THE MANAGEMENT OF WATER QUALITY ALONG THE UMLAZI L-SECTION STREAM (KWAZULU – NATAL PROVINCE – REPUBLIC OF SOUTH AFRICA)

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Abstract
According to the South African Constitution everyone has a right to an environment that is not harmful to their health or well-being and that environment must be protected through prevention of pollution, ecological degradation and must promote conservation. Water pollution observed at the Umlazi L-section stream can be caused by using stream as dumping site posing environmental, health risks. This study employed the use of quantitative measures to conduct the research and systematic experimental case study which showed empiricism value on this study rather than an ideology through a scale of triangulation. In order to ascertain the management of water quality between downstream and upstream, water samples from the Umlazi L section stream were taken and analysed in the laboratory comparing water quality parameters between the upstream and downstream samples. Also the perception of community members with regard to government standards on water standards and causes of poor water quality was determined through a survey. This important issue and other issues as concerns water will be discussed in this paper.

Key Words: Management, Water, Quality, Stream. Environment, Pollution, Degradation, Health Risks, Perception, Community

Introduction
This study investigates the current challenges faced by the river’s environment which includes the decrease of clean water around the globe. More specific to this, the study looks at the management of the stream at Umlazi Section L. In South Africa, access to clean water is one of the fundamental constitutional rights for the citizens. In light of this, a study that investigates how effectively and efficiently water is managed in and around the dwellings of ordinary South Africans is necessary to assist the relevant departments and stakeholders to identify how well they are succeeding in their mandate to manage and provide clean water and sanitation to the people of South Africa and of Umlazi L Section.

Aim of the Study
The aim of this study is to ascertain the management of water quality between downstream and upstream water quality.
Objectives of the Study

- To determine and compare the management of quality of water between downstream and upstream;
- To determine the perception of the community on government standards in regards to water quality;
- To determine the perception of the community regarding the causes of poor water quality; and
- To make recommendations to the Department of Water Affairs (DWA) on appropriate measures that may need to be introduced to increase and maintain the quality of water in the community.

Literature Review

The Significance of Water Management

The demand of water as a natural resource is greater than supply. With a continuous climate change, population increase, globalization and increase in food prices the significance of water management is enhanced. As South Africa is considered a water stressed country as it only receives annual rainfall of 429 millimetres in general and semi-arid region with high rainfall variability, characterized by frequent droughts and floods according to (Engelbrecht et al., 2011) and Theron, 2011, yet the state of the water quality is also deteriorating due to an increase of water pollution caused by urbanisation, destruction of wetlands, human activities result in low levels of safe water thus extensive water treatment processes is required (Shaw & Thaitakoo, 2015).

Water Storage

Dam construction was for water storage during drought season is vital in water management. However, South Africa is facing drastic challenges and changes, firstly due to climate change in terms of rainfall there is a 44% decrease in water level of Hazelmere dam according to Ethekwini Municipality (2014). Secondly the human sewage pollution through sewage pipe spill has also that caused an increase of algae growth and this has and will eventually results in the intense water purification process which also will increase prices tap water supply as Madman Dam is facing this threat (Carnie, 2014).

Urbanization

Urbanization contributes to the deterioration of water quality as migrated people face diverse difficulties in a new place, and often population pressure in a new place also creates water shortage. Therefore, migration presents a social dilemma where people migrate for better lives but often end up in more degrading situations according to Basu and Shaw (2013). According to Quibell (2011) South Africa’s National Strategy for Managing the Water Quality Effects of Settlements suggests that areas with a density of over 35 dwellings per hectare may be prone to pollution problems. Using an average of 4 people per household, this equivalent to 140 people per hectare. 60% out of the 85% of urban population live in natural depression area that lies in South Africa. Demographic Factor Currently, the world’s population is increasing by around 80 million per year and is expected to reach 8.5 billion by year 2025 (Quibell, 2011).

In the 20th century, the world’s population was estimated to 1.6 billion people, but by 1990 it increased to 7 billion (Habiba et al., 2014). As any human settlement will produce waste, Hanks et al. (2007) argues point source pollution management is highlighted a growing problem. Non-point source pollution from poorly serviced or unserviced settlements, however, also poses a problem.

Per Capita Effect

Manning (2008) maintains that water demand can be influenced by two factors, namely demographic trends and patterns of food consumption. While, Singh et al. (2010) believes that global demand for food is determined by population growth and minimum physiological requirements. Data indicated that global food supplies only rose above 2,700 per capita per day in the 1990s and are projected to rise to 3050 kcal per capita per day by 2030 (WHO, 2007).
Per capita usually associated with country's income level, it takes into consideration changes in prices, inflation to the average person's income giving an overall estimation of country's costs of living or average income distribution. According to Macleod (2008a) states that population increase in South Africa has resulted have no access to proper sanitation facilities, while disconnections of water supply was associated with failure or ignorance to report leakage or even citizens not affording to pay their water bills (Macleo, 2007). Balley and Buckley (2005) maintains that Durban water consumption decreased as water prices increased from 2003 especially for low income citizens, while Durban water prices were discovered to be higher than the rest of the 3rd world class (UNDP, 2006 & Carnie, 2014).

The population increase resulted in low supply of sanitation but high water rates while income inequality also increased due to high unemployment level, then Leibbrandt et al. (2010) and Bond (2010) argue that unemployment in urban areas has increased. It is due to these factors that economic growth will be affected in terms of per capita per day. Manning (2008) maintains that without water security, there will be no food security, energy security will be compromised, and poverty reduction and economic growth will not be sustainable as is case.

**Illegal Dumping Monitoring**

Illegal dumping according to Etengeneng (2012) is defined as garbage that is not contained in black bags such as garden refuse, Illegal dumping is also referred to as an instance where solid waste is disposed of in inappropriate manners in places such as drains, roads, near rivers and on private and public land that is not legally approved for such a use (Ball, 2014 cited United States Environmental Protection Agency, 1998).

The impacts of illegal dumping includes threats of: vegetation destroyed as leachates absorption; contamination of water sources like river; devaluation of land or property; diseases like tuberculosis, asthma and malaria such mention the few and susceptibility to floods Ali et al. (2014) According to Ali et al. (2014) leachates is caused by leakage of heavy metals from waste such as copper and this has the potential to destroy vegetation affected by illegal dumping. While Simanjuntak (2014) maintains that water source contamination is possible when the river source is adjacent to the illegal dumping site and this usually occurs during the rainy seasons. Illegal dumping contributes heavy on devaluation of the land and property surrounding the dump sites (NWS Environmental Protection Agency, 2013). The community members around the dump sites have been reported to have been affected by diseases such as tuberculosis, asthma and malaria (Etengeneng, 2014 and Bockarie, 2011).

According to Chapter 2 of The Bill of Rights, section 24(b), (i- iii) states that the environment must be protected through the prevention of pollution, ecological degradation and promoting conservation (South Africa, 1996). Yet, the by-laws although clearly stipulated but it has not been enforced. There are no physical consequences for such an act and this can be due: to lack of efficient monitoring system; no identification of dump sites; lack of private-public participation; ineffective educational awareness campaigns; and lack of community motivation and change of focus from unwanted material dumped to making money of such through recycling (Ball et al., 2014).

Since poor water management is a life threatening concern as it competes with globalization in terms of geopolitical power, technological innovation culture and values changes. This then leaves one with questions like: will this clean water be enough for present time and the future, and whether this clean water will not be compromised by 21st century drastic development demands or whether human beings perception towards water conservation issues change (Jennings et al., 2009:1).

One of the macroeconomic objectives of South Africa is stability of prices and this is associated with inflation rate regulations. It is the government's obligation to try and keep the inflation rate as low as possible so as to meet the other macroeconomic objective of the country which is economic growth per capita (Mohr & Fourie, 2008:197-221).
However, the two mentioned macroeconomics objectives can be limited and affected by the mismanagement of water as food prices are directly influenced by agriculture industry which is directly affected by weather conditions which is affected by availability of water for that particular season (Schiller, 2008:109-141; 332-349). It is therefore crucial for the government and its departments in this case DWA to establish laws that will not only protect the natural resources, but also educate the citizens about the importance of the laws associated with water management.

Laws Associated With Water Management
What is Water Law?
Van de Water et al. (2008) argue that law is a set of rules binding to all in decision-making through legislation of the state. While Burton et al. (2005) describe water law as a tool that should contribute in influencing people and water governance to adaptive and respond to climate change effect. Gradin (2011) describes water law as a foundational institution that should ascertain conflicts solutions with regards to water management. And from the above factors of water management significance, influenced by drastic changes in the globe that is determined water management laws is essential to save the little that is remaining.

According to Chapter 2 of The Bill of Rights, section 24(a) everyone has a right to an environment that is not harmful to their health or well-being. While section 24(b), (i-i) states that the environment must be protected through prevention of pollution, ecological degradation and promoting conservation (South Africa, 1996).

Stream Water Governance Regulation
Streams flow to rivers and rivers flow to dams. This trend shows the importance of the management of water quality along the Umlazi L-section stream. An increase in water pollution cannot be mainly categorized to industries, but citizens as well. Citizens add to water pollution of rivers and stream by using stream as a dumping site, this act does not only affect the inflation rates of the country, but also the whole ecosystem of that particular river as water quality deteriorate.

According to Hanks et al. (2007) solid waste litter and sewage from waste water treatment plants are some of the activities that contaminate water from streams and is described urban pollution. As is the case at the Midmar Dam where human sewage pollution that causes an increase of algae growth can eventually increase water supply as Midmar Dam supply Durban area with tap water. A shift of focus from stream management by industries and the government to citizens maintaining water quality is essential with penalties if this not done for the survival of the next generation. Hanks et al. (2007) maintains that any human settlement produce waste, whereby the urban point source management continuous to be growing concern and non-point source pollution from poorly serviced or unserviced settlements also poses a significant problem.

Urban Water Pollution Regulation
In South Africa the demand for new housing grows at a rate faster than houses that can be provided by local government. Hence informal settlements have an expanding component of urban development in South Africa. Almost 19% of South Africa’s population live in informal settlements in the urban areas. While many studies have shown that water quality is deteriorated downstream of these settlements, with high levels of faecal coliform, solid waste and organic pollution, posing health risks for those living in these areas and surrounding (Quibell, 2011).

The biggest threat of water management is not lack of storage rather contamination of quality water availability due to pollution (CSIR, 2010). While, Carnie (2008) maintains that sewage blockage was due to illegal dumping of for example sheep heads, newspaper in these pipes. Then correct applications of water management laws will not only improve the lives of the citizens surrounding that stream or river, rather the entire ecosystem which includes fish and plants of that resource due to an increased water quality of the stream. As a result R 2 billion needed for upgrade and repair of water infrastructure (Carnie, 2014).
Tibert (2008:18) argues that EMS must be documented, implemented, maintained and continuously improved. Therefore DWA may want to re-evaluate the polluter-pays principle states that countries should adopt environmental charges and penalties to it citizens or organizations responsible for polluting the environment. Re-evaluate the polluter-pays principle as according to Barrow, (2006) that states that environmental charges is enforced organizations responsible for polluting the environment, but rather this law should include citizens of the country responsible for water management as well. As water is a key factor in the achievement of each of the Millennium Development Goals.

Despite the reliable supply at the current state, future water supply faces potential challenges from climate change and declining rainfall. To meet the long term demand for potable water and respond more effectively to the unpredictable climate changes, the Government promulgated the Total Water Management Strategy in October 2008. The Strategy puts an emphasis on containing the growth of water demand through conservation (DEA, 2013).

**Continuous Water Conservation Device Effect**

Effective water consumption can only be realized through the combination of technological and socio-behavioural strategies according to Lau et al. (2012). Water saving devices, however efficient they are, would end up wasting water if operated by people with careless minds. However, high-technology equipment may not necessarily be the solution without the active participation and regulated water use behaviour of residents. Research by Lau et al. (2012) cited Geller et al. (1983) has found that the installation of water conservation devices (aerators, cisterns, automatic controls in irrigation, etcetera) alone cannot achieve the expected savings of water and energy, because by knowing the saving capacity of new products, people tend to justify the over-use of the water resource and end up consuming same or even more (Fang et al., 2015).

Muraguri (2006) cited Holtermann (1972) who differentiated between the provision (supply) and utilisation (demand) for a public good in that it may be public in terms of supply and availability, but its use may contain aspects of a private good in that demand varies between individuals and the greater one individuals demand the smaller the amount available to others. Food and agricultural food production could therefore be defined as a mixed good rather than pure good in that the land itself.

It is therefore crucial for the government and its departments in this case DWA to establish laws that will not only protect the natural resources, but international environmental laws like the precautionary principle should be highly enforced in this country. Globalization factor in this case, where South Africa's two projects of Medupi power generating station and expansion of Durban's south Transnet petrochemical plant should consider precautionary principle. This principle state that risks and uncertainties to the environment must be established first before the development or project proceeds (Barrow, 2006:128).

**Water Ethics as Democratic Right**

According to Astroulakis (2011) water ethics based on substantive and decision making process values, such as democratic governance rights, active participation, transparency, accountability, and public collaboration and partnership is essential. Through determination of the community perception with regard to government standards, the study will determine some of the factors that hinder active participation of citizen on stream management. The active participation of community members is part of RHP of DWA objectives (DWA, 2013). It has been recognized in the above information that water management strategies are inherent in the Act and therefore can be accessed to ascertain what needs to be done in terms of managing the stream under investigation so that the community is not at risk of any related disease (Texier, 2008).

This will also highlight the DWA success in productivity and performance in ensuring that its core functions regarding managing and sustaining the stream for equal benefit, eradication of health risks
factors as well as uplifting communities amongst other things highlighted in the ACT.

**Water Treatment**

In order for this study to ascertain the management of water quality in the stream, water treatment attribute must be considered. Water quality is defined as a method of removing contaminants in water that can be harmful (Pollution Issue, 2015).

**Urban Water Treatment Programme**

Government Drop Green initiative focuses on ensuring and monitoring industries from polluting the rivers and streams as according to section 24(b) that tackles the issues of pollution and degradation of environment through protection and prevention (South Africa, 1996). However with the increase of water shortage, government’s focus on industries more than on community’s impact on water quality would have negative result if an integrated approach is not applied. This approach of refraining community members from dumping in stream would reduce stream pollution. Again this integrated approach can also assist in decreasing government spending on water treatment and also minimise health related costs associated risks of poor stream management (DWA, 2014).

According to Tryland et al. (2011) the presence of faecal coliform and E.coli bacteria in water indicates that water is contaminated with faecal material and therefore this has tremendous re-pp cautious on the physical and chemical composition of water which also deteriorates for example the dissolve oxygen decrease in poor water quality, dissolve oxygen concentration act as indicator that can lead to death of marine species like fish especially in warm weather conditions.

**Water Quality**

Water Quality is determined by comparing the physical, microbial and chemical characteristics of water sample with water quality guidelines or standards. Drinking water quality guidelines and standards are designed to enable the provision of clean and safe water for human consumption, protecting human health. These are usually based on scientifically assessed acceptable level of toxicity to either humans or aquatic organisms (UNDESA, 2014).

Thuiller (2007) states that general population growth; industrial development and general global change have great negative influence on river's ecosystem. Hence lakes and reservoirs are susceptible to eutrophication due to human impact. Quality of water deteriorates in urban areas due to overuse of land resources for housing as it close to the industries resulting in river pollution which later can require waste water treatment (Carvalho & Fidélis, 2009).

**Water Quality Indicators**

There are national even international accepted levels of the above mentioned variables expected on the streams water. Therefore the results obtained from the laboratory on samples collected should be compared against such standards (UNDESA, 2014 & DWA, 2013). Higher levels of such indicators will set as an alarm of concern for water management stream of Umlazi L section stream and also on health of citizens surrounding this area.

This study will focus on selected variables of physical indicators such as pH and turbidity. For microbial indicators: E.coli and coliforms will be examined and for chemical indicators: dissolved oxygen and chemical demand oxygen.

**DWA’s Service**

A service, according to Yeo (2008) is a valuable action conducted in order to satisfy a need or a demand. Services are also intangible products such as accounting, banking, cleaning, consultancy, education, insurance, expertise, medical treatment, or transportation. Sometimes services are difficult to identify because they are closely associated with a good. In cases where service is sold and no transfer is required and they (1) are instantly perishable and (2) come into existence at the time they are bought and consumed.

A service in the regard of the Umlazi L Section is the intangible action that will demonstrate from the DWA they value their livelihood and promote a clean and healthy environment for all citizens. Also the quality of the findings from the laboratory can add in determining the perception of
community members on the causes of poor water quality of the Umlazi L Section Stream.

Act no.108 of 1997 states that it is the minister’s obligation to maintain and monitor the performance of all water services institution. The values of the DWA affairs includes: transparency, respect, excellence. All of these values are centred in serving customers’ needs and through leadership who are available at all times to serve. The actual customers are all water users across all sectors (DWA, 2014).

**Availability and accessibility of Environmental Knowledge**

The white paper according to Constitution of the Republic of South Africa was designed to be a tool that will grant every South African citizen an opportunity to participate in decision making of new law or regulation construction. The white paper’s aim was also to get an overview opinions of the South Africa citizens as stipulated in the constitution as the democratic right of the citizens to partake on government issues (DEA, 2013).

Environmental knowledge according to Haron et al. (2005) can be defined as the ability to identify environmental problems, causes and it effects. Yet, there still seem to be a lack or contradiction with regards to the environment knowledge in South Africa though, South Africa still generate approximately 469 million tons of waste per year that destroys the environment according to Theron (2006) and according to Hanks et al. (2007) solid waste litter and sewage from waste water treatment plants are some of the activities that contaminate water from streams and is described as urban pollution. Hence, the accessibility of the environmental knowledge that transform citizens to make environmental friendly decisions seems to be limited in South Africa according to Swinker and Hines (2006); Momberg et al. (2012).

Also, in 1998, DWA implemented a National Environment Management Act (NEMA) of no 107 of 1998. The NEMA was implemented with the objectives that includes making the decisions taken to be opened and transparent, for information to be accessible, in order to ensure that the cost of pollution remedy and degradation of the environment is paid that could have even the health of the citizens of the country, and to it provide tools to protect the environment.

Only four provinces in South Africa have hazardous waste facilities. The use of waste avoidance and reduction model (4) in order to minimise waste for example plastic bag levy initiative where customers still did not reuse the plastic bag even after paying a levy. This act can be viewed as an element of behavioural change and shortfall of implementation progress. Recycling promotes clean and safe environment, promotes also social and economic benefits (Perella, 2013).

The use of waste-to-energy (WtE) which prevents waste than recover even energy. This approach will have positive benefit on the economy of each organisation or even the country, as more energy will be regained from residual waste while waste is reduced. For recycling technique to be successful, advance technology must be considered in order to create job opportunities. For example the campaign of collect- a-can has been able to feed thousands of citizens. Mondi has other initiatives as well where they buy used paper form the communities (Eurostat, 2013).

**Research Methodology**

**Target Population**

According to Lind et al. (2005) a population can be defined as set of entire individual or objects of interest or the measurement obtained that is from all individual or objects interest. The objects of interest for this study were community members of 250 in number and local which were also responsible for managing and sustaining water resources, in particular the Umlazi L Section Stream was seen as invaluable in achieving the aim of this study. The input from this group enabled the study to gain perspective on the issues surrounding the management of the Umlazi L Section Stream.
Sampling

Water Sampling

The sampling method that was used was experimental systematics using a 1-way ANOVA with replicates at every 250m interval. 10 samples were sampled from upstream to downstream. ANOVA was used to test the null hypothesis of the means of not more than two variables or means, upstream and downstream only and the Turkey’s HSD was used in order to determine the significance different of means that are more than two for water analysis which compared 6 variables of E.coli, sulphates, COD, coliforms, Ph. and TDS and these tests are called post hoc comparisons for this research.

Limitation of Study

Saunders et al (2009:395) researcher need to gain access to sample population and attempt to maximise the response rate. The researcher encountered no limitations with regards to the study as the participants were willing to be part of the study as this issue directly touches their everyday life. The participants completed the questionnaire at the respondent's own pace, and the respondents were also given a chance look through the whole questionnaire before committing themselves to anything by this, the researcher avoided the problem of respondents beginning an interview by answering in a very defensive way. The researcher and her team explained the questionnaire and translated the questions into an appropriate language to the participants where there were uncertainties (Saunders 2009:190-194; Brikci and Green, 2007:5).

Results, Discussion and Interpretation of Findings

Response Rate

The response rates obtained for this research is shown below on Table 4.1

<table>
<thead>
<tr>
<th>Table 4.1: Response rate for the population</th>
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<tr>
<td>Whole population of the citizens along the stream</td>
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<tr>
<td>Citizens selected for research</td>
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<tr>
<td>Total of citizens that responded</td>
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<td>Non-response Bias</td>
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<td>Usable responses</td>
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<td>Un-usable responses</td>
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<td>Usable response rate</td>
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From the total population of 250 members only 120 citizens that live along the Umlazi L-section stream were selected for the study and only 113 responded and from this 113 only 6% of citizens did not return the questionnaires and all 113 questionnaires that were returned or collected back all were usable for data analysis making a total of 94% response rate.

Demographics

According to Barnes (2013) identification of people by gender and age are some of the factors relevant to avoid stereotypes as gender neutral words were used. Criterion validity and content validity to determine accuracy of the information was also determined as part of business research guidelines for this research. 61% of the citizens that participated in this study were the youth, between the ages of 18-35 years, followed by 23% between the ages of 40-60 years. 56% of the participants were females and 44% males. 25% of participants were the majority of the citizens that have stayed between 25-30 years in this area indicating that these citizens have enough experience and exposure about the developments and environmental concerns of this area. Only 7% of these citizens have lived in this area less than a year to be less informed about the study of interest and minimizing the limitation of bias for this study (Pannucci and Wilkins, 2010:1-7).
Community perception

Figure 0.1: Citizens are responsible for the management of water quality resources in the Umlazi, Durban area

![Citizens are responsible for the management of water quality resources in the Umlazi, Durban area.]

Figure 0.1 indicates that only 49% of the citizens indicated that they agree that they are responsible for the management of water quality resources in the Umlazi, Durban area. This implies that more than half the population are susceptible in mismanaging water as they do not consider being responsible for such, hence they can even be contributing willingly to water quality deterioration. Hulbert (2009) maintains that part of water governance role is to implement social acceptable regulations that changes community's behaviour and values towards environmental responsible society. These water governance regulations are to enhance community members to participate also in decision making government departments engages in decentralisation process through engagement of every stakeholder involved.

Figure 0.2 The citizens are well equipped to manage the water quality in the stream

![The citizens are well equipped to manage the water quality in the stream.]

Figure 4.2 indicates that 58% of the citizens indicated that they are not well equipped to manage water quality. Such findings indicate that citizens are faced with challenges in managing the stream effectively and this could be due to lack of community empowerment by the government. The government is meant to deliver appropriate support and training to the community members such that the community members end up being able and willing to participate. Since the process of equipping involves preparing someone both mentally and with resources for a particular activity. Mental equipping can be through training and resource equipping by supplying those resources (Adamson, and Bromiley, 2013).

Etengeneng (2014) argues that a proper and efficient public participation requires training in order to equip the community members to relevant during the process of decision making.
Figure 0.3: The citizens are responsible for the current unappealing state of the stream

Figure 4.3 shows that 60% of the citizens acknowledge their responsibility for the unappealing state of the stream. This percentage indicates that the stream condition should be clean; however there seem to be gaps in the implementation or understanding since there is a growing concern about urban pollution in South Africa. Yet South Africa’s Constitution state the environment must be protected through prevention of pollution (South Africa, 1996). This can be caused by the bylaws that are clearly stipulated but not yet been enforced (Etengeneng, 2014). However this illegal dumping contributes heavy on devaluation of the land and property surrounding the dump sites and spread diseases and spread of disease such like tuberculosis (Etengeneng, 2014 and Bockarie, 2011).

Anderson (2009) argue that responsibility is a two way street both for the management to manage and monitor change or progress of duties and responsibility of those entrusted with that facility, structure or resource to manage it well.

Figure 0.4: The citizens are effective in managing water quality in the stream.

Figure 4.4 show that for statement 4: 69% of the citizens disagreed that they are effective in management of the stream. Such findings indicate that citizens are faced with a challenge of effectively managing the stream and this can be caused by poor leadership and communication skills (Anderson, 2009). Hough et al (2011) maintains that leadership is determined from inside out starting from the personal level of a leader skills to show the ability to motivate people to follow him or her when he is directing and willingness to help the people in finding meaning to the challenges they are facing by identifying threats and opportunities, then lastly managing those people through developing and empowering them.

While Brown (2011) believes that teamwork is ideal in sharing the burden of monitoring the stream
that is in the unappealing state. The concept of community empowerment brings with it the potential for better, more citizen-focused services, yet these are only achieved at a financial cost and will require a reshaping of individual, professional and institutional cultures.

Figure 0.5: The stream is maintained or clean from upstream to downstream.

Figure 4.5 shows that: 83% of the citizens disagreed that the stream is well maintained from upstream to downstream, with 43% that strongly disagree. There are many factors that can contribute to such findings and these include: illegal dumping, increase in population, poor infrastructure, poor sanitation and urbanization just to mention a few. Hanks et al. (2007) maintains that any human settlement will produce waste, whereby the point source management of urban pollution remains a significant and growing problem. Non-point source pollution from poorly serviced or un-serviced settlements, also poses a significant challenge. Anderson (2009) argue that responsibility is a two way street, it for the management to manage and monitor change or progress of duties such is the case with RHP which now involves stream management according Act 107 of 1998, and responsibility of those entrusted with that facility, structure or resource to manage it well in this case the responsibility of citizens not to pollute the environment as Constitution stipulates, and this should all be a part of decision making with regards to water law legislation of the country.

Figure 0.6: Citizens can use the stream as a dumping site.

Figure 4.6 shows that: 76% of the citizens disagree that the stream can be used as a dumping. Yet the Umlazi L-section stream is still identified as a dumping site. This type of behaviour by the citizens shows that there is a lack of understanding in the factors that contributes to poor water quality of the stream and rivers and the consequences of such. For example, illegal dumping has a potential to destroy vegetation especially when heavy metals from waste such as copper has leaked,
increase high risks of rats increase around the area that also has potential of transmit diseases like tuberculosis (Ali et al., 2014).

Brown (2011) maintains that different factors can influence community’s perception and behaviour for example ignorance, laziness, resistance to change just to mention a few. Laziness defined as the state where resources are available but no interest of using them is shown by those the given personal. Bella (2014) state that about 81.3% and 64% of both suburb and township responses indicated that illegal dumping at Grahamstown was mainly due to laziness and carelessness. While the study estimated that around 700 million people worldwide were affected by water scarcity economic development (Abedin et al., 2013 cited Kataoka 2002 & Philips, 2015). Therefore the theory of evaluating the perception process in stages like interpretation, selectivity and the use theories of determining the sources of resistance to change include: is necessary in assisting in managing strategic change of society's perception on water management and it significance especially if the changes are drastic this can lead to resistance of change on the individuals (Brown, 2011).

Therefore an integrated approach to change using an agent of change is necessary that poses skills of leadership; project management; communication; problem-solving; interpersonal and personal skills. These personal can create DWA-community relationship as he or she focuses on a diagnostic approach process to identify the problem, collect data from the community with the aim of closing the gap of performance on DWA side and understanding the lifecycle of resistance to change (Brown, 2011).

Figure 0.7: There is satisfactory waste collection system in this area.

![Figure 0.7](image.png)

Figure 4.7 shows that: 51% of the citizens agreed that there is a satisfactory waste collection system in Umlazi L-section.

These findings implies that 35% of the citizens still feel that there is not enough waste collection system in this area and, this can be a factor that cause citizens to continue with illegal dumping. Yet Bella (2014) maintains that the government can save up to R20 billion if citizens can play a part in waste collection process by using the plastic bags provided to them by the government. This money can be used for empowering and creating more job opportunities. Since the state of satisfactory is defined as a state fulfilled expectations or needs, then it citizens perception towards water management has to improve.

There still seem to be a lack or contradiction with regards to the environment knowledge in South Africa. South Africa still generates approximately 469 million tons of waste per year that destroys the environment according to Theron (2006) and according to Hanks et al. (2007). The accessibility of the environmental knowledge that transform citizens to make environmental friendly decisions seems to be limited in South Africa (Swinker and Hines, 2006; Momberg et al., 2012).
Figure 4.8 shows that: 69% of the citizens agreed that water supply for household activities is adequate.

According to the above findings the government has done a far job in providing clean water to it citizens for survival till so far. However, the demand of water as a natural resource is becoming greater than it supply by day due to continuous climate change, population increase, globalization and increase in food prices the significance of water management is enhanced.

25% of the citizens that disagreed can be affected by the population increase in South Africa (Leibbrandt et al., 2010 and Bond, 2010). This has resulted in low supply of sanitation but high water rates while income inequality also increased due to high unemployment level, while disconnections of water supply was associated with failure or ignorance to report leakage or even citizens not affording to pay their water bills (Macleo, 2007). Bailey and Buckley (2005) maintains that Durban water consumption decreased as water prices increased from 2003 especially for low income citizens, while Durban water prices were discovered to be higher than the rest of the 3rd world class (UNDP, 2006 & Carnie, 2014). While, adequate water supply in the households minimizes health risks related to use of unsafe water due to shortage of water supply.

Figure 0.9: For sanitation, community toilets are used frequently used as opposed to private house toilets.

Figure 4.9 shows that: 38% of the citizens disagreed that they use community toilets more than private toilets.

These results suggest that 35% of the citizens are limited by accessibility or even by distance in using such facilities. Public toilets provided by the government are only accessible during the day due to safety reasons. These toilets are monitored by the elected member of the community to open and close them so citizens may be disadvantaged in using these toilets especially during the night. The communities in such areas still use un-flushed toilets that pose high risks on disease spreading.
such as diarrhoea especially during rainy seasons due to the infrastructure of this area.

Figure 0.10: For sanitation, community toilets used are far in terms of a distance.

![Graph showing sanitation perceptions](image)

Figure 4.10 shows that: 46% of the citizens agreed to that community toilet are far in terms of distance.

Such findings indicate that most citizens still prefer the use of house private toilets instead of community toilets due to the fact that such community toilets are far especially for elderly and sick citizens and not safe to be used at night.

An estimated 8.3% of households in South Africa still have no toilet facility or are using the bucket system (Stats SA, 2007). Municipalities are therefore faced with a number of challenges regarding the provision of complete and effective sanitation services. Inadequate disposal and use of sludge was found at 81% of the sewage plants surveyed (DEA, 2013).

Figure 0.11: Sanitation of this area promotes or contributes to contamination of the Umlazi L-section area.

![Graph showing sanitation contamination](image)

Figure 4.11 shows that 50% of citizens agreed that sanitation promotes or contributes to contamination of the Umlazi L-section area.

From these findings, it is clear that only half of the citizens clearly understand the effect of poor sanitation on stream water quality. This can pose a risk whereby citizens can introduce pollution in terms of sanitation resulting in stream contamination unknowingly which contributes to poor water management. Since streams flow to rivers and rivers flow to dams therefore citizens must be educated factors that contribute to poor water quality factors.

These results infer that 50% of the citizens in this area are unaware of the impact of sanitation on environmental degradation. While Shaw and Thaitakoo (2015) state that water quality deteriorates due to an increase of water pollution caused by urbanisation, destruction of wetlands, human
activities result in low levels of safe water thus extensive water treatment processes is required. South Africa is facing drastic challenges and changes, firstly due to climate change. While Carnie (2014) maintains that the human sewage pollution through sewage pipe spill has also that caused an increase of algae growth and this will eventually increase water prices of water tap supply as is the case at Midmar Dam.

Figure 0.12: Infrastructure is satisfactory for improving water quality of the stream.

Figure 4.12 shows that: 60% of the citizens disagreed that infrastructure in this area is satisfactory for improving water quality of the stream. These findings indicate most citizens in this area are living in poorly developed area. According to Quibell (2011) water quality is deteriorated downstream of the informal settlements informal due to poor infrastructure and this caused contamination of high levels of faecal coliform, solid waste and organic pollution, posing health risks for those living in these areas and surrounding. While the growth rate of demand for new housing in South Africa was higher than houses then what the local government could provide (Quibell, 2011).

The biggest threat of water management is not lack of storage rather contamination of quality water availability due to pollution (CSIR, 2010). While, Carnie (2008) maintains that sewage blockage was due to illegal dumping of for example sheep heads, newspaper in these pipes. Then correct applications of water management laws will not only improve the lives of the citizens surrounding that stream or river, rather the entire ecosystem which includes fish and plants of that resource due to an increased water quality of the stream. As a result R 2 billion needed for upgrade and repair of water infrastructure (Carnie, 2014).

Surface and drinking water quality, in peril-urban and rural areas, is further compromised by unskilled plant operators, old and inadequate infrastructure and poor maintenance. Interruptions in the water supply and provision of poor quality water are common in these areas. The 2008-cholera outbreak in Limpopo is just one deadly example of poor water quality management (CSIR, 2010). While almost 19% of South Africa’s population to live in informal settlements in the urban areas with poor infrastructure since infrastructure is categorized into service and development (Quibell, 2011).
Figure 0.13: Members from the community have suffered from diarrhoea or bilharzia diseases while staying in this area.

![Bar chart showing percentage distribution of members from the community who have suffered from diarrhoea or bilharzia diseases](image)

Figure 0.13 shows that for statement 13: 48% agreed that they have suffered from diseases like diarrhoea, 31% disagreed. These findings indicate that almost half of the population is at risk of diseases due to poor water management. Water can pick up pathogenic contaminants. Among the most prominent water-borne pathogens of recent times are protozoa Giardia and Cryptosporidium, Salmonella, Shalala etcetera and some of these agents can survive longer without a human host, hence water sources must continuously be monitored by using bacteria indicators. The most useful monitoring pollution is gram-negative rods called coliform. These survive in water but do not multiply there. Finding a high numbers thus implicates recent or high levels of faecal contamination. According to Cowan (2012) water monitoring to prevent disease-causing epidemics of cholera have killed thousands of people, and an outbreak of Cryptosporidium in Wisconsin in the 1990s affecting 370 000 people was traced to a contaminated municipal water supply. In a large segment of the world's population, the lack of sanitary water is responsible for billions of cases of diarrheal illness that kills 3 million children each year. In the United States, nearly 1 million people develop water-borne illness every year.

Figure 0.14: The Department of Water Affairs frequently conducts water quality tests to ascertain contamination levels.

![Bar chart showing percentage distribution of citizens' opinion on DWA conducting water quality tests](image)

Figure 0.14 shows that: 81% of the citizens indicated that DWA does not conduct water quality tests and 41% strongly disagreed. These findings indicates that majority of the citizens have witnessed DWA fulfilling its duties of stream monitoring in this area. Such findings can negatively destroy DWA management and
leadership style. Hough et al. (2011) maintains that leadership components includes interpersonal skills of building a mutual trust and cooperation where everyone understands the vision of the organization and can witness the diversity of the techniques used in resolving challenges faced by that organizations. According to Anderson (2009) there must be a variety teaching methods in order to make the learners active and improves thinking capacity, decision making and problem solving skills. According to the NEMA Act, the DWA is expected to monitor the rivers and the streams even through water quality testing as according to the RHP. Yet 81% of the citizens according to this survey disagreed that the stream water quality test are done in this area

According to Carvalho and Fidélis (2011) there is a need for different approach in engaging community participation besides the use of white paper which is usually at the beginning of the law construction. Part of the process and definition of fair water governance should include public participation as a stakeholder involved. Such stakeholders should be engaged in an on-going development that pertains to water related issues. This is the governmental rights of the citizens of that country to be well informed and not only that, but be part of the process of such changes. Resistance to such changes and developments can be influenced by less participation and involvement of community members. Hence, pollution has increased in % in the urban areas. Public complaints are an important indicator of environmental issues (Carvalho & Fidélis, 2011).

Figure 0.15: The Department of Environmental Affairs engages in projects to address the results of the tests taken from the stream.

Figure 4.15 shows that: 87% of the citizens stated that the government does not engage them in addressing the results obtained from the stream.

Such finding with 49% strongly agreeing implies that citizen’s perception on DWA duties on stream management is poor. This however contradicts with the NEMA Act of no 107 of 1998 which stipulates that information must be transparent to every stakeholder involved as part of water governance practise. While Anderson (2009) believes that commitment to the government in informing it citizens can be also be used as another method of DWA to enhance it commitment in changing the perception of community members with regards to the significance of water management. Hough et al. (2011) believes that for a successful strategy and execution alignment in the organization the management or leadership must be able to help it people to interpret the meaning of events and explain why those events or activities are important. Yet according to the results shown in figure 4.15 81% of the citizens maintained that the government has not engaged to programmes that explain the results found when analysing water quality of the stream of this area.
Figure 4.16 shows that: 83% of the citizens agreed that the stream is smelly with 64% that strongly agreed and these findings infer those citizens are not satisfied with the state of the stream’s condition.

According to Oram (2014) smell of water is the first clue that indicates there is a problem with that water and this can be caused by chemicals, bacteria and even toxic. There are different types of smell or odour and these include: hydrogen sulphide bacteria that gives smells like rotten-egg and musty odour; oil contamination that gives oily smell; organic decomposition that gives phenolic smell and; industrial contamination that gives chemical smell (Oram, 2014). Yet 83% of the citizens from this survey indicated that this stream is smelly with 64% that strongly agreed.

However according to Carvalho and Fidélis (2011) public complains submission with regards to environmental issues approach can help in monitoring the environmental programs that are implemented by the government. This approach will also aid and enhance public participation with regards to being hands-on on environmental issues and governance. The feedback from the community members can highlight and act as a measure of gap performance the local authority and government in managing it environmental programs (Carvalho & Fidélis, 2011).

Carvalho and Fidélis (2011) maintains that a clear or even a different perceptive of how community members interprets and understand the laws and procedures at hand will be reached through the use of this approach. Since, the citizens that have stayed longer in this area from 25 years and more were more convinced that the stream is smelly than those citizens that have recently relocated to this area.

Figure 0.17: All citizens in this area are aware of the on-going plan of how to react to the results found after conducting tests on the stream.
Figure 4.17 shows that for statement 17: 74% of the citizens disagree that they are aware on how to react to the test results of the stream has been obtained. This finding reflects that Act no. 108 of 1997 states that it is the minister’s obligation to maintain and monitor the performance of all water services institution has not been prioritised. The values of the DWA affairs includes: transparency, respect, excellence. All of these values are centred in serving customers’ needs and through leadership who are available at all times to serve. The actual customers are all water users across all sectors (DEA, 2014). Yet 74% of the citizens disagreed that such activities are conducted by the minister’s department.

NEMA principles are based on putting the people and their needs first; promotion of public participation when making decision about the environment, educating communities about environment establishment of full Environmental Impact Assessment (EIA) by experts in the field before the new project is implemented. While Hough et al. (2011) maintains that successful alignment of organizational strategy requires the management skill in promoting social justice and morality on its employees and this includes the employees commitment in their job description which includes engaging the community and protecting the community's rights and encourage the community to be responsible for the nature surrounding them as according to the Act no. 108 of 1997.

Figure 4.18 shows that for statement 18: 76% of the citizens disagree that DEA has outreach programmes that educate the community about maintaining water quality as part of its management of the stream mandate. This finding highlights the performance gap on DWA’s services to its community in improved water management. Educating community members according to Lynch and Stretesky (2013) can be used as a tool for community participation and a mechanism for reducing environmental violation that can threaten the health and diversity of the ecosystem of that community and also enhances community satisfaction with environmental police enforced. Educating the community can enhance the citizens to active stewards of the environment as they will be well informed with the environmental issues and this will encourage them to participate freely in decision making as water governance stipulates (Lynch and Stretesky, 2013).
Figure 0.19: The outreach programmes designed to educate the community are embraced by the community.

![Bar Chart](chart1.png)

**Figure 4.19** shows that for statement 19: 51% of the citizens disagree that DEA has outreach programmes that are embraced by the community.

Such findings denote that an effort from DWA is required on improving community’s perception to embrace their programs and this can be due to resistance to change or poor leadership. Leadership is defined as a role and skill that an individual poses in order to direct a certain group towards common goal and this can be achieved by redefining the culture of that group of people using motivation and being the agent of change as tools (Hough et al., 2011: 285).

Agent of change according to Brown (2011) are important in minimising resistance towards change and the characteristics of the agent of change involves a person with good communication skills, that can be trusted by all parts involved. According to the results indicated by figure 4.19, the DWA has to consider the agent of change route in order to bring about change on the community members attitude towards outreach programmes.

Figure 0.20: The stream's condition harmful to you.

![Bar Chart](chart2.png)

**Figure 4.20** shows that: 84% of the citizens agree that the stream is harmful to them, with 52% that strongly agreed.

The above results indicates that the citizens view the stream as an unsafe place, yet the stream is a natural resource that is supposed to be safe for animals and people that live near it and it appearance is a reflection of the lifestyle, culture and norms of the citizens surrounding that area. Yet, according to Chapter 2 of The Bill of Rights, section 24(a) everyone has a right to an environment that is not harmful to their health or well-being. While section 24(b), (i- iii) states that the environment must be protected through prevention of pollution, ecological degradation and promoting conservation (South Africa, 1996).

The perception of the community members with regards to their safety on stream's condition poses a concern that the DWA improve their services through the application of TQM in order to improve community's expectations when measuring their quality service as the department. Since
satisfaction is defined as a person's feeling of pleasure or disappointment from comparing a
product's perceived performance in relation to his or her expectations so customer's measured by
service quality. Introduction of new technology like salt and battery device can also minimise the
health risks and concern when citizens are in direct contact with the stream water.

**Water Analysis Results**
The hypothesis used for water quality analysis was as follows:

*Ho*: There is no statistically significance between pH; sulphates; COD; turbidity; *E.coli* and coliforms.

*Hi*: There is a statistically significance between pH; sulphates; COD; turbidity; *E.coli* and coliforms.

**E.coli and Coliform results**
The most probable number (MPN) procedure as a statistical analysis for water quality was used to
detect coliforms and *E.coli*. The minimum and maximum range for both *E.coli* and Coliform using
the Colilert 18 equipment is 1-2419.6 cfu/g and all the results obtained for both upstream and
downstream were >2419.6 when using MPN procedure Cowan (2012) and *E.coli* and Coliform
were found to fall within unacceptable levels according to WHO standards which has a zero
tolerance. The number of positive tubes in each subset is scored, and this set of numbers is applied
to a statistical table to estimate the most likely or probable concentration of coliforms. It does not
specifically detect faecal coliforms Cowan (2012).

According to Cowan (2012) water monitoring to prevent disease-causing epidemics of cholera
have killed thousands of people, and an outbreak of Cryptosporidium in Wisconsin in the 1990s
affecting 370,000 people was traced to a contaminated municipal water supply. In a large segment
of the world’s population, the lack of sanitary water is responsible for billions of cases of diarrheal
illness that kills 3 million children each year.

Table 4.2 shows the average upstream pH (7.6745) which is much lower than the downstream pH
(7.9375) and also by the average upstream sulphates (11.70) which is much higher than downstream
sulphates (10.25). It has been noted that there is much variation upstream for example pH with a
stable standard deviation (.08345) and much higher downstream with a standard deviation of
(.15918)

The average aquatic animals prefer a range from 6.5–8.0 pH outside this range reduces the diversity
in the stream because it stresses the physiological systems of most organisms and can reduce
reproduction (Etengeneng, 2012) and these results were within WHO’s optimal range pH is 6.5 – 8
and ideal level of sulphates is < 200.0 mg/l (DWAF, 2014).

COD is used to indirectly measure organic compounds in water. High COD levels indicate that not
enough dissolved oxygen is present in water, the aquatic life can die (Etengeneng, 2012) and the
ideal range of COD within the limit of 20mg/l according WHO standards when looking at Table 4.2
(Akan et al., 2010)

Table 4.3 shows that there is a significance difference between upstream and downstream for
sulphates and pH, but there is no significance difference between upstream and downstream for
turbidity and COD.

Interpretation: The p-value=0.00 (Sig.2-tailed and is less than 0.05, hence Ho is rejected and we
conclude that there is a statistical significant difference between pH and sulphates level in the up
and downstream. This confirms the results obtained in Table 4.2 of averages difference.

Only turbidity and COD are the same from upstream and downstream since p-value is > 0.05
therefore Ho is accepted. This can also be observed at table showing turkey analysis that from point
A right throughout point H the turbidity are the same.

Higher turbidity decreases the level of dissolve oxygen causing species like fish not to breath well
in water. Usually the soil particles and material particles range between 0.004 mm to 1.0mm,
However the turbidity mean was 10.5700 NTU (Etengeneng, 2012) whereas WHO recommends level of 0.1 NTU (Akan et al., 2010).

**Conclusion**

The findings indicated that there was no significance difference between upstream and downstream for *E.coli*, sulphates, coliforms and Ph. and parameters. However for turbidity and COD the Ho was rejected as there was a significance difference between upstream and downstream. The stream water quality was found not within the acceptable WHO standard for *E.coli*, Coliform and turbidity posing health risks for citizens in this area.

**Conclusion and Recommendations**

**Findings from the Study**

The findings from the literature review indicated that using strategies of community committee formation and community empowerment in order to solve the research problem of this study in combined with the data collection from the primary findings needs to be considered.

**Findings from the Literature Review**

**Community Committee Formation**

The use community members to form environmental committee that represent their complains or concerns about environmental management can be a tool for community participation changing community perception and behaviour (Lynch & Stretesky, 2013).

**Community empowerment**

Adamson and Bromiley (2013) defines community empowerment as a process of enabling communities to have a greater influence on the way that services are delivered in their local area. It improves service delivery through institutional culture change of its employees, and these will take time as it is a process. Hothi *et al.* (2008) identified evidence that well-being is higher in areas where residents can influence decisions affecting their neighbourhood; have regular contact with their neighbours. With the help of local authorities that are interested in maximising the impact of their powers to promote the economic, social and environmental well-being of their area

Since, community members are viewed as having a role in monitoring local environmental problems, and environmental enforcement authorities have increasingly relied on community members for such roles despite the known limitations of this approach. Community environmental policing and community policing require justice in terms of ensuring community members are empowered through training and education in general. This approach according to Somerville (2009:264) described as “environmental justice” allows the community members not to be limited in fully engaging on the environmental policy decision making.

Recycling can also change community perception and behaviour. Urbanization, population increases are some of the factors that increase waste that is generated. Only 9.8% of the generated waste was recycled from South Africa in an estimated 90.1% of all waste generated in 2011 (DEA, 2012). According to Funk *et al.* (2013) waste dumping is still prevalent in the underdeveloped communities in South Africa. For waste to be dumped, a licence is required (GAA, 2013). While only four provinces in South Africa have hazardous waste facilities. The use of waste avoidance and reduction model (4) in order to minimise waste for example plastic bag levy initiative where customers still did not reuse the plastic bag even after paying a levy. This act can be viewed as an element of behavioural change and shortfall of implementation progress. Recycling promotes clean and safe environment, promotes also social and economic benefits (GAA, 2013).

**Findings from the Primary Research**

**Research Question 1: Is there a difference in water quality management between downstream and upstream?**

In determining and comparing the management of quality of water between upstream and
downstream water sampling and sent to the laboratory for testing water quality on *E. coli*; Coliforms; Ph.; turbidity; sulphates and COD parameters from the stream was conducted and analysed using ANOVA, turkey and independent tests. The results from these analysis indicated that Ho was rejected for turbidity and COD. Also these results indicated that the E.coli and Coliforms is beyond acceptable limits and the stream is heavily contaminated by E.coli and Coliforms posing health risks.

**Research Question 2: What is the perception of the community on government standards in regards to water quality?**

In determining the perception of the community on government standards in regards to water quality, citizens during the survey were asked whether the DWA frequently conducts water quality tests to ascertain contamination levels; whether the DEA do engage in projects to address the results of the tests taken from the stream and above 80% of the citizens disagreed that the government conducts such projects, yet according to Act of 107 of 1998 it is NEMA's responsibility to be transparent and inform the citizens about the environmental issues and information should be accessible to the community in order for the community members to be involved in decision making as improving part of water governance.

**Research Question 3: What is the perception of the community regarding the causes of poor water quality?**

In determining the perception of the community regarding the causes of poor water quality, a survey was conducted at Umlazi L section the following findings were identified: Only 49% of the citizens within that community agreed that they are responsible for the management of water quality resources in this area, and that they are responsible for the current unappealing state of the stream. Yet 69% of them indicated that they are not effective in the management of the stream as they are not well-equipped for the management of such resources. Limitation of environmental knowledge about stream management can promote citizens to act irresponsible and unintentional pollute the stream resulting in poor water quality of the stream.

**Conclusions**

- 93% of the citizens agreed that the stream is smelly.
- The results from the laboratory analysis indicated that the stream is heavily contaminated by *E. coli*, Coliforms, turbidity, COD and sulphates posing health risks as it greater than accepted range by WHO health risks.
- 84% of the citizens indicated stated that the stream is harmful to them.

**Recommendations**

- Recycling approach can be used as a method of rewarding system which minimizes community's resistance to such changes and developments. A change of focus from dumped items to making money from dumped items through recycling. This can improve DWA's Return on Investment (ROI) even that of the community of Umlazi L-section and also minimize the increasing concern of water pollution in the urban areas.
- The department should also continuously monitor environmental assessment programme not only the Umlazi L-section stream, but the whole urban areas and surroundings, this will improve DWA image towards it community on it role in managing water quality standards. Since the use of Environmental Management System (EMS) that is aligned to ISO14001 will benefit DWA.
- The implementation of EMS can aid local authorities from non-compliance penalties as regulators are fond to be lenient with organization that have implement
- Then stream must be fenced and protected to protect young children than use this area as a playground.
- Educational awareness programme from DWA aimed in targeting the community members. This poses a lack in DWA educational programmes as more than 50% of the citizens...
maintained that they do not embrace these programs.

- These programs should include more demonstrations and follow ups on addressing the community on stream's results determined since perception was observed to be a process by which an individual selects, organise, and interprets information in order to create inputs to create a meaningful picture of the world and also influenced by condition surroundings, since different people can conceptualise an idea different although exposed to the same reality as perception influences a person's motivation.
- DWA should encourage formation of community environmental committee as this will enhance fair water governance by engaging community to participate even in decision making of environmental issues.
- The public committees can act uniformly voice out their concern which can indirectly even improve DWA service since public complaints are an important indicator of environmental issues as according to Carvalho & Fidélis (2011).
- An improvement of urban water pollution regulation can enhance citizens behaviour to change from a habit of illegal dumping as they will legally banded to pay the penalty if they continue to litter by the water sources.

Area(s) for further Research
Further research on high cause of E.coli and Coliforms results on inland stream is required since the industrial pollution impact is minimal at this area on the river's water quality.

Conclusion
The findings from this study indicated that the stream water quality was within the acceptable range for pH, sulphates and COD according to the WHO standards but not for turbidity. Also the stream was found to be heavily contaminated by E.coli and Coliform posing a health risks to the citizens in this area. From this study it was concluded that the stream is poorly managed by both the government (no stream assessment as part of RHP and engaging community members in educational programs) and by citizens limitation of environmental knowledge about stream management promotes mismanagement of stream causing citizens to act irresponsible and unintentional pollute the stream resulting in poor water quality of the stream. Urbanization and population increase also contributes to poor water quality of stream's water in urban areas. South Africa is a country that is rapidly becoming a water stressed country with drought causing dam water levels dropping due to global warming, so involving citizens to participate in decision making as part of water governance process will enhance better management of the environment and in the process can be a behavioural change tool on habits and perception about the importance of water management.

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Schaik.


