some are not they just want to have water supply, that's all that they want.

SK: How can water be a political issue if the national water act they are saying that water is a basic human right?

NG: It goes further, the water services act says that we will provide water, you need to monitor the quality of that water. They don't do it, the municipalities are the government entity, they are part of government. Even those who provide water, the moment they put it in, a rural water source in, maybe it's a borehole source or whatever, that's the last time. They leave it for the people to drink, and they don't care about monitoring it. So, if you say, it's a good question that you are asking, but I must tell you I don't think you will have an answer. If you've got an answer, email me from Cape Town and say, somebody else managed to answer me convincingly. They will tell you that it's the budget, it's the money, it's the challenges that they have. Technical, human resources they don't have. You see all the stories that you'll get!

ML: I think maybe one of the things, one of the ways we could approach it is to say that, this kind of system, including a really low-cost, low-resource test for microbiological water safety, because it wouldn't test for very much else, it would just tell you whether the water was safe to drink or not

NG: Is it in the form of a tablet or what?

ML: It's a test in the form of a

NG: You don't have one?

ML: I don't have a prototype and it's not developed yet. Um, it's in the form of a kind of tube.

NG: So they have run trials?

ML: They haven't yet run trials, no. What we are involved in is a pre-study, and they are now hoping to get funding to develop the full test. Um, but what we would focus on asking I suppose is, If you had this test, and then you had a system that was, that helped you to manage the results, would they maybe, if they could give the community schemes with the borehole a phone to go through a sanitary in-

spection and they do it every month, and then every month those results would be received by sms, would it maybe help them to manage the process.

NG: Yes yes it would help. Because one of the things that you must understand, it's a pity there is no map here, is that the municipal office, head office or whatever is sitting here, and the area of their operation is so wide, you find that maybe it's in a radius of about 200km, and then it's not even physically possible for them to drive to those places every now and again. That's another thing, it's quite an expensive exercise because they must claim back from the municipalities all of the kilometres travelled. And with an area so big, you can't really be in the same, at all these places, so that's also... So if now there's a system so that even the communities are able to say, yes we've used this and this is the result, then they would welcome that.

ML: That's great. Well then can I show you the prototype,

NG: Ok before we do a lot of taking!

ML: No, no talking is fantastic and you've already given us a much better definition of what the problem is than we could have come up with ourselves, so that is very helpful to us. Um, the first thing I have to show you (sorry that my phone rang, I had it on because I wanted to show you the little application on it). Um, this is a very rough prototype application. This is just the first screen telling you what it is. Just press ok to go – that's the ok button. It will now ask you to enter the name of the site – you can enter anything there – as far as I understand, if there's a borehole put in place it should have an identifier attached to it.

NG: Mm. It could be a code, and then there could be a full description.

ML: With the community name, or

NG: yes

ML: And then they would enter that [leaving out some demo bits here] And say now, you've done the test, and you've got a result, you could put in whatever numbers you get as the result.

NG: Does it do turbidity as well?

ML: Um, this test doesn't do turbidity, so I looked at some examples of what you could be measuring, I don't know how you do actually measure turbidity.

NG: You do actually get some portable tests

ML: The last thing on there is the sanitary inspection form, and this is one for a protected spring. So they would then go through all of these and hopefully check everything here, and say well yes we've got a problem um,

NG: What if this is a river?

ML: There'd need to be different ones for each source type, so if they have..

NG: How do you select them then?

ML: I've only written on for a spring, but it would be the same thing it would just have different questions. It would just have all the questions for a river.

NG: Ah ok.

ML: And then when you're finished, it doesn't do it, it just shows you what you've entered and then it'll send it over SMS into your central database.

NG: You've also developed that central database?

ML: Yes. So this is what's on the laptop, um... And then after that, the community would maybe get an SMS back saying um, your reading were successfully received, and what might also be possible is to then say, um your readings have been successfully received and we see that you've got a problem with one of the questions that was on the sanitary inspection and this might be some remedial action you could take. Like, put some chlorine in your water, you seem to have quite a high E.Coli reading, or something like that so it could actually help the community.

NG: Who is funding this research

ML: The EU, the Aquatest project

NG: Why do they want to only do it with the University of Cape Town?

ML: I think because we're focusing on the data management aspect, and data collection.

NG: Is this a national project?

ML: No, we're actually just coming to the Eastern Cape for this pre-study, but for the follow-up project when they have actually developed the water test, then I think they'd like to look at other areas.

SK: [Explains why we chose the E.Cape, but she's too far away to hear her properly]

ML: This is the application that shows you the readings in the database that I've developed. And how it would get the readings in is that there would be just a little modem like the modem that connects to the phone line, except this modem would be receiving SMSs, so it would have a SIM card inside and received SMSs coming in from sites that would use the application on the phone. Um, and then this you can, these are all the samples that have been taken. This is the Northern Province up near Venda, because this is where a previous project took place and I have their data. Um, these are all their sample sites – they are quite close together because these are actually household samples. And then you can look at a site, click on the site and then see what the name of the site is, and have a look at the samples that have been taken there. These are colour-coded, so the samples that would be something to worry about are in red, so all these samples came out as something to be concerned about, they're quite high.

NG: This is what, here is E.Coli, and what test did they use?

ML: This is the data they gave me, it might not be correct. They randomized some of it.

NG: How did they measure it, for you to have a .65? Because even a lab, maybe the MPN method. No, that's impossible.

ML: Ok but the data in there isn't proper data, it's just to demonstrate how the system could work.

NG: Ok, ok.

ML: I did get their data, but I don't know how they got their results. And then this is some graphs of the same data so you can see also, with the same strange readings.

NG: What confused me; in most cases you'll find the total coliforms should always be greater than E.Coli

NG: So you've developed the software.

ML: Yes

NG: Is it developed for this purpose only or?

ML: Yes it's using a free map viewer software and then I've written special modules for water quality management. Um, but to be used in practice by a municipality obviously it would need a few more features and we would need to do a lot more interaction with the people who would use it, asking them what would be useful to them and what would help them, but this is just a prototype to show you the concept.

NG: It is a good one

ML: That's great to hear

NG: I'm actually impressed, it's similar to these other systems that you do find

ML: Ok, um cos what we were thinking of maybe doing with it was taking this then as a proposal to the water research commission, and saying we'd like to develop this system that could then be given to all the municipalities

NG: It's a pity I'm not, I wasn't there – there is a system that was developed for DWAF, but my understanding was that... I missed the presentation. In fact the reason why I didn't go is because we've got our own system LIMS here, but that one it is linked to the DWAF head office, so they do all their reporting of all their water quality data and all their results, it goes straight to the DWAF national database.

ML: Maybe what we should put in our project then as a better proposal, maybe we should say that we could develop a cellphone-based reporting tool that would link to that system

NG: The advantage of your system is the cellphones yes

SK: It would also help to get the community more involved in water quality. I would think that if you are supplying water to the community, especially a municipality for example that doesn't have the manpower to be able to track people up. That gets the community to believe more in the municipality

NG: Mm. And they aren't reliant on the laboratory, that would also help them. And there are no laboratory facilities.

SK: How long does it take to test your water samples on average.

NG: For E.Coli and such? Lets say, overnight.

ML: I've just got a few more general questions about water quality. [Questionnaire]. Do you think security of a phone would be a problem in a rural community?

NG: No, most people have got cellphones now

ML: Language: for a local community, an English menu like that wouldn't be much use, it would be better to have it in Xhosa?

NG: No, not English

ML: Do you have any idea how much the two systems you've described, LIMS and the DWAF water quality system, could cost?

NG: I'm not sure about the DWAF one but LIMS is quite costly. It's a private system, i think even here to get it was about R76 000, and we're still paying annual fees, and every year there comes a new version, you must upgrade, and the support system they give is also not free. Although for us in the lab it is very useful.

ML: You saw that this was running on Ubuntu and not on windows. One of the things that we are quite focussed on is Open Source software. Because we would be developing this with research money, it wouldn't be right to sell it to people, you'd have to give it away for free. So that's something we would focus on is making it really affordable.

I've got quite a few questions on how often you monitor various sources, but you say it's mostly you monitor the distribution system.

SK: Do you monitor the dam and the treatment works?

NG: Yes

ML: Do you monitor at point of use – what comes out the taps?

NG: No. Reservoirs once a month, water treatment works at least 10 times a month. We are guides by SANS 241

ML: And household water:

NG: Not really, we take from the reservoirs and treatment works not from houses. [more questions about what is monitored – see standard]

ML: You obviously don't do a sanitary inspection, but would this be something that would be done at a borehole for example

NG: Only when there are problems, that would be part of your investigation.

ML: Have you ever had problems, where there has been for example a diarrhoea outbreak and someone has come to you?

NG: Not from this side, but it know it happens around. In rural areas often. There was a cholera outbreak.

SK: Andrew Lucas told me there were 3 cases of typhoid this year, 1 confirmed and 2 unconfirmed

NG: That could happen.

ML: But that would be more likely to happen when people were getting water from rivers, or from an unmonitored borehole too?

NG: No, I don't think boreholes.

ML: The other questions about reporting. Who do you report to – you said the DWAF water quality management system reports directly to their system in Pretoria.

NG: We report to DWAF, because DWAF has a system. We forward all out test results to DWAF

SK: So do all the municipalities in the Eastern Cape send it to the person who co-ordinates water quality for the Eastern Cape, and then they send it to DWAF?

NG: Mm. We go through DWAF

ML: So you don't spend a lot of extra time preparing results for DWAF?

NG: Us no, because we just extract it from our LIMS system. It's 2 minutes extracting and emailing.

ML: So the reporting in that system is very useful to you. So you would say that any system we develop would have to have quite good reporting?

NG: For those that don't have, yes.

ML: Is data security important?

NG: Yes, otherwise people might modify the data for whatever reason.

ML: Ok, so is the main reason for data security to stop people modifying your data. If people could see the data but not manipulate it, would that be a problem?

NG: It depends. I personally feel that it should be the way, people should know. But for some reason some people don't want that kind of transparency. I don't know.

ML: Ok so you would be more concerned about people getting in and modifying the data?

NG: Yes

ML: Has HIV/AIDS had an impact in the area that you've noticed?

NG: All social problems have got an impact. HIV/AIDS, poverty, drug abuse, all those things. If you go to communities you will see for yourselves, but really it is does have a negative impact. You'll find that maybe those people who have been trained, to manage this operation they have, a borehole system or what. They fall sick – who is going to do this? Things like illiteracy in the rural areas. You are lucky to get people who can use the system, you would really love to keep those people, but due to those other things – poverty, maybe they leave to look for work, or maybe they fall sick due to HIV/AIDS, it would really be a problem.

ML: That's useful for us to know, because it means that any system we develop we would have to make very easy to learn.

NG: Yes, it must be a very user-friendly system. Very simple.

NG: The other place that you could target, I think you could target schools. School kids are eager to learn.

And it may be that the school you could give a cellphone for them, and then the kids could be given a project, say maybe this is July, the grade fives do all the water testing. It would be nice. School kids are so enthusiastic, listening, asking questions, eager to learn wanting to do things themselves. In some villages, you find that even if they asked, you will give a date that you are coming to talk about water quality, and only 3 people turn up. If it was food parcels, then the whole area will be there. That's the reality of things, I'm not saying don't do your work, but these are the kinds of things you must be aware of. In that case it's easy to cover schools, you know you will find the kids at school.

ML: I don't really have any more questions, but you've been very helpful and you've answered most of them without me having to go through the questionnaire.

NG: Ah wonderful, good to know. I was really worried, I wondered if I would be of much help.

ML: No, very much help, We obviously still need to go to communities and go to local municipalities where there are boreholes in the area and that kind of thing,

and in the follow-up to this we would have to do that, but as an introduction to the problems they face you've been very helpful, thank you

NG offers to help further if she can. ML says she'll send a copy of the report.

NG: Say for instance there is a municipality, they've got all their sampling points they've got everything, but they don't have a reporting system. Would you be able to assist them?

ML: Yes, I think in the follow-up project that is something we would need to do and would like to try and do.

NG mentions that there is someone in Barkley East looking for a system. She will email him and copy ML.

Interview with Pinkie Hermanus - Makana Municipality

PH: Pinkie Hermanus

ML: Melissa Loudon

SK: Sarah Kiggundu

Intro: Melissa introduces the project, the IT system and the aims of our research.

ML: You are Makana municipality and you supply water to Grahamstown. What other areas do you supply?

PH: We supply Grahamstown with water but from different sources

ML: Are they non-piped supplies like boreholes and or do people use springs?

PH: There are boreholes in Alicedale, Riebeck East.

ML: And as far as rural communities in the area? What water supply do they have?

PH: I'd say in terms of Grahamstown, we do comply but we still have a problem with Rub Riebeck in East. We are about to employ ....(can't make out what she says here).

ML: Does everyone in the area receive water from a supply that you manage or are there people who get water from rivers?

PH: In terms of Grahamstown, we have piped water supplies. We have the outside areas, like some farms, which specifically, we do not supply. There are farms that have water tankers and we fill the water tankers for them. There are other who

don't have those tankers, which in the mean time, I would not be able to say. I think some of them use boreholes, according to the farmers. The farms are privately owned so we don't supply water for them.

ML: So it's not your responsibility to monitor those boreholes? Do you monitor private boreholes?

PH: We're not involved.

ML: In terms of community-managed supplies, are the community managed supplies in this area?

PH: No.

ML: As far as monitoring goes, do you manage your supply system and your distribution system? What monitoring do you do?

PH: In the meantime, we don't have a lab for chemical and biological testing. We have a small lab that we use for physical testing. We've got shifts, per day. If we're talking about the other reticulation, we're doing that once in a month. Then there is the Nelson Mandela Metro which is Port Elizabeth (PE), coming down once a month to test for chemical and biological.

ML: The people who don't get any water from your distribution system, like in the other towns, does as much monitoring take place there?

PH: We do monitor all of them.

ML: As far as reporting, what reporting to you do?

PH: We're doing reporting on the basis of the results- the physical and the chemical and micro. But there is a system now that we have to log onto. You input the data into the system. During the course of this year, some members of DWAF came by to take some samples in our purification works, because they were no longer accepting the results. They came down to take the samples on their own and those samples are taken for testing wherever. Then at the end of the day, those results were recorded on the system. We're still struggling to get into the system. One guy was scheduled to come, last week from DWAF, to come and assist us to log onto the system, but they haven't come back to us. We have our results at hand, but we're still going to use the system.

ML: That system, have you seen it? Has anybody demonstrated it to you? What are your views on the system?

PH: I just know that we have to report on it. I tried to open it and it wanted a login password and unfortunately, we didn't have those until "this guy" (representative of DWAF) came in at the beginning of this month and he gave us a login. They had to come and give us the training and understanding of the system. We're unable to get into the system now!

SK: When exactly are you supposed to start reporting your the results through the system?

PH: I'm not sure. We were supposed to start....I don't know but it's either towards the end of last year to the beginning of this year. We went to a meeting in PE and it was just an integrated water services meeting and that's where it was mentioned that the WSA are not reporting but according to us, here at Makana Municipality, we were not aware that we had to report because we were still waiting on the WSP to come back to us to say to us: " we've taken the information. The information has already been fed into the system. This is how you're going to get into the system." So we didn't have any information. What happened, is that they came here and told us that DWAF is trying to implement a system whereby all the municipalities are going to report into the system and they are will be able to see those reports....but they didn't come back to us.

Melissa gives the demonstration.

ML: I don't know if it's in your area, but would you mind taking a look at it?

PH: It's not in my area since we at the municipality, don't have guys that are working on the .....(couldn't make that word out). We have a project that is coming up in one of the areas whereby we have a water purification worksite which is the one that is on the containers (not too sure that see saying at this part- it does not seem coherent). In the meantime, i would not say that that (the IT system) is applicable because they areas of ours are not being served with anything at the moment. The planning that we have for the future: we're planning to have something like the container system. There is another one: its a pumping system.

ML: But it's a point source and someone from the municipality will monitor it?

PH: You'll find that this area consists of farms and you'll find that the people on these farms are not educated to be able to do some of the scientific work.

Melissa continues to demonstrate the system.

PH: Do you think that community take an interest in their water sources? Do you think the farmers are concerned?

PH: I think the farm workers are concerned and they are owners, specifically, of those boreholes. In terms of our community members- even if you can have a document in place where they receive information on their quality, it is not their main concern (that is paraphrased from what I understood about what she said- it what I could make out!). When time comes, that you have a problem, it becomes a concern.

ML: Most people drink from safe sources except those on farms, who drink from maybe unsafe boreholes? Would you say there is a significant amount of people that are poor?

PH: I'd say 45% of people in this area are poor. As I've already mentioned, we are surrounded by farms. People come here looking for jobs in the town.

ML: so unemployment is also a concern Is HIV/AIDS a problem?

PH: I won't lie, I don't know. If for example, you use this system, it has to be simple. Most of the people, are uneducated.

ML: Obviously not in English but in Xhosa?

PH: I think in English. You'll find others that can speak in Afrikaans. Grahamstown, way back, was quite Afrikaans. (explaining the history of Grahamstown with regard to the language and workers migrating here!) Even the old guys that we work with, they understand Afrikaans.

Melissa concludes and thanks Miss Pinkie Hermanus.

Interview with Deanne Karshagen - Buffalo City Municipality

DK – Deanne Karshagen

ML – Melissa Loudon

SK – Sarah Kiggundu

[Before recording, we discussed giving consent for the interview – consent form was not signed, but verbal consent was given provided we supply a copy of the research to Buffalo City municipality.]

ML: As far as resource constraints. What would you say the worst are?
DK: I don't think there's any place that doesn't have, but we always.. As your size of your area extends, it becomes increasingly difficult. You have the same resources that you now need to spread over a larger area. Budgets don't always increase, and you budgets don't always increase in line with say rising fuel costs, so that makes things slightly more difficult. Particularly when you want to collect a sample from somewhere far away then you have to justify sending a vehicle to one very remote site, whereas you have a number of closer sites that you could possibly monitor more often. But, not to exclude remote sites.
ML: Would you say having sites over a wide geographical area is a big challenge?
DK: It's not necessarily the size of the area. I think it's also that rural areas are sometimes not as easy to access, the terrain might not be so easy so it's not a case of any vehicle will get there, you need the right vehicle to get there, so that adds on some additional limitations. But I think there will always be financial implications, it just depends on the situation.
ML: And as far as community-managed supplies, do you have cases where communities manage their own supplies, or do you have boreholes that the municipality might put in and then leave the community to do the maintenance, make sure there's fuel in the pump or whatever
DK: That you would have to ask, finer details you would have to get that from the water department because we on our side have a monitoring programme that we follow. And as we can add on additional sites we do add on additional sites. But regarding the operational side of it, I can't answer that.
ML: What we, the system we developed, and it comes from another project also in civil engineering which was giving home-based carers who visit HIV-positive pa-

tients a cellphone. so that when they visit a patient they can record information about how a patient is doing on the phone, and then they can send that information to a central database so the doctor can see it. So now we have developed a kind of similar thing using a phone to collect information for water quality monitoring, with that the community or somewhere near to the sampling point could go and do a test if they had the field test kit, and could then report on a cellphone and send their results over SMS to the municipality rather than having to drive all the time. And also then helping the communities to take more control over their own water quality.

DK: Ok, so you're optimizing things

ML: Ja, and that idea came from the international consortium saying oh, you are doing this with home-based carers, could you maybe do it with water as well. So where're here asking people who are a bit closer to the reality of water quality monitoring, how they think it would work or what they think would work.

DK: Well if I think of where our water is treated, um, primarily we're dealing with water treatment works that are not too rural, it might have a lot more application where they are far more rural, but at the moment we deal with primarily 2, 3 water treatment works. But rurally speaking I can see its benefit.

ML: Ok. Can I show you the system anyway although it might not be that useful to you, just to get your thoughts on it. Before I do that actually, we've been hearing a lot about another DWAF system

DK: The EWQMS

ML: Yes, have you had any experience with that?

DK: Yes. We enter data on a weekly basis. Um no not weekly... well we do enter weekly but we have monthly reports that are generated from it. So that is something we do currently enter data into, and that is very much a data entry but also it can be used as a management tool, which one can use. So, it's a very useful tool to then advise them on the water quality because they can then see provincially or nationally what the drinking water quality is like.

ML: And as far as being a management tool, DWAF use it as a management tool is it a useful management tool at your level as well

DK: Yes it is it's a very useful management tool because I believe it can send red flags when it picks up anomalous results. I believe, I don't know because I don't receive from them. It might depend on how you administer the system, I didn't go that far. It's very useful because you can see trends so a historical record. You can manipulate the data against certain parameters and then you can get a graphical output, so it does have a lot of advantages there. I actually think it's quite a good system.

ML: Um, knowing that the system exists and is working makes things a lot easier for us because we're not coming here saying, why don't you use an IT system when nobody has ever used one before and doesn't see the value in it. So it's nice to know that it's being used an being useful.

DK: I believe it will also grow into sanitation, but at the moment possibly only in the Eastern Cape it might have grown into sanitation in the other provinces I don't know, but in the Eastern Cape it's very much still in drinking water. Obviously the quality of your final effluents from your treatment works will impact on your drinking water quality downstream.

SK: When exactly did you start using the EWQMS system?

DK: We started using I would say about 1 year ago. I think it was also rolled out in stages in certain provinces, I don't know how far the Eastern Cape was in the roll-out programme, but I have been involved with it myself for one year.

ML: I'm just going to let the laptop boot up, and can I show you the demo on my phone, and I'll show you the HIV one as well because that's much more finished, and is used in practice.

DK: Ok, this is what would now be issued to your operator?

ML: This is a very, very rough prototype of what would be issued, but ja – this is quite a cheap phone and we'd probably look at something a bit more rugged than this.

[demo]

DL: So site1 would have its information in the database, and they would then know where it is and..

ML: Ja, and which number they should be sending from maybe, so that people who aren't supposed to can't send results.

[demo]

ML: It might be possible also to get a reply by sms, saying say, I see you have a problem with the fence, you should fix it – some kind of feedback. And then, that's the reading that would be sent in to your central database. Then just the smarter phone, but also quite old, this is one of the much nicer looking applications, for collecting patient information during a home-based care visit.

[demo]

ML: For my thesis I developed this system also very much in prototype just to try out some technologies that could be used for reporting, one of them being open source software..

DK: Being..?

ML: You can see it's not running Microsoft windows, it's running a free operating system. Everything I've used to make this is available free, so also looking at ways that that could support resource-constrained areas. This system has some data for the Northern Province collected by other people involved in the project. Everyone else who has looked through it has said oh, those are totally wrong, it's quite likely that the readings are then totally strange..

DK: So then in other words you then would have you own site number, you would then feed information and you would then represent one of the dots.

ML: Yes, everyone with the phone would represent one of the dots.

DK: And that is your time delay between sending the information and being captured?

ML: 14 seconds, on average in the patient information system it would be 14 seconds

DK: It looks very good.

ML: One of the other things you can do that is quite nice is if you know what the normal range for a parameter is and you get a reading that looks totally wrong you can send it back to them and say, this looks wrong, check it again

DK: But then you'll have to have someone manning the system the whole time to do that? someone with a knowledge of what water quality should be, historically and whether it's in you acceptable limits for drinking water..?

ML: I think you could also have it serve as a warning, and have the acceptable limits as a starting point but still let them enter a reading that looks wrong if they're very sure.

[demo]

DK: I would say where your system has a lot of relevance or a lot of benefit would be in your rural areas, because they will not have a computer system or internet access. The DWAF system is internet based, so if you don't have access to the internet you cannot enter the data, so I can see it would have relevance there. Possibly you could even link onto that, as a service to DWAF even, or as well as to the municipality...

ML: We'd like to do that, maybe go to the water research commission and say we'd like to propose a project, for further development and to go to a municipality and find out what their requirements would be, and take it as a project. So that would be one way we could approach it. The idea of making it so that it can submit data to EWQMS is good

SK: Wouldn't you find that in the different communities in the rural areas, something like that would be better served towards the municipality, so they can compile it. Because I would think.. when we were speaking to the other people like Makana Municipality for example, they told us how issues like that are usually handled by the municipality , and then they compile the water quality report and then they send them up for example to DWAF.

DK: Yes it would because the municipality also would have an obligation to supply potable water to the consumers, where the municipality is a water service authority, so yes it would have relevance, whether it was one level lower where you are now informing the municipality and the municipality then reports some of the information to DWAF ultimately DWAF wants to know about the quality of the drinking water that is supplied by the municipality to dropping down one level over.

ML: I have a question that isn't on my questionnaire, just some thing we picked up this morning. If there's a private borehole say on a farm, and there's a farmer supplying water to the farm workers on the farm, does anyone monitor the water that is supplied?

DK: At the moment we don't monitor private boreholes, but if there was a borehole that was being supplied to, say there was a borehole on municipal land, there are certain boreholes that we don analyse at the moment. The water is then obviously extracted from the borehole and fed to the reservoir and then it's chlorinated and supplied to consumers. As we make use of in buffalo city. But that information, because of its proximity we can get a sample there done on a weekly basis and brought to our lab for analysis. But if it is a far more remote one then yes it would have relevance as well. But we tend to test boreholes where consumers are not simply limited to one one farmer and his farm workers. We don't tend to test those boreholes because they are scattered everywhere. Where you have one that is supplying a number of consumers, then those we do try and bring on to our monitoring programme.

ML: And as far as reporting, I suppose it is very standardised once you've got a DWAF system in place, but how often do you report, and is reporting an overhead?

DK: In terms of all our reservoirs etc? Well, our reservoirs are reported to the Water dept, we give them a report on a weekly basis of the reservoirs. There are certain daily reporting, that we can also react and respond to, because if you bear in mind that you cannot analyse bacteria every single day so you use indicator tests, like a turbidity, and a residual chlorine. You are then assuming that if you residual chlorine is sufficiently high, that you then have adequate disinfection in your sample, therefore you're gonna have a reduced health impact. We do those analyses on a daily basis in and around the greater East London area, and then our supply reservoirs we do a full chemical analysis not just bacterial, weekly. Those results are copied to the water department, they're also copied to the water treatment works so they can see how they are treating their water. They will do their own minor testing as well, their process control testing within their own laboratory. We're more the compliance monitoring testing, and then we feed that to water, we feed

the drinking water results also to DWAF because they are our regulating authority, and we will then send those to them via the EWQMS system on a monthly basis.

ML: And communities in your area, do communities assume that their water is always safe? Is there any way for them to access those results. would they want to?

DK: That is something we should be doing, we should be advising consumers on the quality of the drinking water because they are entitled to that information. That is something that we do need to focus on doing, um, I'm not aware of too many systems in place that do the feedback to the consumer. Usually when there is a complaint they'll react to that straight away, and they are given the results, but the routine programme, we don't often feed that information back but yes, we should be. And we have addressed that, we have discussed that.

ML: So maybe the system we develop could report, could be used to produce reports for the community.

DK: Well it's just how. Where would you present the information, where would you include it? Whether it goes on a water and lights account, but then you're going to reach only the folk that have water and lights and that pay it, are you going to put it in community centers, then you're relying on the person to actually go to the community center, there are some logistics there..

I think that is a shortfall, we do need to address that.

ML: Information security is kind of a related question I suppose. Previously people have told us that they don't mind other people seeing their results so long as they don't modify them. Is that the case here, is there any information that's really sensitive that you wouldn't want people to see?

DK: I don't see why they should modify at the moment, at the moment there is potential for it to be modified but there's no reason for it to modify. If you have an information management system, I know you can then not modify the data, so there you would have a protection on it which has obvious benefits. But at the moment we have one data capturer who captures the data and prepares the reports, they are then signed off for accuracy by the first-level managers, they do it visually, and then the reports come to me for signature for submission. So there's actually 2 checkings but then I don't physically go and check the accuracy of the typing, it is

the.. The chemistry manager will check that first of all, then the microbiologist will check this.. They will initial the report, confirming accuracy of typing and the feasibility of the results, and it then comes to me for signature so it can go off.

ML: Ok, so it's actually quite a process

DK: It's got a safety check built into it.

ML: I've got some general questions about the area, but I don't know if they apply. We were thinking we might be in more rural areas. Do you know what percentage of the people in the area drink from unsafe sources?

DK: There is information that comes through from time to time, benchmarking information but I don't know the most recent figures. There again that could be information that the water department could give you, and not necessarily that I would have to hand. We deal on the analytical side, we don't deal so much with the provision of the service and the backlog. So that sort of information you are welcome to confirm with Water Services, and I can refer you to somewhere to speak to.

ML: My other questions are, for example about HIV/AIDS,

DK: Would the water quality have an impact, you mean?

ML: Not the water quality on HIV, more HIV on a monitoring programme. People have told us it's difficult to set up a monitoring programme, often people that you train get sick

DK: That I could imagine could be a problem, it doesn't have as much of an impact where we sit over here. Our obligation then is to supply the water to the best standards you can, because you don't want to provide an additional risk to someone who is immuno-compromised.

SK: Do you think it would be beneficial to have the software in a language other than English, for example in Afrikaans or Xhosa?

DK: I would see great benefit, but you're also going to have to have someone who is fairly literate to enter the information. It would have great regard - if you ask me in Xhosa what turbidity was, I wouldn't have a clue. There would be great benefit in putting it in a language even if you are using a whole sentence, sometimes turbidity itself might not mean a whole lot but you ask them clarity or colour, if you gave a

description of what it involved I think they would have a greater understanding of what it was. Unless you train the person doing the test, that eliminates the need a lot.

ML: I suppose it's a difficult line to draw with how much training you can do. [Describes cyber-tracker, picture-based]

ML: Hopefully we'll be back with something better, something we can actually try out in a community. It's easy to demonstrate but I think trying to implement it will be a lot more challenging.

DK: How will you then offer a system like that, because there must be certain royalties?

ML: No, one of the things that we would definitely do is release it as open source software, for people to use and modify. And that would be partly because it would be developed with research money and we therefore feel that it should belong to everyone, and partly because the research group we're involved in has always been very strong on open source software, and we used open source software to build the system. It wouldn't be a case so much of people needing to buy it, but we would need to have an infrastructure so that there would be support available, and DWAF I think would be the people who could help us with that.

DK: I'm just thinking, say we had an operator in little settlements that could do basic testing for us, and then feed the information for us, and then feed the information back to us, basically they would need to be issued with the cellphone, and it would then need to have you system to feed the data through to somewhere. So now what is that system, that it feed through to?

ML: There's a modem with a SIM card inside it, that works basically like a phone to receive SMSs, so then it will receive an SMS and passes it to the computer, so that basically receives the SMS that you've got and stores it in the database

DK: I'd like very much if you could leave me with your contact details, because I can see value in a system like that, and we were just discussing at a meeting yesterday how difficult it is to get through to some areas. So if you have an operator that you can train up, you might be even a n on-site reservoir, it need not even be a water treatment works but it could be an on-site reservoir, then we can at least

get certain information coming through to us, where it reduces the need of our going out there to collect the samples, which is what we are hamstrung by. We just need to make sure that the test that is used to generate that information is a verified / validated type of test, because we would need to advise whichever results are coming in, that they are using this test vs. the test that we use in the laboratory.
ML: Leaves details, offers to let DK know when the system is on the web.

Interview with Francois Nel - Chris Hani District Municipality

ML: Melissa Loudon
FN: Francois Nel
SK: Sarah Kiggundu

ML: We'd like to give an interview. We're Master students from the University of Cape Town, looking at drinking water quality monitoring specifically in more rural areas or community-managed supplies. The reason that we're doing the research, is because we're involved in an international project called Aquatest, funded by the EU and that project is to develop a low-cost test that can be used to test to E.Coli, without that much training. It is to be used in developing countries and more rural areas. Our part of the project, is to look at how this test can be used to improve water quality monitoring and improve the ability of the municipality to reach more out-lying areas to monitor sources that, for example, at the moment they may no be able to monitor. So most of my questions are around water quality monitoring and specifically drinking water quality. I've also got an IT system, issuing a cell-phone to collect water quality readings. I'd like to show you this system and get input.
FN: Ya, that would be good!
ML: We need to ask you to sign a consent form to be interviewed.
FN: I don't have a problem with that!
ML: Generally, what is water service provision like in this area? Do you supply large towns?

FN: We consist of 8 local municipalities. I can give you a map so you can know exactly where they are. I don't deal directly with water provision, I focus particularly on environmental health. We're dealing directly with the monitoring of water points. I'll tell you exactly what it is we do in terms of water monitoring. The supply is very well covered. We are a very rural area so there are areas that are not directly covered but you could speak to the Water Service Authority (WSA) about that! You can ask for access to their water service system and they could show you access to the areas. In terms of sampling, that is currently a discussion point with us because it falls within the spectrum of environmental health but it is also a core component of the WSA. At one stage, we wanted to take over that component of water quality monitoring in the area....we're looking at 600 schemes. That is a huge number of samples that must be taken. Currently, though, we have appointed a Water Service Provider (WSP). Amatola Water is working with the WSA in terms of water quality monitoring, maintenance and looking at the schemes. We do adhoc sampling. If we go to abattoirs, we take samples. If we go to food places, we take samples. We do not focus on river systems as such. I know some municipalities, for example, if you go to Ukhahlamba (check the spelling) and Barkley....they went with the option of environmental health running the whole thing because you get the data first hand and can intervene immediately. There is a break in communication between the WSA and health. They get all the results, they are able to intervene but there is also a part that municipal health must play, for example, teaching health to people and showing people how to treat the water. All engineers do is throw in chlorine and then the water is right. They do not address the issues as to why the water is dirty. We have our own lab its not operational yet but we have all the equipment (nitrate, fluoride tests and bacteriological). I have a full set that I can use to do filtration as well (on the agar plates). I brought this stuff.....previously I was employed at one of our local municipalities. I have a fully-fledged lab. So that's basically how we run water samples at this stage. WSA run water quality sampling. They have a database in terms of an information system. There is also an information system, I don't know if they are working on it yet. It was developed by DWAF. I'm on the steering committee of that project. It's run

by Emanti.

ML: Then we have alot of questions for you on that.

FN: There is a little bit of a limitation on that programme for us. I think that there are one or two aspects that relate how we run it!

SK: With regard to the WSP, do they provide you with the information after they've tested the water?

FN: Yes. Amatola Water....I think they've started working already. Technical staff in the field analyse the samples and then the results go into the database. In terms of the results, they do their interventions etc.

SK: Can you access the information from the database?

FN: At this stage, they are supposed to supply us with the information and we discuss how we are going to make use of the information. I have my own system which has a water quality component in and it is a GIS system. The two systems don't talk to each other as such. My idea was: if I take a sample, this system must immediately update their database and vice versa. Otherwise, one will sit with two databases and one must dump information into one of the databases to get the bigger picture....but that is still in the pipeline and there's alot of work to be done on the information system.

ML: Do you have dial-up internet?

FN: No. We have fixed-line internet.

ML: Broadband.

FN: Each and every staff member has access to a computer. We're moving to a new phase where each and every Environmental Health Practitioner (EHP) (that's my proposal to the council) where each staff member can have a laptop when working onsite. They are placed in local municipal areas. IT infrastructure is an enormous expense. Broadband and 3G is so cheap....you can obtain access for R300. So they can take their samples and analyse them and immediately, it will be accessible on the system. We are moving in that direction, however, people do not always buy into that area because it is IT. I don't think the councillors always understand what IT is always about....even GIS. I thought GIS was a map with dots on it, until I took a course and I realised what an enormously powerful tool it is.

We're putting these systems in place but everyone had their own system. We're moving into corporate GIS for Chris Hani, where all the information will be available on a central server. We will access the information via 3G. We're still struggling with reception in some of our towns....even in Queenstown. In certain areas, you don't get 3G.

SK: Don't you find that you'd have to train these people because the majority of them would not have the computer training?

FN: All my staff have a BTech degree. There are, however, people who come out of a university of technikon and don't know the basics of using a computer. We did a first-round training and at final implementation, the staff are trained again. IT progresses, thus the staff are trained regularly. Next month, we will have a final training session on the system. I now buy GPS for the workers to use. It helpful for them to see a visual picture of the area and prioritise where the critical areas are. They must get training on all these systems.

Melissa demonstrates the system.

FN: If they are sending information via sms (using the cellphone), what in systems must you have in place, in terms if in terms of infrastructure, to accept that information.

ML: On the receiving side, you'll need a database and the piece of hardware re you need is a GPRS/SMS modem. It's a little device, costing R1 500, with an aerial and it's got a simcard inside. It receives the SMSes and passes them to the computer. We're running everything on free software.

FN: How do you link you work with DWAF?

ML: We haven't at this stage. It's a pilot prototype system. It wouldn't work yet, we'd have to do more work on the system. What we're doing now, is a feasibility study. When we have the results, we'll then take this information to DWAF or WRC.

FN:I'm very system orientated and the more information you have available to make the work easier for the guys, the better for me but also, for us at management, that information is very important. I think that lacks in local government alot. They sit in the office and plan for thing one year and another the next. We didn't do

anything about that. I ask my staff, if you go to site and test milk, for example, what will you do about the results? Whether they comply or don't comply, what are you doing about the results? If you have a guy in your area who does not comply, you write him a letter. If, however, you have 50 negative results, you have a big issue and you must plan and budget accordingly. These type of systems can help you to keep up-to-date and it's very nice.

Melissa continues to demonstrate the IT system.

FN: One of my biggest issues, in terms of developing software like this, is how it will link up with the software in place. You must remember that this system (the system they use in DWAF) is not GIS based. This can be a component linking to that. I think you will easily get Water Research Funding for that. There is a need for such systems. It can save the guy outside alot of time and it can save us alot of money at the end of the day.

SK: Wouldn't it be easier to teach someone within a rural area, which might not be easily accessible, to use the cellphone and they test the water quality....

FN: You can do that as well. There are EHP in the rural areas. My view point, is that we have people in the field who are based in local municipal areas within the rural area. I know that sometimes, they want to fight with me because we have a 38 000 km2 area. Some of the places are not even accessible by 4x4. I think it's a good idea, where there is no service but is not supposed to be the case, especially for environmental health. Adding to that, sometimes it's very difficult to get to these areas. I think I need another 30 EMPs to cover the national norm. Some of these guys are working in areas where there is a ratio of 1 EMP to 45 000 people. Council sometimes does not understand what environmental health is all about. It's water quality, its disposal of the dead - they then realise that its an enormous field. That's why some of these guys get hooked onto projects that take up alot of their time and they can't focus on their normal work. If they have the basics, and we have the basics, in terms of chemical, physical and bacteriological. Faecal coliforms is too broad a term to look at in any case. If you have a test like that you can input your data immediately. The test for me is very interesting. There was a test developed (hydrogen sulphide). If you can get a test that indicates the presence or

absence of bacteria, it will be much more easier to intervene on the spot. It's a problem not only for water but for food as well.

SK: Once you know a source is contaminated, wouldn't you have to take need to take more samples, to identify what exactly is contaminating the water?

FN: That's unfortunately sampling. We do this sampling to get a rough indication of what's going on. If you look at the Water Quality Guidelines, things have slacked down a little bit. If I know there is 100 000 E.Coli present in 1ml of the water, then I know that there's a big problem. It's really just a presence/absence test. You must then send samples away and look at interventions. If E.Coli is present, I already see it as a risk. We would have to intervene in any case. The biggest issue is : using a presence/absence test and something is present, the guy must intervene and locate the potential risk factors in the upstream or downstream conditions.

SK: How do you address the issue when you are intervening?

FN: It depends on where we get the contamination. In rural areas, we get contamination in water tanks. The first reason is birds. They don't close the tank properly or the pipeline is broken and remember, this is the deep rural area. There's alot of animals. In terms of river systems or service water, there is alot of animal and human activity around that water source. The cattle are drinking from there. We isolate the circumstances around the water source. If we see animals, even if the animals are not the source of problem we address it. People also use the river systems toilets. They've been doing it for 200 years and to get them to walk 100m to a toilet, they are not receptive of that. That's what we're focusing on: educating the people.(For example: there are cattle and these are the potential pollution sources.).....I went into water quality as my Masters. I didn't finish. It's alot of work especially when you're working full-time, but in any case.....There are different things that you must look at. It does not help if you (if for example) you close the tank and the biofilm develops inside the tanks. A study on bio-film was done at the Free State Technikon. There are various aspects that we look at. We're not going to say: there's 1 E.Coli, don't worry. They need to investigate where the potential contamination places are.

ML: Do you work with schools at all?

FN: Yes

ML: We were at Amatola Water and they suggested that if we want to try out the system, we should give the system to school children.

FN: That would be interesting. We're working with 6 six schools now on an Environmental Management Project. It's biodiversity, waste management etc. The schools like these types of initiatives. We have programmes in place that we want to establish and we can fund. Sometimes we can work together. I know there is a bio-monitoring system in George. The lady piloting that project was my previous director's wife. We wanted to implement a project whereby the river systems would be monitored. You can link that directly to transferring of information to the children. Why mustn't you waste water? Why mustn't you throw things in water? And all the linkage in terms of waste pollution. You can go to Vodacom and ask them to sponsor your initiative.....they will give it to you. I promise you. For them, it becomes a national thing: being involved in this initiative. I think it's a good idea to go to schools, definitely. And environmental health people - give it to them and say "let's test it from a professional point of view". How do you find it and maybe you could change things on the system but with children, it must be very very user friendly. They must understand. That's where we can come in with what's E.Coli, where is it coming from and why do we test for it? Why do we test for turbidity? Why do we test for all these other things? That becomes part of their curriculum. They are marked on that so immediately, you start targeting alot of issues. You're targeting the curriculum, you're targeting water, you're targeting waste management - all of these things in a package. That can be a brilliant exercise!

ML: As far as language is concerned, I think that it's become very clear that English isn't the most used language out here?

FN: Afrikaans, you can forget in this area. In the Chris Hani area, its Xhosa. Around the towns, yes, but when you move in rural areas, you can forget it! When you move around in rural areas, those people can't speak Afrikaans. Some of them can speak Afrikaans especially when they live near farms but in the Eastern Cape, it's more English-speaking people.

SK: When we googled the Eastern Cape, we were of the opinion that 80% were Xhosa-speaking!

FN: Definitely.

ML: As far as data security, you would probably want a system where people cannot modify the data.

FN: The only people that can modify data at the moment, is myself and a senior. We want the community to be aware of the issues and sometimes we get a little bit if flack about that but they will immediately put the pressure on politicians. It's supposed to work like that. I think we should put it out there and state why the issues are there. So politicians can see these are the problems.

ML: Not modifying it but reporting to the communities and important people.

FN: That's my personal view point. I don't know how my director would feel. I think she would feel the same. I think things (information) should be out there. To say "hey here is a problem". If it's the community that contributing then immediately, we must take responsibility and realise that? we're polluting our sources. What can we do- collaborations with the municipalities to address the issues.

ML: What we would like is for eventually communities to monitor their own water sources.

FN: That's one of the problems, to get communities involved. There's still this attitude: "If I do this, what do I get?". I've tried to change it now with my projects. What are they giving back to us? I think the government has spoilt our guys a little bit. The government has said they are going to do all these things, now people sit back and say " the government must provide". Our politicians are clued up and we are working very well with them. But I think some communities believe that it is the responsibility of government to give them everything. Like the last year's project, its R150 000 project. It's not alot of money, but 7 schools benefit out of the project and we had to cover one of the pieces of land, which we had to plough and they sent me an account of R350. I asked them what is your contribution to the project? They could not understand what I was talking about. You are making the project here, you must pay everything. It took a while but the community will cater R2 000 out of their own pocket. The children are working physically on the project. Previ-

ously, the municipality did everything and said "here is your project" and it failed. They must own the projects. This is our first big project at a school level. Our other projects, include the removal of alien vegetation from the area. It's because of over-grazing and there is no grazing land anymore. That's a big project but its a 6-month project where we pay them R2 000 per hectare to clear and the guy gets his R 2000 and the next year, we go to another area. This one is our first big project and we've been running it a for year now. The children are working and we're beautifying the schools. Other aspects, is to get the buy-in of the teachers. When I see the teachers that teach our children, it's scary. Teachers just sit there and don't do anything. The children will be committed because it's something new and something to get involved with....sometimes, we struggle with the principals.

SK: Would you say that poverty is accounts a little bit for what whether the community buy into the project or not? They will reap[benefit eventually, but not monetary benefits.

FN: That is a mindset that you must change. People must understand, its not the monetary value that you get out of the thing but at the end of the day, it's a resource that is very scarce in our country that we must look after. I fight everyday with the politicians in the planning section, in terms of water resources. People should be aware that a project may not always benefit them financially but it will benefit the community in terms of water quality and immediately, when you address water quality, there are primary care issues, you address environmental issues and at the end of the day, you have a healthier community and its cheaper to maintain for government, than an unhealthy population of people. I thinks that's where EHPs must come in - with awareness. Why are we doing this? Not for the sake of the law says, this must be done but the bigger picture and I don't think people always see the bigger picture.

ML: Has HIV/AIDS had a noticeable impact on the community?

FN: You just missed the HIV/AIDS co-ordinator. HIV/AIDS is a big problem in the country and the Eastern Cape. I made a presentation the other day to the HIV/AIDS council on the involvement of environmental health in HIV/AIDS because I think that's one thing that lacks. You have an HIV/AIDS department but there is

not support from the departments. I think, like us that work with communities, it's the ideal time especially with their training in health, they have basic aspects of HIV/AIDS so you can use them. Why must you run HIV/AIDS on your own if you have support staff? Why can't engineering projects include a component for HIV/AIDS. I budget for HIV/AIDS awareness. We're the only department in the municipality that are doing HIV/AIDS awareness. On our posters, on our campaigns....everything, there's a message on HIV/AIDS. We're going to talk to the HIV/AIDS people to train EHP so that each component of a project will include HIV/AIDS. This project that we are running at the school, primary schools, but there will be a councillor there and they are going to be testing. We're not going to test the school children. The teachers will be tested. We'll give them some support in terms of that. We have a wellness day twice a year (Chris Hani District Municipality). All the officials test themselves, in terms of HIV/AIDS. The programme can become enormous with the impact of the other departments into the HIV/AIDS component. The HIV/AIDS guys made a brilliant proposal. They requested that 1% of each director's budget goes towards HIV/AIDS. I think it's a brilliant idea because then they have alot of money and they're ploughing the money back into the departments. So that's how I see it. It's an enormous issue - it's an economic issue and we must change the mindset.

Notes from Interview with Booi Malghas – Water Service Provider to O.R. Tambo District Municipality

We met Mr Booi Malgas on the afternoon of 24 May 2007. We had been referred to him by the provincial water quality coordinator for the Eastern Cape, Mr Andrew Lucas.

Although Mr. Malgas reports on drinking water quality to DWAF using eWQMS, he is not part of the water service authority (O. R. Tambo District Municipality). His role is that of a water services provider, providing laboratory services to the municipality. He tests and report on water samples provided to him by the municipal-

ity, but is not involved in monitoring programme planning, or responsible for remedial action if water quality testing identifies a problem at a sampling site.

Mr Malgas assisted us by identifying Mr Eric Mzayiya at O. R. Tambo District Municipality as the correct person to speak to regarding drinking water quality monitoring in communities, and by helping to set up an interview with Mr Mzayiya for the following day. He also clarified the role of DWAF with regard to defining what tests can be used to monitor drinking water quality monitoring. Currently, the H2S presence/absence test is used by some Water Service Authorities (including Alfred Nzo District Municipality), but this test is not accepted by DWAF as proof that a source complies with SANS241. The stressed that any field testing method would need to be accepted as valid by DWAF if it was to be seen as fulfilling the legal requirement of WSAs to test water in accordance with SANS241.

Notes from Interview with Eric Mzayiya - O. R. Tambo District Municipality

We met Mr. Eric Mzayiya on the morning of 25 May 2007. He kindly agreed to be interviewed despite not having been contacted in advance with official details of the research. Because we had not followed the official process, it was not appropriate to use a dictaphone for this interview. However, we recorded the following notes:

Have some water purification works, some boreholes, some protected springs. Monitored on a monthly basis, community members involved in operations and maintenance of the schemes and paid a stipend. Currently if there is a problem they might phone, or they might wait for the municipality's technicians (who come monthly to test the water) to come. In this case it is a problem because people may drink unsafe water for a while before the municipality knows about it and can fix it.

Water quality is a concern particularly after heavy rains – you might test a source and it is safe, but if it rains heavily it can become unsafe.

Would support getting schools involved – the municipality is already involved in teaching about sanitation and hygiene in schools.

Report to DWAF but are not yet using EWQMS. Mr Booi Malgas is contracted to do the reporting to DWAF as well as the testing of the samples they collect. Technicians are however involved in preventative maintenance.

Likes the idea of a cellphone-based system and thinks it could be helpful particularly in the more remote areas. Does not see cost as the major barrier to such a system – water quality is a serious concern, and they would like to set aside budget if the system could help them monitor their schemes better. DWAF were also suggested as being able to help with this – they have paid for the development of EWQMS and are making it available at no cost to municipalities.

Asked about the specs of the phone required – one of the only people to ask this.
At the end of the interview, Mr Mzayiya provided us with his contact details. He seemed enthusiastic about the possibility of implementing this kind of system in O. R. Tambo.

Interview with Mthetheleli Gcali, Nowthando Chongo, and C. M. Qomto - Alfred Nzo District Municipality

MG – Mthetheleli Gcali
CQ - C. M. Qomto
NC - Nowthando Chongo
ML – Melissa Loudon
SK – Sarah Kiggundu

ML: We were sitting in your office and we saw a map up on the wall about all the schemes that you have, could you tell us a bit about water supply in Alfred Nzo, and also a bit about how monitoring works?

MG: Ya, maybe we'll start by saying, most of our schemes are in rural areas. That have got sources as boreholes, or springs, or streams, and we've got a few schemes that supply the urban areas, Mount Ayliff, Mount Frere. We operate and maintain the schemes ourselves.

ML: Rural areas obviously present more challenges than a scheme in an urban area, what challenges do you face in operations and maintenance of those rural schemes?

MG: Well, maybe, basically the challenges in the rural schemes are with the maintaining part of it, we won't have our staff permanently there, we are relying on locals, local communities, community-based organizations. Who help us, but sometimes they don't report faults quickly enough and it takes some time to repair things. But ya,and the other thing is this water quality. Because some like during the rainy season there this a lot of runoff. That means the sources, there is high incidence of contamination by E.Coli, total coliforms.

ML: More background to what we're doing is that the University of Cape Town is part of an international project called AQUATEST funded by the European Union. And what they want to do is develop a low-cost field test for E.Coli. I know, we spoke Mr. Booi Malgas in O.R. Tambo, and he said that you were using a field test for E.Coli, a presence/absence test

MG: Ja, ja

ML: Ok, this is designed to be not quite a presence/absence test, more of a banded test, like there could be say 3 bands for water quality. The test hasn't been developed yet, and the University of Cape Town is not involved in the development of the actual test, but more in the management of results and how we can help municipalities support schemes that are in rural areas when there are community-based organisations looking after the maintenance of the scheme, as happens in your area.

How much is the community involved in testing, is it mostly your technicians? Who tests the water?

MG: Oh, we've got Nowthando (sitting next to him), she is our chemist. And we've also got staff from the department of health, environmental health officers. They do the field testing, but I do the reporting.

ML: Are you, I know there's a system that DWAF is proposing, EWQMS, are you using that system?

MG: Yes, yes. It's a very very useful system. We started using it last year, some of data is already on the system, you can just go into it and have a look.

ML: The system that we have is something that is more intended for rural schemes to report to you, so that you could then report further to DWAF. And what we'd like to do with it is take it maybe to the water research commission, and say we've got this system that uses a cellphone for the community-based organization at the scheme to collect information about the work they're doing and the problems they are having, possibly the results of the test. We might want to go to the water research commission and say, would this be a good project to develop further. So what we are here doing is a feasibility study, asking people is it useful, would it be useful.

I'll show you the phone part of the system. If you imagine giving each of those community-based organizations looking after a scheme, maybe giving them a phone which they could then use to report information every time they did a test if they were using a field test kit, or every time they checked the fuel level or whatever

[demo]

ML: [..] so as soon as the SMS came in, you could then see that the person responsible for that scheme had done some tests, and had maybe done some maintenance. You would know exactly what was going on at that scheme.

MG: The challenge we would have with that, is that the people in the villages are either totally illiterate, or semi-literate, and we cannot really expect them to do these tests.

ML: I think the idea of this test they are developing is that it should be so easy to use that even a person who is semi-literate could use it. That they could be given instructions, or that you could maybe train the person in a local language rather than English, maybe in Xhosa. But the idea is that it should be simple enough that someone who is semi-literate could use it.

ML: Are these people paid at all?

MG: We currently give them a stipend, but they are not employees of the municipality.

[demo]

ML: [..] So that's an idea of what the system could look like, it obviously doesn't do everything you would need it to do in practice as this point, and we haven't tested it in practice either. What we are doing now is coming around and showing it to people, and asking do you think it is something that is worth testing, this cellphone-based reporting system, and should we go to the WRC and try and get a project together?

CQ: What does it cost to send an SMS?

ML: There are a lot of ways of doing it, one is you could put airtime on the phone, or you could use a reverse-billed line so they don't pay to send, in which case it could cost around 40c. The cost of the SMS isn't that high. The cost of a phone, also not that high – you don't need a particularly high-tech phone to do it, any phone would work. Any phone with Java, so any of the newer phones. The software, we have developed as Open Source software so it's all free software, and we give it away free and making it available for free because we would be developing it as a research project and with research money. Though we would maybe want to give it to DWAF to support and install it. But the municipalities would probably need to manage giving phones to people and making sure there is airtime, that kind of thing.

CQ: So, you can load the data from those maps?

ML: Um, the GIS files that I saw next door? Ja, we could load that.

CQ: So, they can report anything from the messages?

ML: Ja, you could maybe report text too. It's nice to have a kind of structure that they got through, so that you make sure that they check certain things every time. And then you would define what you want them to check every time, and then there would maybe also be space for them to put any other concerns that they have or things that are not working.

MG: Ya, I think it would be very useful if it could do that. Because now, we eliminate now this problem of not responding immediately when there is a problem. Cos now, the operator will send an SMS saying there is whatever problem with the scheme, and it would be picked up here in the office, and we would dispatch someone to fix it or whatever. Ja in that respect it would really really help us, we are battling with reporting. People are complaining we don't attend timeously to problems, they are for days without water. But in fact we only now hear that there was a problem. But if someone had you system they could pick it up instantly. Sounds very very useful.

But like I was saying ja, even on the water quality side of it, the only problem that you would need, wither you would have to simplify the test, not like currently they are, so that those people there could do the test.

ML: I hope that the EU project will come up with a very simple test. They've got the prototype and they are going to be testing it, and I think it would help a lot of people if they could come up with a simple test.

MG: I think it would really help, it would be very, very welcome cos ja, the tests that we are currently using are complicated , needs people to do them, you cannot ask just anybody to do them. So if you can make a simpler test that will also be accurate.. Because ja water quality is very crucial, and we are battling to monitor it especially in the rural areas. There it can act up at any time, when we don't have the conventional water treatment works where we know we control the process.

ML: On way to use the system might also be to say, if you get a result that indicates a problem and you can't go immediately, then you can maybe send an SMS back saying, put this much Jik in your water or this much chlorine, or boil everything before drinking, until you can go there.

MG: It's good to know that there are people trying to simplify and help use deal with our responsibilities , but like you are saying you would have to develop it, let the WRC have a look at it, and most importantly DWAF because it is our regulator. And they also have this responsibility of giving us support, like this new reporting tool that we have got here (EWQMS), that was developed and we are getting for free. But ja it is good that you come to us, see how we feel about it.
ML: Thank you very much then.
MG: Thanks for coming.

Interview with M. Gcali – Alfred Nzo District Municipality 02/10/2007

The interview was conducted with Paul Levy, an undergraduate student in Civil Engineering.

Key:
PL – Paul Levy
SK – Sarah Kiggundu
MG – M.Gcali

An introduction of our aim, with regards to the questionnaire and what our respective studies entail.

PL: Are you familiar with the drinking water quality framework?
MG: Yes
PL: SANS 241 (South African National Standards)
MG: Yes, I have.
PL:Are there any other regulatory requirements related to drinking water quality, besides SANS 241?
MG: Basically, we use SANS241.We also use the DWAF guidelines on Drinking water quality.

PL: Since before 1994, laws on water quality different, compared to now. What's the most important piece of legislation since 1994?

MG:Water Services Act

PL: Why?

MG: It determines how drinking water should be. It provides information on who is responsible for what. It allocates responsibility to different parts of government. It's a guideline and everything to do with water is contained there!

PL: What about the National Water Act?

MG: It's more concerned with water resource.

PL:Legislative requirements in terms of the service delivery of potable water?

MG: One thing that I can think of- provision of water should be continuous and not be interrupted for longer than 48 hours.

PL: So it's just a continuous supply, not longer than 48 hours (referring to discontinuous water supply).What personnel/ plant would assist you more effective management and/ or monitoring of drinking water quality?

MG: Yes, a lot of them. The turbidity meters, the chlorinatory meters. Al the required equipment to test the water.

SK: Do you test your own water quality or do you use a Water Services Provider (WSP) to do the actual testing?

MG: No, we do it in-house. It's not a laboratory, we've got mini-labs in the treatment works where we control the process. Then also we've also got the municipal health services staff and the Environmental Health Officers who do the actual health testing. The compile a report afterwards.

SK: What happens to the reports after they are sent to Pretoria?

MG: Not sure but they are supposed to give us feedback.

SK: Do they provide you with feedback?

MG: They didn't previously but now they are doing it. We are using a new programme where the reports are submitted online (internet-based). We do get feedback in the form of emails once we report our reports on that (referring to the internet-based programme).

SK: Are the emails more confirmation emails, or rather email telling you where improvement is needed?

MG: Yes, it does tell you where the failures are. You required to take action, produce a report, on the action you have taken to address the failures.

PL: Are you saying that the feedback have improved since the new system have been implemented?

MG: Yes. There were some glitches with the implementation of the new system, but it is starting to work very well now!

PL: Can you comment on the effectiveness service delivery to smaller towns/ communities in the non-metropolitan areas of the Eastern Cape?

MG: In the rural areas, we've got schemes that are designed to RDP standards. 25ℓ person per day. The walking distance should not be more than 200 m. That is basically the standards that are out there.

PL:In terms of the data of the water quality monitoring, do you feel that the data is readily accessible for management and monitoring?

MG: Yes, In fact, since we started in November 2005, when we started the monitoring of water, we've go to all the data. We've not yet met what we intend to do. Currently, we're sampling each scheme- once every 2 months and our goal is too service it once every month.

SK: Is this because of not enough funding or lack of capacity to accomplish these goals?

MG:We don't have enough capacity. We do need support from the DWAF national department. We don't have capacity. We've got approximately 100 schemes to monitor. Not at this stage, but we're comfortable at what we've got now.

PL: How accurate are the lab results? Do you personally find them accurate?

MG: Yes. In fact we've got our own equipment and we can test for the presence of bacteria (example, tests will reflect a presence of E.Coli). We send the samples out to Umtata, to do the actual counts. If there is contamination, we'll know.

PL: So the test reflect whether there is or isn't bacteria, not how much?

MG: Yes, not how much! But with the other "things", it will tell you the other counts.

PL: Would you describe the municipality's approach to Water Quality Management as reactive (compliance monitoring) or proactive (preventative risk management)?

MG: I think we're proactive now. Initially, we were reactive. There was not water quality monitoring in the rural areas until there were outbreaks of certain diseases. We disinfect all our schemes now and the challenge that we're having is that all these plants don't have treatment plants. There is no treatment process. It will be either a borehole or a spring. From time to time, there will be contamination, especially when there is rain and it mixes with the water. We apply chlorine to all these themes.

PL: So your rural communities are served mainly from boreholes and springs?

MG: Yes.

PL: Who is responsible for hazard identification and risk assessment?

MG: We're responsible for that. We do the operations and the maintenance.

PL: If there is some kind of emergency with the drinking water supply, what planning is in place in order to minimise public health risks associated with drinking water failure?

MG: We've got plans. We've got our (didn't get this bit) and our technicians out in the field. So if needed, contamination is detected, we inform the technician in the field and he'll know what to do. Apply chlorine, inform the communities, retest, inform us (the municipality).

PL: What training /skills development programme(s) exist to ensure employees are competent to perform tasks assigned to them?

MG: No, not really. The people who perform the testing are qualified people with diplomas in Environmental Health.

PL: So you don't bring people in and train them yourself?

MG: No.

PL: Are you maintenance budgets sufficient to ensure adequate maintenance of infrastructure?

MG: Yes.

PL: Are you aware of any appropriate technologies that should or could be implemented to improve infrastructure management?

MG: (reluctant to answer), I do know that are technologies that are available and that can be used to improve (water quality monitoring). For instance, DWAF is also organising a course in Asset Management. This will also help us to use the technology- such as a telemetry system, which helps you monitor your system: the water levels, the flows.

PL: What impact does vandalism have on service delivery/ sustainability?

MG: It is not really there. You get incidences of people breaking taps, manhole covers, illegal connections to the pipeline.

PL: How is public awareness and involvement in drinking water quality issues achieved, especially in the case of non-metropolitan communities?

MG: In the cases of the serious failures, we've got ward committees there, ward councillors, as well as, traditional leaders. BUT I must say, in the past, we've had serious failures. You can classify failure. We assess the risk. You know that you can have an E.Coli count of 1 - 10 but if it's more than 10, you've got a risk. We make use of CBO (community-based organisations)

SK: How many community water sources / points does your municipality monitor in this area?

MG: Plus minus 100 communities.

SK: Do the communities have electricity or adequate network coverage in terms of cell-phone based technology?

MG: Not all of them. Most of them don't have but some do.

SK: What are the general sizes of the communities? How many people would you expect to find on average for any given community?

MG: I'd say 2000 people, and you have one scheme serving between 20 to 25 000 people.

SK: So this is quite a big municipality – how many people are you servicing in total?

MG: The population served by this municipality is close to 500 000 people, and I think we are covering only about 55%, we still have a backlog. There are communities that are not yet covered.

SK: Do you have any community-run water-quality testing programs in place?

MG: No.

SK: How do you think communities can better manage their water sources, especially the deeply-rural communities where you cannot go out there as often as possible?

MG: We wouldn't like to give that responsibility to the communities; we would like to do it ourselves.

SK: Are there communities that use unprotected water-sources?

MG: Yes, they are.

SK: What are you as a municipality doing to prevent this?

MG: There is not much that we can do, except to plan to fix things in those areas. Those people have been using those sources for ages, for generations. We know its risky but we cannot stop them, because where would they get their water? We do not have the capacity to supply them with water, but in the case of very serious problems we do make emergency interventions, such as drilling boreholes when their sources are contaminated, and equipping them with hand-pumps as an interim-measure where a scheme has not yet been built. In certain places, we cart water to the village in tanks.

SK: Do you have any community-awareness programs? That is, once providing the community with water, are there any programs which educate the community about the risks of using unprotected sources?

MG: Not at this stage but we would like to have that. We are planning to go out into the communities and educate them about the dangers of using unprotected sources.

SK: Does the municipality support the use of HWTS such as using solar powered tanks to disinfect water before use?

MG: We would not recommend it but we do not really have a problem with it. There are communities which we do not cover in terms of water services. So if there are ideas to help those communities have safe drinking water then we would welcome that, that would help us a lot. We would like to know that all our people are covered; they have potable drinking water that we can be sure of its quality, which is not the case now.

Interview with Mr F. Nel - Chris Hani District Municipality

04/10/2007

Key

FN – Francois Nel

PL – Paul Levy

SK – Sarah Kiggundu

FN: Since this area is an agricultural zone, most of the water is used for agricultural purposes in this district. I'm not 100% up to date with what's going on with the Water Services people currently in terms of their planning and putting up plants to treat drinking water, but we will have to look at recycling and reclamation of water in the future. We are planning a workshop on drought relief and water management where we are going to discuss issues such as how to manage our water and alternative technologies which we can apply. I think that everyone in this country is used to opening a tap and obtaining water, as well as to using drinking water for irrigation purposes – not looking at greywater or other types of technology such as centre pivots. People are putting up centre pivots all over the district, and we don't have enough water to centre pivot because 90% of the water evaporates. Why not look at alternative technologies such as underground water irrigation systems? These are issues for the future, but it's a total mindset-change. The other issue is, in terms of water quality, to create awareness (and we're responsible for water quality in this section), you need a lot of financial resources and staff. Currently I'm sitting with 19 EHP's in the district who report to me, as well as another 22 which report to province. They should be on our staff establishment because MHS (Municipal Health Services) is now our function as a district municipality. It's not a provincial function anymore, or a local municipal function. It's now a district municipality and a metro function. So there you have several staff members, and if you look at the scope of the profession of environmental health, it's so vast that each person is doing so much that they don't always get to the nitty-gritty things like awareness

campaigns. This is a big problem for us, we try to address it but it is on an ad hoc basis.

There is a water research commission in Stellenbosch which is dealing with a water quality management program. The project title is 'The failure of water quality in small distribution networks' as best I can remember. In terms of water quality there are disputes between environmental health and water services providers. The WSA is responsible for water quality in terms of the law, but in terms of our scope of profession we are also responsible for water quality. So we have a fragmented situation where each organization is 'doing their own thing.' We have all these nice frameworks and programs in place, but I don't think it's run correctly and that's my personal viewpoint. What we are trying to do now is to take over water quality totally within MHS. We have established a lab at my offices where we do our own analysis. It's not analysis like in a lab where you do filtrations, which we can do because we have all the equipment, but it takes a lot of time for the water quality practitioners to isolate E. coli forms or faecal forms. So we just use presence/absence tests using dehydrated E. coli plates. We are planning to put up a full lab and employ a lab assistant so we will analyse them in the proper manner in terms of the SABS codes. Currently what happens at Chris Hani is we appoint a service provider which is conducting our water quality. They have staff in the field that take samples, analyse them and submit the results to the WSA. Those results are supposed to come to us at the end of the day in terms of intervention and awareness because those link together. What we've found with engineers normally is if they have a problem, they 'throw chlorine in the tank.' They don't investigate the real problem of say, why there is E. coli in the water system. I think the main problem is communication and the individual operation of sections and departments. It's not unique to Chris Hani DM, I think it's all over the country. DWAF and others work mostly on their own – the only time they get involved in health is when there's an issue such as cholera or diarrhoea. That's an enormous problem for us in terms of local government, where you have more than one department that is legally responsible.

PL: Are you familiar with the Drinking Water Quality Framework for South Africa?

FN: Yes.

PL: Are you familiar with the requirements of the South African National Standard 241 Drinking Water Specification, or other regulatory requirements related to Drinking Water Quality Management?

FN: Yes.

PL: The legislation governing drinking water consumption has changed greatly since 1994. What, in your opinion, is the most crucial piece of enabling legislation that has been passed by the South African government, and why?

FN: The National Water Act, since it puts a strong emphasis on the management of our national water resources, looking at quality, putting up forums and structures to address quality issues, etc. From my point of view in terms of health, the most important element is the structures which were put up. I think there were structures in place in the past, but they were very fragmented and again, working individually.

PL: What are the legislative requirements in terms of service delivery of potable water?

FN: A continuous supply of water which is not more than 200m walking distance away.

PL: What personnel / plant would assist in achieving more effective management and / or monitoring of drinking water quality?

FN: More effective MHS, i.e. more personnel as well as better linkages with the WSA. My personal viewpoint is that we are using too many consultants in the field to monitor these things. The capacity is there, the biggest issue is human resources in terms of MHS to deliver the proper functions in terms of water quality. If you just look at Chris Hani alone, we take 600 samples a month, over 38 000km^2 of rural areas which must be covered. Sometimes you can't even drive a 4X4 to the areas that must be sampled. I think we have over 300 schemes which must be monitored. People sometimes lose focus since we have the schemes but we have other water sources which they don't monitor. There are boreholes, river systems and springs which aren't monitored or don't fall in the mandate of what is re-

quested from the WSA. This is where we come in – we normally do analysis or take samples on an ad hoc basis on rivers or other water sources which aren't covered by the WSA.

PL: So if there is an unauthorized water source being used, you will test it to make sure it's safe?

FN: If we find the communities are using it or we receive complaints, we will go in and intervene. This is one of our biggest problems – we're currently not proactive, we're reactive. If something happens, we intervene. And I think that's maybe because all the groundwork has not been laid. The linkage between us and the WSA is there but it's not strong enough – we don't know of everything they've done already in terms of mapping all the water sources being used, analysing the quality of those sources, investigating whom these sources serve. I think there are data available but you would have to obtain it from the WSA.

PL: So it would improve matters if there were a consolidated group who was responsible for everything?

FN: Yes. It would be better if we could co-ordinate with MHS since those are the people who are on the 'ground-level' every day, they work with the communities every day. So within their normal scope of work they can take their samples, we analyse them and immediately stage an intervention. But what normally happens is the service provider goes into the field, finds something wrong, it goes through the whole engineering structure and two weeks later we hear that there was a problem, at which time it's then too late. So if the environmental health section can ordinate the water quality data, from my point of view it would be much easier in terms of awareness, prevention and intervention at the end of the day.

PL: Can you comment on the effectiveness of service delivery to smaller towns / communities in the non-metropolitan areas of the Eastern Cape?

FN: Service delivery in terms of water is still an issue for everybody because of the vastness of the communities – you have two houses here and then 300m further away you have another two houses which will definitely have an impact. I think in terms of coverage of Chris Hani DM, most of our villages have access to water. There are small villages nearby as well – they don't have water supply in every

house but they have central points where they can tap water from. Our biggest issue is constant water supply, but I think most of Chris Hani's jurisdiction has been serviced. It's also not just in terms of water – all the engineering services are impacted by the layout of the villages, including sanitation and electricity, etc. It's because of what happened in the past in terms of fragmenting the people and 'putting them in a corner of the country', but also this area is very culture-orientated. There are chiefs and tribal leaders who allocate land, and that is how these small communities are established, which then become very difficult to service. Providing water and refuse removal are enormous issues for this reason; however in the deeply rural communities refuse removal is not such a problem since the communities recycle and reuse everything. They use paper for heat; they use empty cans as containers. Thus all our service delivery can create chaos, especially water, electricity, health and waste management.

SK: Do you also use members of the community to act as operators of, for example, boreholes?

FN: I think they're called community development workers. I know that when you were here last time you were talking about the system where community members are used to do monitoring, and that can work. The biggest problem with this (and we find it in other spheres like HIV/AIDS and primary health care in general), where use is made of volunteers is that their level of commitment must be high and they must be passionate about what they're doing. Unfortunately we have a culture in this country which dictates that "If you want me to assist, you must pay me", it's not, "but what can I do to better the lives of my people?" So if you get the right people, then it can work, especially if you obtain the support from the chiefs, village committees and ward councillors in the rural areas, it can definitely work. But you would have to monitor those people on a regular basis. There are different strategies to look at but I think if you look at all your community structures, you will definitely get one or two people who would assist you.

PL: Is drinking water quality data readily accessible for management and monitoring?

FN: It's available, there's just an issue with how the data is disseminated to the relevant sections. We have a program at Chris Hani which has been established by engineering; I personally have a program and DWAF has a new water quality management system. I personally think these three things don't talk to each other, and what we are trying to do is to link these three systems: if I put something in my system, it must update the engineer's system and vice versa, and at the end of the day fill in the water quality management system since this is the system which is going to be used by DWAF for monitoring of schemes, etc. I think that's one of our biggest issues in data management – there are so many systems available that don't 'talk' to each other, and somewhere down the line data is not sent to MHS, data is kept at engineering or data is being kept by DWAF, and these three are not communicating in terms of the data.

PL: So again, if it could be consolidated it would be a great improvement?

FN: Yes, definitely. Again, it comes back to us. I have the program on my computer but we don't use it at this stage. For my EHP to go into the original program and input all his data, then go to my program and input all the data, then send it to engineering for analysis. It's going to take him too long to do it a different way each time. And you have to keep learning new systems. My system is brilliant; it will notify you and certain people if there's a problem at a certain village; it will send someone in the village an email; it will send me an email from MHS. But that system is not 100% up and running as of yet but your system is only as strong as the people using it. So if one system could be made centrally available and all parties responsible for water quality had a link to that system or a notification procedure, it would be brilliant.

PL: Do you have access to basic laboratory equipment for testing of samples?

FN: Yes.

PL: Can you comment on the accuracy and / or usefulness of laboratory analyses to you personally?

FN: It's very helpful. We use the Guidelines as a reference point, but from a health point of view, if we see indicator organisms like E. coli, we know exactly how to intervene. So for me its all about intervention, in terms of the data I receive.

PL: Would you describe your approach to Water Quality Management as reactive (compliance monitoring) or proactive (preventative risk management)?

FN: Reactive. It's basically just compliance monitoring but it's not really supposed to be that way.

PL: Can you tell me about any preventative strategies which exist?

FN: In terms of environmental health, the most important thing for us is awareness. 'Awareness' is very vast in the context of water quality, but for us we look at it in terms of water contamination due to human activity and do awareness around that. I think it's also very important to look at recycling, how to save our water. We also look at community development around water sources –we look at ways of preventing those communities from contaminating current sources or new sources.

PL: So you're trying to educate the communities to prevent them from contaminating their own water?

FN: Yes, that's the main thing we're responsible for; awareness in terms of contamination routes; how does contamination occur; how to prevent it; how to treat water that's contaminated with cholera. You should remember that epidemiology and microbiology are sciences on their own; these are part of our courses (as EHP's) but for us the main thing is simple education – "don't do this, because if you do, that will happen." It also links in to finance – if a failure occurs, how much money is it going to cost to correct it or put measures in place to prevent it in the future? We don't look at it as preventing disease; we come in and attempt to remedy the situations if and when they occur.

SK: Do you find that during the rainy seasons the stormwater floods the pit latrines and the runoff enters the boreholes or rivers?

FN: Yes, that can happen. There are a lot of preventative measures that take place such as lining the VIP's, etc. The only way water can get in is through seepage since the latrine is enclosed by the superstructure. I think there are a lot more technologies available that can treat our waste for a longer term than we are using now.

SK: But are they feasible for low-income areas?

FN: I think so. I'm preparing a research document to motivate it. The main problem with pit latrines is that they have approximately a 5 year lifespan; after which you need to send in trucks to remove the waste physically. Also, they require a lot of maintenance since people throw anything you can think of into these things. It's a living organism and people don't understand that, which again is where awareness comes in. There are health consultants which come in, speak to the people, and then leave. They don't monitor the effectiveness of their talks. We are trying now to do that. If you look at the White Paper, it says that Environmental Health is responsible for monitoring and control of health and hygiene. In this district, currently, there is no EHP on a steering committee of a sanitation project that is looking at health and hygiene. I didn't get a plan on health and hygiene from any consultants. What we do is we recommend that the money allocated to health and hygiene be given to environmental health, and then employ people on a contract-basis to perform health and hygiene education. So if we could get a unit that is just responsible for health and hygiene, and we monitor it from our side, then we can do the health and hygiene, plus the evaluation of their results.

PL: Who is responsible for hazard identification and risk assessment?

FN: It's supposed to be Environmental Health. They must identify the risk and plan interventions but it's also the responsibility of the water services department.

SK: So you have inter-lapping functions?

FN: Yes, definitely. We overlap with engineers, electricians, plumbers, primary health care, medical professionals. We have a role to play in all of these. Environmental Health and Environmental Management must work together since the first affects people and the second affects the natural environment. But often we are so focused on delivering the structures that we don't worry about the one's effect on the other. It's understandable but we must change our mindset; say we must provide housing – what impact is that going to have on the environment?

PL: What training / skills development programme(s) exist to ensure employees are competent to perform tasks assigned to them?

FN: We have skills development plan, where all the environmental health people meet and identify the critical areas where we have issues. We then ask ourselves

whether or not we are competently trained in that area and take appropriate steps if we aren't. We do try to keep up to date with science and technology, and we have to gain a certain amount of CPD (continuous professional development) points every year to retain our registration. This can be accomplished by holding or attending workshops, training programmes, etc. We are trying to establish a formal programme but we have a very limited budget. Training is an issue; we have the plans but we have minimal funds from the skills development levees.

PL: Are your maintenance budgets sufficient to ensure adequate maintenance of infrastructure?

FN: I speak under correction – the required operation and maintenance budget for Chris Hani water infrastructure is R80 million. We have R20 million.

SK: Why do some provinces receive more funding than others?

FN: It relates to capacity. If you have some people who can motivate better than others, then they will receive more money toward their budgets.

PL: Are you aware of any appropriate technologies that should or could be implemented to improve infrastructure management?

FN: Specialised computer software like GIS, which can pick up faults and report it immediately. Again the biggest problem is that we don't have the capacity to run these systems, especially in the smaller municipalities where the staff is not always qualified to operate these systems. Also there could be electronic monitoring systems at the water purification plants and reservoirs; using community members for monitoring. There aren't many more technologies involved in the supply of domestic water, save for things like underground irrigation systems and reclamation systems.

PL: What impact does vandalism have on service delivery / sustainability?

FN: A large impact. Examples of vandalism are the theft of pumps which provide water from reservoirs to communities. They also steal covers and electric cables. However in rural areas you don't find a lot of theft since the communities deal very strongly with offenders.

PL: How is public awareness and involvement in drinking water quality issues achieved, especially in the case of non-metropolitan communities?

FN: The Environmental Health people are responsible for awareness; what we're going to do in the upcoming workshop is to use media like TV, radio and billboards to create awareness.

PL: What impact does community consultation, involvement and awareness (or lack thereof) have on the provision of drinking water, especially in terms of the needs of non-metropolitan communities?

FN: It's an integral aspect; they must be part of the process from a ward level up to a district level. The community has a big role to play in terms of participation. If we run a project or start a new project, then normally the participation starts at the lowest level. The ward councillors go to the communities and speak to them and take their priorities to council. Council prioritises and then sends it up to district. We assist with things when our budget allows. We've seen a lot of projects which start out brilliantly fail because of a lack of community consultation. The needs of the community must be felt by the relevant authorities.

SK: Do the communities have electricity or adequate cell phone network coverage?

FN: I think the whole district is covered in terms of cell phones and all our villages have electricity.

SK: What type of water sources are in use in these communities?

FN: They harvest rainwater, use boreholes and springs, but mostly boreholes.

SK: Have you found that the awareness programs improve the hygiene practices and reduce the incidences of illness?

FN: Because we are not currently engaged in high-level awareness, I don't have any data on that but it normally works. If you look at the cholera outbreak 4 years ago, the communities would wash the corpses as part of their traditional practices. With our awareness campaign, they stopped that practice for the duration of the outbreak. So just on that small incident, you can see it definitely made an impact. It is hard however to measure the impact since if people stop falling ill, it's not necessarily the awareness campaigns which have prevented further cases of illness.

SK: Do you promote the use of HTWS in the rural areas?

FN: No, we don't but I know the WSA does.

SK: Would the municipality be willing to subsidise a project on this?

FN: Yes, I think so.

SK: Do you feel the use of low-cost technology such as solar disinfection, boiling, safe storing would be effective in this context?

FN: Yes.