

Strategy for developing an ecological sanitation system at the Barrage informal settlement

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DECLARATION OF AUTHENTICITY

I hereby declare that **Strategy for developing an ecological sanitation system at the Barrage informal settlement** (BIS) is my own work. It has been submitted for the MAGISTER ARTIUM degree to North West University (Vaal Campus). All the sources I have used or quoted have been indicated and acknowledged by means of complete references.

Signed at Vanderbijlpark on _____

Mita Mokoena

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ABSTRACT

The Barrage informal settlement (BIS) is a peri-urban community of about 300 people resident on private land close to the banks of the Vaal River in Gauteng South Africa. The study focuses on the living and sanitation conditions in which people find themselves. Measured against the Millennium Development Goals (MDGs) BIS and its residents clearly are far from meeting MDG 7 target 7 C. For the purposes of this study the researcher investigated ecological sanitation (EcoSan) as an alternative solution for the current local sanitation conundrum. Residents either use the veld or a dysfunctional pit system. The data used for the project was generated both in a qualitative and quantitative mode. Semi-structured interviews were randomly conducted. Participants were requested and subsequently assisted in completing a questionnaire. There were also several focus group discussions for gathering relevant data. The researcher tried to form an impression of the perceptions of community members in terms on the type of sanitation system they wished to use. Community members actively engaged in strategies aimed to find out how they perceive sanitation, potable water supply and matters of hygiene.

The findings revealed dissatisfaction regarding to current conditions in BIS. Residents are uncertain because the land on which they reside on does not belong to them. This, in turn, creates uncertainty and feelings of insecurity, about the relevance of a potential water-based sanitation system. At the same time members of the community indicated they had no interest in a dry toilet system. Neither are they keen on the use of community ablution blocks (CABs) as alternative. Residents showed no willingness and are also not prepared to pay for sanitation because they cannot afford it. The dilemma is that residents are at the mercy of Emfuleni Local Municipality (ELM) and the private owners of the land on which they reside. Where do we find the solution to all of the issues? Participatory deliberation strategies were used to determine which system of sanitation local residents preferred. They clearly came out in favour of the Water Bank concept as a feasible sanitation system option. However, as a result of the unfulfilled promises of Emfuleni Local Municipality (ELM) and landowners the community remains in a state of uncertainty about the permanence of the BIS.

KEYWORDS

Keywords: Millennium development goals; ecological sanitation; urine diversion dry toilet; informal settlement; pit latrines; participatory approaches; community development.

Table of Contents

Declaration of Authenticity	i
Acknowledgements	ii
Abstract	iii
Keywords	iv
Table of Contents	vi
List of Photos and Maps	vii
List of Figures and Tables	viii
Acronyms	ix
CHAPTER 1	1
THE MDG 7 TARGET 7 C AND THE BARRAGE INFORMAL SETTLEMENT (BIS)	1
1. Orientation and background	1
1.2 Problem statement	4
1.3 Research questions	5
1.4 Research objectives	5
1.4 Hypothesis	6
1.6 Methodology	6
1.7 Outline of chapters	9
CHAPTER 2	10
ECOLOGICAL SANITATION AND HOW IT WORKS: LITERATURE REVIEW	10
2.1 Introduction	10
2.2 The concept sanitation	11
2.3 Definition of ecological sanitation	12
2.4 Contribution of ecological sanitation	15
2.5 Advantages of ecological sanitation	16
2.5.1 Advantages for the environment.....	16
2.5.2 Advantages for households	17
2.5.3 Advantages for municipalities	18
2.6 Disadvantages of ecological sanitation	19
2.7 Ecological sanitation, ancient and new practices: Case studies	20
2.7.1 Ecological sanitation: the international experience	20
2.7.2 Ecological sanitation: the South African experience	22
2.8 Water and waterless ecological sanitation technologies	23
2.8.1 Urine Diversion Dry (UDD) toilet system	24

2.8.1.1 Design.....	25
2.8.1.2 Operating principles	25
2.8.1.3 Applications.....	25
2.8.2 Compost latrine.....	26
2.8.2.1 Design.....	26
2.8.2.2 Operating principles	26
2.8.2.3 Applications.....	27
2.8.3 Ventilated Improved Pit (VIP) Latrine.....	27
2.8.3.1 Design.....	28
2.8.3.2 Operating principles	28
2.8.3.3 Applications.....	28
2.8.4 Aqua Privy	28
2.8.4.1 Design.....	29
2.8.4.2 Operating principles	30
2.8.4.3 Applications.....	30
2.8.5 Pour-Flush Toilet (PFT).....	30
2.8.5.1 Design.....	31
2.8.5.2 Operating principles	31
2.8.5.3 Applications.....	31
2.8.6 Water bank system	31
2.8.7 Community ablution blocks (CABs)	32
2.9 Conclusion	33
CHAPTER 3	34
THE CURRENT SANITARY CONDITIONS AT THE BARRAGE INFORMAL SETTLEMENT (BIS)	34
3. Introduction.....	34
3.1 Research methodology.....	34
3.1.1 Methods used.....	34
3.1.2 Literature review	35
3.1.3 Field observation	35
3.1.4 Selection of the sample dwellings	35
3.1.5 Selection of respondents and sampling process	36
3.1.6 Survey schedule.....	36
3.1.7 Interviews	36
3.1.8 Data collection for the demographic and socio-economic survey	37
3.1.9 Data analysis	38

3.1.10 Basis of analysis	38
3.1.11 Mita Mokoena Oral Archive (MMOA)	38
3.2 Water and sanitation at BIS	38
3.3 The study area: Barrage informal settlement (BIS)	39
3.3.1 General background history of the settlement	39
3.3.2 Brief overview of the study	40
3.4 Living conditions in Barrage informal settlement	43
3.5 Dwellings and their surroundings	47
3.5.1 Affordability	48
3.5.2 Activities in the dwelling	50
3.6 Fuel and power usage	50
3.7 Water resource availability	56
3.8 Waste management	58
3.9 Sanitation conditions at Barrage informal settlement	60
3.9.1 Features of pit latrines.....	62
3.9.2 Distances between pit latrines and dwellings	65
3.10 Existing sanitary system in Barrage informal settlement	69
3.10.1 Hygienic practices	73
3.10.2 Problems with existing sanitary conditions in Barrage informal settlement	75
3.11 The rubric at the pits and their re-use: knowledge levels of residents	77
3.12 Health condition, observed hygienic practices and prevailing diseases	77
3.13 Safety factors	78
3.14 How can the problem of inadequate sanitation in Barrage informal settlement be addressed?	78
3.15 The economic, social and psychological impacts of inadequate sanitation	80
3.15.1 The economic impact	80
3.15.2 The social impact	80
3.15.2 The psychological impact	81
3.16 Women and sanitation usage	81
3.17 Men and sanitation usage	82
3.18 Children and sanitation usage	82
3.19 Barrage informal settlement resident perceptions of ecological sanitation	84
3.20 Coping strategies	85
3.21 Conclusion	87
CHAPTER 4	88
RESEARCH RESULTS	88

4.1 Introduction	88
4.2 The proposed ecological sanitation (EcoSan) systems	89
4.3 Proposed ecological sanitation options	89
4.3.1 Mr Mofolo's system	90
4.3.2 Community ablution blocks (CABs)	91
4.3.3 Urine Diversion Dry (UDD) toilet system.....	95
4.3.4 Water Bank (also known as 'comfyloo')	96
4.4 Community knowledge and attitudes about ecological sanitation	98
4.5 Research results	100
4.5.1 Community recommendations on ecological sanitation	100
4.5.1.1 Monitoring and evaluation	100
4.5.1.2 Education	101
4.5.1.3 Security	101
4.5.1.4 Access	101
4.5.1.5 Fire fighting	101
4.6 Knowledge, preferences and acceptability of sanitation	101
4.7 Biographical profile of the respondents	102
4.8 Conclusion	106
CHAPTER 5	107
CONCLUSION AND RECOMMENDATIONS	107
5.1 Introduction	107
5.2 Recommendations	108
5.3 Suggestions for further research	109
5.4 Conclusion	110
LIST OF BIBLIOGRAPHY	112
ANNEXURE A	128
ANNEXURE B	129
ANNEXURE C	132
ANNEXURE D	134
ANNEXURE E	135
ANNEXURE F	136
ANNEXURE G	137

LIST OF PHOTOS AND MAPS

Photo 1: Ground plan of the study area	42
Photo 2: Types of common housing in BIS	43
Photo 3: Big stones placed on top of dwelling	44
Photo 4: A laundry line solution	45
Photo 5: Fence used as a washing line	45
Photo 6: A vegetable garden planted with spinach and pumpkin	46
Photo 7: Man cutting his lawn with a garden scissor	47
Photo 8: A one room zozo without any windows	49
Photo 9: Typical two room zozo in BIS with ventilation	49
Photo 10: Car battery charging a cellular device at Mr Mofolo's tavern	51
Photo 11: Gas stove used for cooking at the informal shop	52
Photo 12: Paraffin stove used for cooking inside the dwelling	53
Photo 13: Candle used as a lighting source inside the dwelling	53
Photo 14: Paraffin sold in two litre bottles at the informal shop	54
Photo 15: A coal stove used inside the dwelling	55
Photo 16: Typical cooking area outside	55
Photo 17: Chopped firewood used for a coal stove	56
Photo 18: This is one of the four standpipes where residents collect water in BIS	57
Photo 19: Damp, poor drainage and stagnant water at one of the communal	58
Photo 20: Dumping site inside a yard	59
Photo 21: Baby nappies dumped in a pit that is used as a coping mechanics for waste disposal	60
Photo 22: Plastic dustbin used for waste dumping placed next to the gate entrance of Ms A Nhlapo	60
Photo 23: Dirty and unhygienic pit latrine of one the residents of BIS	63
Photo 24: An unstable pit latrine	63
Photo 25: Pit latrine placed behind the dwelling	64
Photo 26: Pit latrine under construction in Mr Abiel Senooe's yard	64
Photo 27: Pit latrine that has collapsed due to improper construction	65
Photo 28: Pit latrine placed behind a dwelling	66
Photo 29: A pit latrine facing south ward of the dwelling	67
Photo 30: Pit latrine constructed on the left side of the dwelling	67
Photo 31: Researcher standing next to a latrine	68

Photo 32: Mr Les Lange, (the researcher) and Ms Martha Ntuze (gatekeeper) standing at latrine behind the dwelling	68
Photo 33: Pit latrine standing behind the dwelling	69
Photo 34: Pavement accessibility strategy to a pit latrine	70
Map 1: Map indicating sites of toilets in BIS	72
Photo 35: A full and closed pit latrine of Mr Abiel Senooe	74
Photo 36: Destruction of shack caused by a paraffin stove	81
Photo 37: Paving accessibility	86
Photo 38: The plastic bag inside the latrine of the informal shop containing sawdust. That is sprinkled over the faeces after each toilet use	86

LIST OF FIGURES AND TABLES

Figure 1: Support for types of EcoSan for use in BIS	99
Table 4.1: Gender of head of household	103
Table 4.2: Age of head of household	103
Table 4.3: Number of people in household	104
Table 4.4: Duration of stay at BIS	104
Table 4.5: Employment status	105
Table 4.6: Sources of income	105

ACRONYMS

ANC	African National Congress
BIS	Barrage informal settlement
CABs	Community Ablution Blocks
CSIR	Council for Scientific and Industrial Research
DA	Democratic Alliance
DHS	Department of Human Settlement South Africa
DWAF	Department of Water Affairs and Forestry
ECATU	Eastern Cape Appropriate Technology Unit
EcoSan	Ecological sanitation
E.coli	Escherichia coli
ELM	Emfuleni Local Municipality
IDP	Integrated Development Plan
MDG	Millennium Development Goals
MMOA	Mita Mokoena Oral Archive
NC	Northern Cape
NW	North-West
O & M	Operation and Maintenance
PFT	Pour- Flush Toilet
RDP	Reconstruction Development Plan
RSA	Republic of South Africa
TB	Tuberculosis
UDD	Urine Diversion Dry
UDS	Urine Diversion Sanitation
UNDP	United Nations Development Programme
UNESCO	United National Education Scientific and Cultural Organisation
UNICEF	United Nations Children's Fund
VIP	Ventilated Improved Pit
WHO	World Health Organisation

CHAPTER 1

The Millennium Development Goal 7 target 7 C and the Barrage informal settlement

1. Orientation and background

The South African White Paper on Basic Household Sanitation (cited in Duncker *et al.*, 2006:5) stated that:

Sanitation refers to the principle and practices relating to the collection, removal or disposal of human excreta, household waste water and refuse as they impact upon people and the environment. Good sanitation includes appropriate health and hygiene awareness and behaviour, and acceptable, affordable and sustainable services.

Sanitation plays a pivotal role in the lives of many South Africans. Twenty years into democracy, the health of many South Africans is still in danger due to the lack of sanitation and inadequate sanitation in informal settlements. This can lead to poor hygiene practices, high child mortality and the spread of sanitation-related diseases. Local government is committed to work with citizens and groups within the community to find sustainable ways to meet their social, economic and material needs and improve the quality of their lives. It should target those members and groups within communities that are most often excluded, such as disabled people and the very poor.

Section 4 of the Constitution of the Republic of South Africa (RSA, 1996) stipulates that the Batho Pele principles (meaning “people first”) must be considered when realising socio-economic programmes. The Batho Pele principles focus on the fundamental human rights that should be taken into consideration (Kuye & Ile, 2007:82–92). They also aim to maximise social development and economic growth, integration and co-ordination. This implies that local municipalities must be able to strategise, develop vision and mobilise a range of resources to meet basic needs and achieve developmental roles in their areas.

Ecological sanitation (hereafter referred to as “EcoSan” in this study) is a new and innovative concept in the management of wastewater. It is a method of dealing with the worldwide problem of inadequate sanitation that aspires to being ecological, environment friendly and economically sustainable (Langergraber & Muellegger, 2005:433).

The United Nations Millennium Development Goals (MDGs) comprise eight goals that seek to create a better life for all. Adequate sanitation has been included as one of the priority features in the MDGs. With the deadline for the MDGs on the horizon there is still a great deal that needs to be done in terms of improving sanitation. In this study emphasis will be placed on MDG 7, sanitation target 7 C, which stipulates that it is necessary to halve the population of people without access to hygienic sanitation by the end of 2015 (Bajpai, 2006).

Barrage, an informal settlement under the jurisdiction of Emfuleni Local Municipality (ELM) situated 20km outside Vanderbijlpark is ideal for the purposes of this study because residents experience some of the poorest sanitation facilities. The Barrage informal settlement (BIS) houses 300 people who live in 74 shacks near the Vaal River. They share four communal taps. This settlement is located on private land which implies that the municipal council cannot install improved sanitation facilities.

BIS have limited water resources and the water quality is very poor; there is no storm water or refuse removal. There is poor sanitation coverage which impacts negatively on environmental health. Furthermore, there is no central treatment facility for sewage. People in this settlement, especially the children, practise open defecation. The reason for this malpractice is that the pit latrines are sometimes full, or may collapse. Space is the biggest obstacle and parents do not seem to be concerned about promoting privacy and hygiene. No previous research has been done in this informal settlement on matters related to sanitation.

According to Mofokeng (2013) the main problem that residents at BIS face is the lack of functional sanitation facilities, since only pit latrines are used. Secondly, these conditions pose a major health risk especially with the children falling into the pit latrines. According to Sano (cited in Tsinda *et al.*, 2013:6940) in BIS, as is the case in many other informal settlements in developing countries, the most widely used sanitary facilities in this poverty-stricken neighbourhood are pit latrines; there are no flushing toilets. Over the years the local authorities have not held themselves accountable for the provision of basic services in informal housing because these areas are not recognised as lawful residential areas and therefore do not qualify for public services (Ubale *et al.*, 2013:31–46). It is imperative that more research is undertaken into the problems of provision and maintenance of services in dense, informal settlements such as BIS. Wood *et al.*, (2001:12) re-iterate that “service provision in the past did not involve a detailed symposium with the community”, but that this must be addressed.

There are certain principles and approaches, which municipalities should take into account when dealing with service delivery. The Local Government White Paper (1998:93–100) states that the affordability of services should feature prominently. According to the most recent Integrated Development Plan (IDP) (2012\2013–2016\2017) of Emfuleni Local Municipality (ELM, 2013:97) sanitation is still a serious problem in areas that are not yet proclaimed as townships. Pit latrines in informal settlements are poorly maintained and are rarely emptied. According to Tsinda *et al.*, (2013:6940) even in cases where strategies have been implemented to empty liquid from the pits, the sludge is not disposed of in a proper manner. Failure to empty the pits or employing poor-quality emptying services can lead to serious health implications and human and environmental consequences. From the statement above it is clear that residents are struggling to secure access to safe sanitation services.

The local government authority has been mandated and therefore has an obligation to provide and administer sanitation facilities at BIS but this is poorly maintained due to lack of political will; financial constraints in the provision of infrastructure; lack of trained staff; and insufficient expertise in dealing effectively with all aspects of the appropriate systems (Pybus *et al.*, 2001:26). It is against this background that there is an urgent need to improve the current sanitation situation at the BIS. The contention of this study is that ecological sanitation could be the most appropriate and sustainable sanitation for this settlement.

Werner *et al.*, (cited in Langergraber & Muellegger, 2005:435) agree with this contention and base their argument on the advantages that it can provide in reducing pollution, recycling, re-use of nutrients and water conservation. According to Urwibutso (2008:4) the low cost and management of the Urine Diversion Dry (UDD) system compared to the existing sanitation facility will make it affordable to the poor as well. Previous research carried out on ecological sanitation technologies, especially in countries like South Africa, China, Zimbabwe, Mexico and Namibia, shows that it has been successfully implemented (Duncker *et al.*, 2006:11). A large number of UDD systems have been built in South Africa, notably those in Taung in North West (NW) Province; and Barkly West, Kimberley and Augrabies in the Northern Cape (NC) Province. Therefore UDD may well be a viable alternative short term solution at the BIS. Saff (1996:235–247) maintains that sanitation hotspots in informal settlements are a major health hazard because wastewater is full of micro-organisms such as *Escherichia coli* (*E. coli*), and contains high levels of nutrients that are needed for the proliferation of these organisms. The consequence is that there is eutrophication of the whole system in many cases.

It is against this background that this research aims to analyse the problems faced by people living in BIS who are obliged to make use of the current sanitation system and concomitant wastewater treatment. The community can be uplifted firstly by the introduction of participatory approaches and building consensus between service providers and users. This will encourage contributions from stakeholders in matters such as technical design and get the community and local stakeholders involved in participating actively to finding sustainable ways to solve sanitation problems. It will also place focus on effective and efficient participation (Pybus *et al.*, 2001:34). The findings that emerge may help the local government to make informed decisions and accelerate the improvement of sanitation systems that are best suited for BIS and similar informal settlements countrywide.

1.2 Problem statement

Inadequate or non-existent sanitation facilities pose health-related and environmental risks for the community at large and contribute to poverty. The residents of BIS do not only experience poor sanitation facilities but also other related problems including lack of electricity, unemployment, lack of space, and limited institutional capabilities to make ends meet. As the population grows the situation will get worse and there will be a higher demand for adequate, affordable and sustainable sanitation. According to Kukard (2014:6) residents of Orange Grove low cost housing in East London, Eastern Cape, some residents use buckets which are full and others use pit latrines which they dig by themselves in their yards. The situation in this settlement is that residents experience poor sanitation which has a negative impact on their human dignity. In addition, toilets are placed some distance away from their houses, sometimes making reaching the toilet in time an embarrassing situation. Residents in this ineffective informal settlement state that on occasion their buckets have been left un-emptied for as long as seven months when municipal strikes are under way.

Resident unrest is inclined to break out when residents are of the opinion that their demands are not being addressed and their situation has not changed for the better over the years. They claim they have to “live life in a stink”. In Mganduzweni near White River, Mpumalanga a jobless mother claims she has a very uncomfortable toilet which was not properly installed in 2010. When she went out to get assistance from her local municipality she was told to buy a toilet seat and put it in herself (Sengwayo, 2014:6). It appears that sanitation is by no means only a problem in BIS, but also in many other informal settlements. As a result of service inequality in these areas a large number of residents are without access to adequate water and sanitation. Therefore EcoSan is appropriate as a temporary solution because it will alleviate the challenge of poor sanitation that these low cost housing residents face.

To meet MDG 7 sanitation target 7 C will require intensive community participation which is the key for community initiatives and growing empowerment (Khawaja, 2004:427–436). EcoSan must be implemented in co-operation and interaction with the community members and not simply for them. The needs of various communities differ and it must be kept in mind that such systems must be appropriately tailor-made to suit a certain community. This implies that consultation with the community is important, which is in fact also one of the Batho Pele principles. The Barrage informal settlement is no exception in this regard, hence the problem to be addressed in this study is:

There exists a sanitation service shortage at Barrage informal settlement that needs to be addressed.

1.3 Research questions

Flowing from the problem statement above, the study will attempt to find answers to the following questions:

- Is it possible to link the conditions in BIS to MDG 7 target 7 C regarding sanitation?
- What is EcoSan and how does it work?
- What is the current level of sanitation at BIS?
- Will it be possible to use participatory strategies with stakeholders to introduce EcoSan?
- What recommendations can be made to stakeholders in terms of ecological sanitation?

1.4 Research objectives

According to Babbie and Mouton (2001:81) the primary goal of research is to discover knowledge. The research goal or objective is particularly important because it outlines what the researcher wishes to achieve with the research. The aim of this study is to improve and develop a strategy for EcoSan in the Barrage informal settlement and to empower residents within the broad decision making mechanisms at community level.

The following can be outlined as the main objectives for this study:

- Work towards the goal of reducing the sanitation problem in Barrage informal settlement against the background of MDG 7 target 7 C.

- Outline a potential sanitation system for this settlement that is ecologically sound and sustainable, such as for example an EcoSan system.
- Assess and describe the existing conditions of the sanitation system at Barrage informal settlement.
- Use a participatory approach to come to a better understanding and secure consensus amongst stakeholders about a suitable sanitation service at BIS.
- Make some recommendations that can be of value in the process of taking decisions on local sanitation matters.

1.5 Hypothesis

The hypothesis of a research study, according to Brynard *et al.*, (1997:19) can be defined as a proposed potential answer to a particular problem which must be tested “... empirically before it can be accepted as a concrete answer and incorporated into theory”. They argue that a “...hypothesis is actually that which one wants to know based on the research question. It proceeds from a statement of the research problem”. For this research study, the following hypothesis has been formulated:

- It is possible to develop an ecological sanitation system that might lead to quality, adequate, effective, efficient and improved sanitation for residents of the Barrage informal settlement.

1.6 Methodology

The study will be conducted at the Barrage informal settlement (BIS). Primary and secondary data sources will be used. A qualitative research approach will be applied with the aim of gathering various views and responses to sanitation from a variety of stakeholders. This methodology will provide a wide approach towards data gathering and analysis. Thornhill and Hanekom (1995:19) are of the opinion that a randomly selected sample can be used because it will offer the same opportunity of selection to all residents. The sample will be selected by using a purposive sampling method. This technique implies that interviews are conducted with respondents who are able to provide information dealing with the purpose of the proposed research outcome. Certain characteristics will be taken into consideration such as race, gender, position in the household (e.g. head of household), age and language. Additional factors such as poverty and health threats will also play a role in selecting participants. The different methods to be used in this study will be discussed below.

Qualitative research is any kind of research that produces findings not arrived at by means of statistical procedures or other means of qualification reductionist strategies. It can refer to research about a person's life stories and behaviour, but also about organisational functioning such as social movements or international relationships (Strauss *et al.*,1991:17). Qualitative data gathering methods will include transact walks through the settlement, field observations, field notes, questionnaires, semi-structured interviews and report writing in a participatory way, so that the community have ownership and participation in the process. The study will begin with an unannounced field observation of the BIS and a rapid assessment of the sanitation system and the current condition of this system.

According to Babbie and Mouton (2001:276), observation can be in the form of an everyday observation, where the researcher remains an outside observer. The researcher can use participant observation where the participant is part of the group that is being observed. Babbie and Mouton (2001:294) conclude that the greatest advantage of observation is the attendance of a researcher who observes, thinks and makes evaluations based on what was actually seen. Households at the Barrage informal settlement – where the ecological sanitation unit will be built on a trial basis – will be visited to find out how the system was constructed and the manner in which it is being used. Gatherings with the Emfuleni Local Municipality (ELM) and community members must be attended in order to determine the level of community participation. Observation will also be used to determine different dynamics in the community. The ability of stakeholders to communicate and voice their concerns in the community will be monitored and emphasis will be placed on the behaviour of the community and the impact on the system.

According to Gray (2009:371–373) there are two types of interviews, namely structured interviews and semi-structured interviews. Semi-structured interviews will be conducted with community members and stakeholders for the purposes of this project. The responses made by the participants will be recorded by the interviewer. According to Babbie (2007:489) a qualitative interview is an interaction between an interviewer and a respondent in which the interviewer has a general plan of inquiry, including the topic to be covered. Semi-structured interviews involve the use of open-ended questions as an interview guide, and this method is crucial to the study in order to gather more in-depth information relating to the research problem. According to Van Rensburg (1994:504) the questionnaire is a set of questions dealing with some topic or a related group of topics, given to a selected group of individuals with the purpose of collecting data on the problem that will be researched. A short questionnaire will be designed in such a way that it eliminates uncertainty, bias, technical language and unfairness. A questionnaire with at least 5 to 10 questions will be posed as a

point of departure. At least 25 semi-structured interviews will be conducted. Interviews will be audio-taped and transcribed by means of using an Olympus digital voice recorder. Field notes will also be made to document non-verbal behaviour and responses. The following interviews will be conducted with stakeholders in order to seek consensus and to gain their participation with regard to sanitation at BIS. According to Hendriksen *et al.*, (2012:102) participation of stakeholders is an important component for the successful implementation of (environmental) policies and programmes.

The first interview to be conducted will be with an official from the Metsi-a-Lekoa Local Municipality (Water services unit of ELM) working in the sanitation sector, to assist in the promotion of EcoSan. This official will be asked to act as a facilitator if EcoSan sanitation is promoted at the Barrage informal settlement. Will he/she assist in overseeing the dynamics of communicating the EcoSan idea in the Barrage informal settlement?

It is proposed that an interview will also be conducted with an educator at the Barrage primary school because if sanitation and hygiene education programmes can be taught at schools, children can apply these teachings at home to secure a safe and healthy environment (Chariar & Sakthivel, 2011:168). Children are important agents of change because they can be effective representatives to spread the word to their parents, siblings and wider families. Children are the ones who usually take care of their younger siblings, help with domestic chores such as cleaning and collecting water. They can be used to identify health or development priorities in a fun way. It is true to say that change representatives are only there to act as catalysts – it is community members who are the centre piece of development.

Lastly, most of the interviews will be conducted with community members by using random sampling to determine which sanitation system they are using currently and whether, if a sanitation system like EcoSan was to be introduced, will they be keen to accept it. If the community has an input, this builds self-esteem and a sense of accountability and responsibility. Interviews will be conducted in order to hear their views on whether there are any identifiable illnesses or sanitation-linked diseases that residents of BIS are prone to suffer. Some of these interviews will be conducted to determine the nature of the problems that the community faces and whether, in the respondent's view, EcoSan can be used effectively on a trial basis. Questions may well be of the following nature: Will EcoSan work or not? If not, why will it not work? Which sanitation system does the respondent think will work best? (Crous, 2010). Placing emphasis on decision-making processes begin at

community level. The findings of this survey will be used to determine which constraints and problems stand in the way of improving sustainable, affordable and adequate sanitation at the Barrage informal settlement.

1.7 Outline of chapters

This study is divided into five chapters:

- Chapter 1:** The MDG 7 target 7 C and the Barrage informal settlement.
- Chapter 2:** Ecological sanitation and how it works: Literature review.
- Chapter 3:** The current sanitary conditions at the Barrage informal settlement.
- Chapter 4:** Research results.
- Chapter 5:** Conclusion and recommendations.

CHAPTER 2

Ecological sanitation and how it works: Literature review

2.1 Introduction

This chapter provides a brief background on the context of ecological sanitation (EcoSan) systems. EcoSan is a simplified sanitation technology that is potentially useful, economically feasible and environmentally sustainable. The importance of various EcoSan sanitation systems is discussed, providing advantages and disadvantages of each. The chapter also presents information about EcoSan within the framework of international developments and the South African perspective. The chapter concludes by identifying and discussing the alternative systems applied for waterless sanitation technologies.

2.2 The concept sanitation

The term sanitation signifies certain types of sanitation systems that are used around the world. Sanitation can be described as the collection, removal or disposal of human excreta, household wastewater and refuse. Internationally, this concept has a uniform connotation. Good sanitation practices include suitable health and hygiene awareness and behaviour; as well as acceptable, affordable and sustainable sanitation services (RSA, 2001:14). The collection, removal or disposal processes may be applied in a traditional or in a contemporary technological style. Such processes are used to combat the health risks to which people and the environment are exposed.

According to Fawcett and Black (2008:42-44) the nineteenth-century sanitary revolution in Britain was the beginning of a successful transformation trend. This brought significant change, especially for people in urban areas, giving them access to improved sanitation facilities. If we were to start a sanitation revolution again from scratch in Britain, it would in all likelihood not be the same system we have today. Instead of flushing the system and piping all the waste away, we would probably collect the solids once a week like household refuse, before conveying this to a central sewage depot where it would be composted. If waste were used as fertiliser in the developing world it would cut costs on buying expensive chemical fertilisers. However, the matter of sanitation automatically gives rise to questions of health hazards and the logistics of collection that would be required by a big city such as London (Anon., 2003). The sanitary revolution and the systems that subsequently evolved in Britain, Western Europe and North America were a direct result of the planning and propagation of Sir Edwin Chadwick's initiatives. He realised that there was an urgent need to address the absence of appropriate water and sanitation systems in urban areas, because poor

sanitation was causing the spread of water and sanitation related diseases (Mara, 2003:452-456 quoting Chadwick, 1842).

The release of Chadwick's sanitation report in 1842, at the time of severe water-related pandemics, changed the way water and sanitation services were managed in London. Cairncross (2003:193-195) points out that one must be fully aware that diarrhoeal disease is not exclusively a waterborne illness but can also be transmitted by hands that have not been properly washed (and the subsequent consumption of contaminated food) if people are guilty of poor hygiene behaviour. The sanitation revolution came with many merits. Most important perhaps, were improved social prospects for the provision of adequate and sustainable sanitation – including a clean and constant water supply, adequate sanitation infrastructure and good personal hygiene. Improving sanitation can certainly lead to better levels of health by minimising diarrhoeal diseases. Still *et al.*, (2009) endorse the view that these outbreaks are easily transmitted from hand to mouth or food, as well as contaminated drinking water. Cutting down significantly on diarrhoeal health hazards therefore depends on the type of sanitation system used.

The Industrial Revolution began in the mid-1700s in the United Kingdom. Within the next century, London became one of the world's largest modern urban complexes. By the 1830s many of the inhabitants of London were reeling under the dire effects of water-related diseases such as typhoid, cholera and diarrhoea. Primarily as a result of these conditions, Chadwick started promoting what was to become known as the sanitary revolution and some civic-minded people began giving close attention to issues of sanitation. The effects of the sanitary revolution also reached South Africa before the end of the nineteenth century. With the development of a uniform system of municipal governance in the four provinces of the former Union of South Africa (as of 1910), sound sanitation systems became part and parcel of well-organised urban life.

In the 1980s informal settlements started flourishing in many parts of South Africa as the former government lifted its influx control policies in South Africa's urban areas. By 1994, when the new post-apartheid multiracial and democratically elected government came into power there was the promise of a Reconstruction and Development Programme (RDP) with housing for all. Despite achieving substantial success there remains, up to the present, a housing backlog that has not been resolved. Consequently, informal settlements continue to increase in size. The ruling African National Congress' (ANC) key aim when it came into power in 1994 was to meet the basic needs of the South African population in an integrated

manner, combining urban, peri-urban and rural development processes (African National Congress, 1994:6). According to the World Health Organisation (2004:68) the RDP document made provision for basic needs such as water and sanitation. The result was that many sprawling informal settlements formed on the periphery of South Africa towns and cities. A United Nations (1990:20) document maintains that in the early 1990s it was apparent that development, as far as sanitation was concerned, had reached a stalemate. Nor was this only the case in South Africa. Households in many parts of the third world lacked access to safe and sufficient sanitation, and the number of such households was increasing. Sanitation approaches implemented by development agencies were neither sustainable nor replicable (Winblad, 1974:296-303).

However, small numbers of people in the third world have what can be considered adequate or satisfactory sanitation systems. These sanitation systems range from pit toilets, to ventilated improved pit (VIP) toilets, pour-flush toilets and toilets (WCs) connected to septic tanks or sewers. Each of these systems has specific merits (advantages) and drawbacks (disadvantages). External factors also influence the efficacy of sanitation systems. For example, in areas where the groundwater table is high, where there is a lack of space and/or an irregular water flow or seasonal floods, some of these sanitation systems have become dysfunctional. At the time when they were installed the environment was still reasonably conducive to conventional types of sanitation, but they did not prove sustainable in the longer term.

If working effectively, sanitation protects both environmental and public health. Historically in South Africa, sanitation services in dense urban informal settlement areas are as yet inadequate due to institutional problems such as capacity and the lack of governmental responsibility for sanitation provision. Other debilitating factors include poor planning of the settlement and the need for available space within the settlement (Tsinda, *et al.*, 2013:6942). For the purposes of this study, attention will be given to sanitation problems that have arisen in informal settlements, and the potential for addressing these problems by introducing ecological sanitation.

2.3 Definition of ecological sanitation

The term "ecological sanitation", often abbreviated as "EcoSan" was coined by the Swedish scientist Uno Winblad in his book *Sanitation without Water* which was published in the early 1980s. In short, the concept stands for sanitation that is effective, adequate, efficient and sustainable. It is about a new philosophy on sanitation rather than a new technology.

EcoSan is a new approach to ecological sanitation; an approach also known as “closing the loop” (Matsebe & Osman, 2012:3). EcoSan focuses on developing or third world countries where there is an absence of adequate sanitation systems, and it has been introduced with some success in a number of countries. However, many governments and sanitation authorities have not yet made provision for EcoSan in their legislations and national frameworks. This is especially the case in Sub-Saharan African countries (Soon, 2003:2). The aim of EcoSan is to take action in wastewater management in a more sustainable, economical and environmentally friendly manner by putting human excreta to good use for the benefit of many role players in the area concerned (Morgan, 2004:1). The design of the EcoSan system is based on three principles, namely: reduce, re-use and recycle. In short, as Chariar and Sakthivel (2011:13) put it, EcoSan can be seen as a process that goes through different phases. According to Duncker *et al.*, (2006:5) EcoSan means minimising pollution, saving and utilising urine and faeces and using these products for agricultural purposes. While using affordable materials and making the cost of installation and operation low, it is possible for EcoSan to maintain a high level of efficiency. Ecological sanitation systems use less water or, in some cases, no water at all. The available ecological sanitation systems include: waterborne (making use of water) systems; ventilated improved pit (VIP) toilets; and urine diversion dry (UDD) toilet systems (Matsebe & Osman, 2012:2). According to Chariar and Sakthivel (2011:3) most popular sanitation systems in use today fall into two categories: ‘flush-and-discharge’ or ‘drop-and-store’ systems.

A key element of EcoSan is to stop pollution and the transmission of sanitation related diseases caused by human excreta. Human excreta is seen as a resource rather than merely waste. It is a useful resource because in the natural world excreta from humans or animals enrich the soil; it can provide food for others and produce valuable nutrients for plants (Esrey *et al.*, 1998:5). The flush-and-discharge sanitation system disposes of the waste. In other words, conventional sanitation systems take excreta for waste that must summarily be disposed of. Furthermore, as pointed out in a document published by the United National Education, Scientific and Cultural Organisation (UNESCO, 2006:4) conventional sanitation systems use water while EcoSan is all about saving water resources. By keeping implementation costs low, community members can use their own labour and skills to erect EcoSan sanitation systems. After proper training, users gain knowledge and understanding of what EcoSan is (Petrowitsch & Arroyo, 2004:369). According to Korten (1990) cited in Davids *et al.*, (2009:17) people-centred development is about making a contribution to alleviate poverty; local residents are encouraged to increase personal and

institutional abilities. They can reuse their own nutrients by developing their own vegetable gardens or selling fertiliser and improving their quality of life (Chariar & Sakthivel, 2011:129). EcoSan is all about doing things in a green way. It entails zero pollution, meaning that fresh water resources will not be contaminated. Water will only be used for drinking purposes while a minimal quantity is used for flushing toilets. The system works towards the goal of nature conservation where environmental and human health risks are eliminated (Esrey, 2000:37).

According to Esrey (2000:37) there are two types of ecological sanitation systems. The first is the urine-diversion system where urine and faeces are not mixed. This type of toilet has a small separating wall so that urine falls in the front part and faeces falls below into the back part of the bowl. The other well-known type of EcoSan system is the compost system where urine and faeces are blended together to make compost. In both these sanitation systems it is possible to deal with urine and faeces with less water, or even no water at all (Rajbhandari, 2011:11).

Sanitation should not simply be seen as a matter of providing a toilet (Austin *et al.*, 2005:3), but as a human right, the right to dignity as stipulated in Section 24(a) of the Bill of Rights of the Constitution of the Republic of South Africa, Act No. 108 of 1996. According to Parnell *et al.*, (2002:164) government must take reasonable legislative and other measures to give substance to these rights. In other words the government must ensure that all residents have adequate sanitation. However, implementing proper sanitation systems requires a comprehensive commitment from all stakeholders, including the active participation of the community for which the system is intended. It is imperative therefore that the people at large have improved health knowledge about sanitation-related infectious diseases; and are fully instructed about the necessary hygiene practices (Austin *et al.*, 2005:14).

Successful ecological sanitation systems must follow certain environmental strategies to kill harmful pathogens, so that human excreta are processed in a hygienically safe manner. Those responsible for planning and managing EcoSan systems must be highly skilled in the necessary techniques. They must be knowledgeable about the correct time for storage purposes and perceptive about appropriate operating temperatures for required dryness (Abarghaz *et al.*, 2012:215). For example, there are certain environmental risks involved in composting excreta together with household refuse at high temperatures (Simpson-Hébert, 2002:131-132). Ecological sanitation (EcoSan) is ideal in areas where there are limited water resources, even if there is an absence of wastewater management systems (Matsebe &

Duncker, 2005:24). South Africa is a water scarce country therefore it is the responsibility of the government to educate the community at large about the merits of ecological sanitation. This should include aspects of promoting sustainability and a green environment for all, in the hope that people's attitudes towards the use of EcoSan will change. According to Esrey (2000:41) a change in approach has the potential to increase employment opportunities while keeping the environment clean and green. According to Sinanovic *et al.*, (2005:629) ecological sanitation will not only make a contribution to Millennium Development Goal (MDG) 7 target 7C (which is to cut the proportion of unserved residents by half) but will also place focus on the Batho Pele principles, which form the cornerstone of the civil service's delivery undertaking made to the country's residents. The aim is to render quality services to customers by means of putting them first. It is believed that Batho Pele has the potential to bring about significant improvement in the provision of public services by all sectors of government.

Ecological sanitation can work in any given residential area, but will require different resources and pose different challenges. Materials and management of the particular EcoSan system may differ, but the basic principles remain the same (Chariar & Sakthivel, 2011:25). The factors that need to be taken into consideration before embarking on an EcoSan initiative include the abundance or scarcity of water; whether water conservation is possible; available financial resources (affordability for all); and ambient temperature and climate (humidity and precipitation) (Chariar & Sakthivel 2011:44). Technical capacity is another essential requirement in the form of local skills, expertise, knowledge and the necessary tools. Population density and settlement patterns in informal settlements should also be assessed. Furthermore, Esrey *et al.*, (1998:5) suggest that the availability of space should also receive attention when deciding on whether or not to implement an EcoSan system.

2.4 Contribution of ecological sanitation

Ecological sanitation is a system that contributes towards equity and a sustainable environment and aims to prevent the spread of sanitation-related disease. For Wilsenanch (2006:3-4) it must be a sustainable system that is affordable to everyone, even to the poor living in makeshift dwellings. According to Esrey *et al.*, (1998:5) the system does not lead to pollution, but instead takes note of nutrients recycled back into the soil and large quantities of fresh water being conserved. EcoSan systems must be user friendly and acceptable to those who make use of them. They should not be offensive and inconsistent with people's norms and values.

Taing *et al.*, (2013:5) explain that the ecological sanitation system selected must be simple in terms of operation and maintenance (O&M). This type of sanitation can be characterised as a “closed loop” sanitation system, which treats human excreta as a valuable resource. Nutrients in the form of excreta are recycled. Access to affordable and more nutritious food increases food security (Esrey, 2000:41). According to Stenström and Jenssen (2007:7) EcoSan is about recycling nutrients, humus and water to the soil and agricultural systems.

2.5 Advantages of ecological sanitation

According to Werner *et al.*, (cited in Langergraber & Muellegger, 2005:435) ecological sanitation offers a number of advantages for the environment, households and municipalities.

2.5.1 Advantages for the environment

Ecological sanitation is about water conservation. Instead of using water for flushing toilets, if an EcoSan system is in place, the available water can either be used for drinking or for developing a food garden. According to Water Aid (2011:27) it is also possible to apply ecological sanitation on a large scale which then provides protection for fresh water resources such as groundwater, streams, lakes and the sea from faecal contamination. Esrey (2000:41) suggests that this represents savings made on water resources and ground nutrients. Furthermore farmers are able to save money because there is no need to buy expensive fertilisers (Esrey, 2000:40). Instead EcoSan allows us to make use of the quality fertiliser value of urine. The 400-500 litres of urine produced by a single individual per year have considerable value as nutrition for plant life (Esrey *et al.*, 1998:75). People should recycle in order to keep the environment clean and unpolluted. The more the environment is kept clean the more infectious diseases and germs are kept at bay. According to Winblad (2002:3) EcoSan makes a positive contribution because it protects the environment.

After human faecal matter has been stored for long periods it becomes harmless and does not contain any poisonous elements. This is important for both humans and the environment because any pollution and health-associated threats are negated (Kramer *et al.*, 2011:26). After sufficient storage and undergoing a drying process, human faeces can serve as a valuable soil conditioner because faeces are full of micro-organisms. Before being recycled back into the soil the pathogens must be killed to stop the spread of sanitation-related diseases. Pathogen demolition and handling is safer when faeces and urine are separated. According to Chariar and Sakhthivel (2011:116) when using faecal matter as a fertiliser in agriculture, one must wear protective clothing, such as face masks and gumboots.

According to Povlsen (2001:109), poorly treated domestic sewage will lead to organic pollution sources. However, he agrees that when human urine and faeces are recycled back into the ground they will help with soil fertility and that agricultural productivity will increase accordingly (Kramer *et al.*, 2011:11). A Swedish study found that the nutrient content found in compost toilets compared with normal farmyard manure, the compost nutrient is not as powerful (Redlinger *et al.*, 2001:4039). If and when EcoSan is introduced and large-scale recycling begins it will reduce greenhouse gases that contribute to climate change. Esrey (2000:37) maintains that the recycling of human excreta could possibly help to decrease the greenhouse effect if implemented on a large scale as part of a learning programme to add to the carbon content of soils.

2.5.2 Advantages for households

Holden (2004:164-74) explains that ecological sanitation at household level will improve personal living standards (e.g., households will have the advantage of an indoor sanitation facility with the benefit of security, privacy and comfort). In terms of the operation and maintenance (O&M) of EcoSan systems, if they are properly managed they will not release bad odours, nor will they attract flies and insects. This is where EcoSan systems have an advantage over traditional pit latrines. With some EcoSan systems urine and faeces are not mixed, but are kept separate, which will counteract bad odours. Furthermore, lime or ash is poured onto the faecal matter to control odour problems. Fly breeding is low since moisture levels are low. The general problem with pit latrines, as mentioned in the previous chapter, is that small children can fall into them and die (Tsinda *et al.*, 2013:6949).

The EcoSan system tries to minimise all these objections. The systems can be built above ground and there is no need to make the pit deep. Another major advantage, as mentioned previously, is that EcoSan systems save water. These systems require very little water and in some case no water at all. According to Esrey *et al.*, (1998:76) by installing these systems individual households can make a contribution towards their financial resources. Urine separated during toilet use can also be sold because it is a rich natural fertiliser that can be used in backyard vegetable gardens Esrey (2000:37). Implementation of EcoSan systems will lead to the creation of improved livelihoods because large numbers of people living in informal settlements are currently unemployed (Kramer *et al.*, 2011:16). Furthermore, householders do not have to wait for municipalities or sanitation authorities to install piped water and sewerage systems. They can instead have their own toilet built into their houses and acquire privacy at the same time.

This is of course particularly important for women and according to Calvert (2000:36) women have been quick to realise the advantages of the ecological sanitation solution. The fact that toilets can be placed close to their homes or even inside the house means an enormous improvement in privacy, safety and security for women (Rajbhandari, 2011:40). This is a vast improvement, particularly for those residents of informal settlements who are forced to practice open defecation. When people ask the authorities for toilets they seldom want to know what health benefits will ensue. For those who are indeed concerned about their health, EcoSan sanitation systems that do not pose health risks but lead to a healthy community provides the answer (Esrey *et al.*, 1998:77). Local people must, in the process, be educated about the health hazards of poor sanitation practices. According to Esrey (2000:37) the nutrition of families who have EcoSan systems would improve if urine and faeces are recycled to fertilise vegetable gardens. In this way EcoSan systems have the potential to create individual and community empowerment and be an income generator. Attendance of school going children will also be higher if EcoSan systems are installed. This again is particularly important for mothers, because they are usually responsible for the children and taking care of the household (Esrey, 2000:37). Women must therefore be included in the education, promotion and empowerment process. Another advantage is that some EcoSan systems are not heavy and can be easily moved. They are thus ideal for use in informal dwellings because these places are more often than not illegally built on land which has not been allocated to them by the responsible authorities. When the residents have to relocate to a different area they can take their sanitation systems with them. With the EcoSan concept it is possible to have a toilet that can be moved easily.

2.5.3 Advantages for municipalities

Mandated local government authorities have a responsibility towards the administration and provision of sanitation facilities (Pybus *et al.*, 2001:26). However, in many countries municipalities can only supply a certain amount of water to communities, sometimes just once a week, while others are fortunate to have access to unlimited water resources and are able to collect water whenever they need to. Residents who fall into the poorest of the poor category often have to walk for kilometres or stand for long hours in a queue to get water from communal taps. EcoSan systems aim to use limited water resources, but also want to impress upon residents that water must be conserved.

There are certain principles and approaches that municipalities must take into consideration when dealing with the delivery of sanitation services. According to Esrey *et al.*, (1998:7) EcoSan has the distinct advantage over conventional sanitation when it comes to providing

sanitation coverage to unserved communities, because the service can be made available very quickly. Furthermore, municipalities will be able to deliver high quality sanitation services at a reasonable cost. Municipalities are currently under significant pressure to ensure that there is full sanitation coverage for everyone countrywide. However, the reality is that they are unable to achieve the objective of providing sanitation services for all. Financial resources are inadequate and infrastructure is ageing. In addition and there is a severe lack of trained staff with the necessary skills to administer sanitation services and a shortage of labour to implement the systems efficiently. According to Du Pisani (1998); Nel (2010a); Van Vuuren (2010); and Burger (2012), cited in Taing *et al.*, (2013:15) conventional sanitation systems cost a great deal of money and there is seldom enough space to erect the necessary facilities. In contrast, the installation of an EcoSan system will require less capital outlay for the municipality and reduce maintenance costs for the residents (Melo, 2005:6). In other words both the municipality and the users will save money.

Other advantages of EcoSan systems include the fact that some of them require no pipelines; they release no odour; and can be placed anywhere according to the preference of the user. EcoSan is cost effective and can function as a short term solution, for example while people wait for waterborne sanitation to be installed (Winblad, 2002:13). According to Roodt (2001:470) municipalities must ensure there is active participation with the people living in the area so they can be closely involved in influencing decisions that will affect their lives. According to Watson (1995) cited in Melo (2005:6) it is vitally important that there be mutual agreement between the two parties. For example, users can help in the operation and maintenance of the system. Municipalities can save on serving costs by giving responsibilities to residents. On the matter of community participation and co-production, Joshi & Moore (2004:1) discuss the provision of public services through long term relationship between municipalities and citizens. They point out that both parties can and should make substantial contributions. In summary, there is a need for interactive participation where people are involved in planning, decision-making and analysis (Roodt, 2001:472). According to Watson (1995:51) cited in Taing *et al.*,(2013:16) user participation, acceptance and negotiation with municipalities will lead to improved quality and appropriate services and performance on the part of service providers.

2.6 Disadvantages of ecological sanitation

However, one should also realise that EcoSan can pose certain disadvantages for its users. Examples are mismanagement of the sanitation facilities, or their incorrect use (by, for example, not allowing enough storage time for the human waste; or allowing water into a

dehydrating system), or because of errors in the installation of the facilities. As is the case with any kind of technology, if users do not co-operate fully or misuse the facilities there are consequences. Bad odour may result, for example, if users urinate in the faeces compartment, etc. This is why there is a need for adequate training for users to ensure that the EcoSan systems are operated correctly and do not pose any undue health risks (Boot, 2008:6).

Ecosan requires exhaustive education on management before implementation. Social-cultural beliefs against handling human excreta could also be a barrier to ecological sanitation (Urwibutso, 2008:12). Boot (2008:6) also makes the point that installing an EcoSan system has a higher capital cost than simpler types of latrine (Boot, 2008:6). Finally, users must be made aware that with these sanitation systems, one cannot use any sort of anal cleansing materials.

2.7 Ecological sanitation, ancient and new practices: Case studies

The rationale of the project in this study is to build up and test EcoSan sanitation systems for individual households; to make available a setting for training and special studies in the field; and finally, to provide a focus for propagation of EcoSan systems. It is necessary first to provide a brief overview of the international and South African developments and experience of EcoSan.

2.7.1 Ecological sanitation: the international experience

According to Duncker *et al.*, (2006:11) ecological sanitation systems have been successfully implemented and widely used in countries such as China, Mexico and Sweden. Sweden, for example, has implemented these sanitation systems into different housing estates in both single and double storey townhouses and apartments (Austin, 2006:4). The WM Ekologen, type ES system was developed by Professor Mats Wolgast of the Karolinska Institutet, Stockholm, Sweden, in the early 1980s (Esrey *et al.*, 1998:26). Similar to the system used in Vietnam, faecal matter is dried while urine is diverted separately. Urine is diverted into an underground tank with a volume of 0.5 cubic metres per person. Faeces and toilet paper fall into a separate insulated vault and are collected in an 80 litre plastic container. The container usually fills up in 2-3 months and is then replaced by a new empty container beneath the toilet. The full container is left outside for a further six months where secondary treatment is required before it can be used as compost for agricultural purposes.

In the early 1990s porcelain urine-diverting toilets were first produced in Sweden (Schönning, 2001:4). According to Still and Foxon (2012:4) the municipality of Tanum in Sweden then began to implement the urine diversion sanitation system to serve low-income householders who live in single houses built on rocky surfaces. This type of terrain makes wastewater sanitation systems costly and almost impossible to implement. The municipality made it a priority to provide and encourage both dry and dual flush urine diversion systems. In 2002 Tanum adopted the urine diversion EcoSan system as its municipal sanitation policy. This policy sets out that dry sanitation can be used in both rural dwellings and within the wastewater jurisdiction of the municipality. The municipality also undertook to be accountable for implementation of strategies for the collection and use of urine for agricultural purposes (Still & Foxon, 2012:5). According to Winblad (2002:4) it is a well-known fact that for centuries China has been recycling human excreta to use as fertiliser for agricultural production. The “night soil”, is collected and used to increase agricultural productivity for more than 500 years (Kramer *et al.*, 2011:12). Black (2001:27) explains that in the Guangxi province of China more than 25000 urine diversion toilets have been installed. Diverted urine is used in vegetable gardens and in greenhouses (Winblad *et al.*, 1998:75, cited in Rusong, 2001:26).

Many families have installed ventilated and double vault urine diversion sanitation systems in their houses. All family members use these toilets. For residents in the province this type of system is easy to maintain when it comes to cleaning and preventing flies from breeding. The systems are odour free because users have all the knowledge, and skills in terms of operation and general maintenance. Comparable results have been reported on other EcoSan projects. However, research has shown that positive outcomes cannot always be guaranteed and Winblad (2001:8-9) cautions that problems and drawbacks may occur, which could even lead to failure (for details, see tables below).

In the 1950s the Vietnamese people began to use double-vault urine diversion toilets. Today hundreds of thousands of rural households still use them. Furthermore, according to Winblad (2002:5), in the early 1980s NGOs and individuals in Central America and Mexico NGOs began working on the implementation of dehydrating and composting EcoSan systems in both urban and peri-urban areas. According to Peasey, Mexico has been called the “dry sanitation capital of the world” (Peasey, 2000:2). Since then, at least 235 000 EcoSan toilets, and possibly many more, have been built in at least in 17 Mexican states. In one of the projects conducted, research has shown that user satisfaction and acceptance of the EcoSan toilets was very high.

It is obvious that levels of acceptance and satisfaction will increase if users are equipped with the necessary skills in terms of operation and maintenance of systems. EcoSan systems have also been introduced in El Salvador and Guatemala with thousands of units being installed in households. However EcoSan was not as popular in El Salvador due to less interest for recycling human excreta because of the unavailability of space to grow food (Esrey, 2000:43).

2.7.2 Ecological sanitation: the South African experience

According to Duncker *et al.*, (2006:11) ecological sanitation (EcoSan) technology was implemented in South Africa for the first time in 1997 as an experiment conducted by the Council for Scientific and Industrial Research (CSIR) funded by the Eastern Cape Appropriate Technology Unit (ECATU).

The first case study of an EcoSan project was conducted in a medium density mixed housing area in Hull Street, Kimberley. The objective was to get perceptions and gain insight on how residents experienced ecological sanitation and whether they understood its implications (Drangert *et al.*, 2002:4). According to Landman *et al.*, (2007:4) the aim of the project was to glean valuable information on the positive and negative experiences of users and other key factors that might lead to the failure of the Urine Diversion Dry (UDD) toilet system. The study was qualitative and the group comprised 16 participants. According to Matsebe (2011:65-75) residents in the mixed housing area were not keen on the UDD sanitation system. All respondents had previously used waterborne sanitation system. At first, participants were reluctant to take part in the study because they did not receive any remuneration for doing so. Some members of the sample group claimed that the UDD toilets were unhygienic and released bad odours. In their opinion, the flush toilet was cheaper and was more hygienic than the UDD toilet.

Users also complained that the UDD system was more costly to maintain, largely because the necessary chemicals and cleaning materials were expensive. According to Matsebe and Osman (2012:6) some respondents in the study were of the opinion that the toilet seat was uncomfortable, especially for the ladies. There were also household members who found it embarrassing to explain to first-time users how the toilet worked. The research findings, in terms of user perceptions and attitudes, showed that many preferred the flush rather than the UDD. However, other users were more positive in their responses. Some claimed that they favoured the use of the UDD toilet above the flush type. The only difference for them was the use of lime.

The researcher also found that some participants were completely unaware of EcoSan and its advantages as an alternative to flush toilets. These people were of course unable to comment on the UDD system in comparison to waterborne sanitation.

In conclusion, the researcher was unable to persuade residents to buy into the EcoSan project because social interventions in the form of promotional support, training and demonstrations were not provided for them. These are all prerequisites for successful implementation of EcoSan sanitation systems (Matsebe, 2011:77). It should also be borne in mind that high quality ceramic products will help to promote EcoSan as an upmarket system. This is an important initiative to promote in South Africa because dry systems are particularly appropriate for use by the poor who cannot afford waterborne sanitation. However, according to Duncker *et al.*, (2007:454-455) the use of EcoSan systems is not without problems. In certain case studies conducted in KwaZulu-Natal, North-West Province and the Eastern Cape, user response to Urine Diversion Sanitation (UDS) has been particularly negative. Among the reasons for malfunction was a toilet design that did not satisfy the needs of the users. There were complaints that the pedestal was poorly designed. Although there are currently approximately 50 000 toilet units of this same UDS system (with the same pedestal) installed in KwaZulu-Natal, the researchers came to the conclusion that many people have simply refused to make use of them. They claim they do not like the UDS system and have gone back to using traditional pit latrines that they have erected with minimal effort and resources.

2.8 Water and waterless ecological sanitation technologies

Sanitation systems can be classified into two broad categories: water or waterless systems. Water systems use water to flush and remove waste. A continuous supply of water is required so that the system functions to its full capacity. Waterless systems that use no water or minimal water, when waste is removed. These systems are characterised as dry storage systems and carriage is usually conducted manually. This does not mean that no liquid or water can be used for cleaning the toilet. A small amount of water may be used for the cleaning of components of a dry system, such as the sitting bowl.

According to Chariar and Sakthivel (2011:16) any sanitation system that disinfects waste and materials and recovers useful substances can be termed an ecological sanitation system. It is no easy task to identify which methods can achieve this aim. Convenience and features the users want are also important. Ecological Sanitation (EcoSan) is not a one-off solution. Certain factors must be considered, such as differences in terrain; availability of

water; available space; and the impact on the ambient environment (Austin *et al.*, 2005:3). The design of an EcoSan toilet is based on its collection capacity because on average an individual excretes 500 litres of urine and 50 litres of faeces a year (Esrey *et al.*, 1998:2). Chariar and Sakthivel (2011:49) explain that an EcoSan toilet is usually designed to serve a household of 5-7 members. However, EcoSan is not about one-size-fits-all approach. In this section the following sanitation systems will be discussed. The final two types in this list will be dealt with briefly in this section and receive closer attention in a later chapter.

- Urine Diversion Dry (UDD) Toilet
- Compost Latrine
- Ventilated Improved Pit (VIP) Latrine
- Aqua Privy
- Pour-Flush Toilet (PFT)
- Water Bank system
- Community ablution blocks (CABs)

2.8.1 Urine Diversion Dry (UDD) Toilet system

Matsebe (2011:15) explains that the Urine Diversion Dry (UDD) Toilet is a dry sanitation system that does not need water to carry away excreta. Urine and faeces are diverted during toilet use; this makes a contribution to sustainability and less pollution on the environment. Piped drinkable water is a limited resource and should rather be used for drinking and other basic household cleaning instead of flushing toilets.

According to Makaya *et al.*, (2014:468) UDD is a system that separates urine and human excreta. To prevent the risk of spreading infectious diseases, UDD systems have a special seat or squat plate which separates urine and faeces. Urine is then stored to be used for agricultural purposes. Faeces and toilet paper fall into the chamber below the toilet. This chamber can be a removable container that is emptied when it is full. Urine diversion is based on the understanding that it is important to remove excreta safely from the environment with minimal risk to humans. Human urine does not always contain pathogens that can be passed on through the environment (Schönning, 2001:30). For example, urine used on crops like cereals hardly poses any risk of infection through consumption (Schönning, 2001:31). For food crops that are to be consumed raw, it is recommended that urine be applied no later than one month before harvesting.

The producer household or farmers can use human urine as fertiliser to good effect but as far as possible it should be used undiluted. If urine is diluted with other fluids such as water it will require longer storage time before it can be used although it will increase the volume available (Chariar & Sakthivel, 2011:32). To control odours from the faeces, dry absorbent organic materials like wood, ash or dry leaves are added after every use (Tissington, 2011:10). According to Kramer *et al.*, (2011:22) soil may also be sprinkled after using the toilet since soil it is locally abundant. This will absorb excess moisture present in the faeces and also helps to control flies.

2.8.1.1 Design

The capacity of collection chambers for a UDD system is designed to store faeces for at least six months. A ventilation system is required for the collection chambers in order to increase the drying process of faeces and to reduce the problem of odours (Chariar & Sakthivel, 2011:56). The toilet should be built entirely above ground to allow easy access to the collection chambers through a vertical trapdoor. Temperature or heat can be increased if the door is made of metal and constructed so that it faces eastwards in the direction where the sun comes up. Urine collected from a single individual in a year is enough to fertilise 300-400 m³ of an agricultural area.

2.8.1.2 Operating principles

Two vaults are used alternatively with only one vault in use at any time, until it is almost full. As already mentioned above, additives such as ashes, lime or leaves can be added after defecation to absorb humidity and control odours (Chariar & Sakthivel 2011:33). Once the first vault is full the defecation hole is sealed and the toilet container is connected to the second vault, which now comes into use. When the second vault is full the dried contents in the first vault can be removed. The product has a sandy look and is odour free. According to Chariar and Sakthivel (2011:103) secondary storage or composting is recommended with other materials before the mix is hygienic and safe for use. Urine falls into a container and can be used directly as fertiliser (in large scale systems urine should be stored for one month at 20°C before it is used). If urine is applied as a fertiliser, a period of at least one month should elapse before the crop is harvested.

2.8.1.3 Applications

UDD can be used in any climatic conditions, but work best in dry and/or hot climates. They can be installed peri-urban and rural areas as well as in urban areas. If urine and faeces are not used for agricultural purposes collecting services will be required.

This EcoSan system has certain advantages and disadvantages.

Advantages

Disadvantages

<p>The advantages of the UDD system are:</p> <ul style="list-style-type: none"> ▪ the environment has a natural fertiliser instead of chemical fertilisers; ▪ there is increased food security through use of cheaper fertilisers (Boot, 2007:2); ▪ structures can be more or less permanent (Rajbhandari, 2011:27); and ▪ they are suitable for all users. 	<p>The disadvantages of UDD include:</p> <ul style="list-style-type: none"> ▪ information programmes for implementation are needed since it involves new technology (Mack, 2006:72); ▪ the system may be difficult to use for minors (Mack, 2006:72); ▪ full operation and maintenance is essential (Rajbhandari, 2011:28); and ▪ users have to give their full cooperation. If this is not achieved there may be odour problems (for example, if users urinate in faeces compartment).
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2.8.2 Compost latrine

The structure of a compost latrine is very similar to that of the pit latrine. The faeces, urine, and anal cleansing materials as other bio-degradable matter such as garbage, leaves and grass should be placed over the faecal matter to control odours and promote decomposition (Chariar & Sakthivel, 2011:33). Decomposition takes place inside the privy, producing humus called “compost”. According to Esrey *et al.*, (1998:32) bacteria, worms and other types of organisms break down organic substances and these are mineralised and turned into humus. The capacity of the pit depends on how much fertiliser is required and should be in accordance with the needs of the people concerned. According to Boot (2007:3) in composting toilets human waste can either be separated or mixed.

2.8.2.1 Design

If necessary, the design used could provide separate urine drainage in the form of a slab, which would separate urine and prevent it from going into the compost. This would then reduce nitrogen and moisture levels in the compost pile.

2.8.2.2 Operating principles

According to Judais (1986), cited in Momoh and Oladebeye (2010:105) composting involves the process whereby organic waste proceeds to produce a humus-like material which can be used as a fertiliser for gardens and lawns. According to Schönning and Stenstrom (2004:13) an increase in temperature will speed up the activation mesophilic bacteria. These are bacteria that require very specific conditions to grow and proliferate.

When temperatures reach the required level mesophilic bacteria begin to work and decomposition processes take place (Mack, 2006:32). There is no fixed time period for the decomposition process. For the compost process to be effective the correct balance of materials is needed. The microbes need an equal amount of carbon energy and nitrogen which will enhance growth. To achieve an adequate ratio of carbon and nitrogen, organic materials such as crop residues, leaves, grasses and sawdust are needed (Schönning & Stenstrom, 2004:22). Likewise, urine should be separated to reduce nitrogen and moisture levels in the compost. No form of liquid must be added to the pit.

2.8.2.3 Applications

A compost latrine is suitable for use in areas where people use human excreta for agricultural purposes. According to Chariar and Sakthivel (2011:134) compost can be used in gardens to improve the soil structure. Compost is rich in macro- and micro-nutrients as well as organic matter and adding carbon sources like lime or ash to faeces will increase the buffering capacity and the pH of the soil, especially in areas where soil has a low pH. This particular EcoSan system has certain advantages and disadvantages as shown below.

Advantages

Disadvantages

<p>The advantages of the compost latrine include, among others, that the system:</p> <ul style="list-style-type: none"> ▪ can used in tropical areas where nutrients soak away quickly into the soil; ▪ can be easily constructed, utilises local materials and is easy to maintain and operate (Mack, 2006:67); ▪ is inexpensive (Alcock, 1999 cited in Sesani, 2005:37); and ▪ requires no water for flushing. 	<p>Disadvantages of the compost latrine include:</p> <ul style="list-style-type: none"> ▪ the process is not a once off thing. It requires supervision, user education and periodic follow-ups to make sure that regular rotation is carried out (Mack, 2006:67); ▪ it cannot be used in areas where the groundwater table is high because water will infiltrate the pit; and ▪ more costly than a pit latrine.
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2.8.3 Ventilated Improved Pit (VIP) Latrine

The VIP latrine is a modified version of an ordinary pit latrine. According to Tsinda *et al.*, (2013:6940) a pit latrine is a hole dug in the ground, which covered with either a squatting plate or a slab that is used as a seat. A structure is built over the pit to provide privacy and security. This type of sanitation system requires no water. What happens with the urine and faeces is that it soaks away into the soil.

The VIP is a pit latrine with an external ventilation pipe. A screened vent is installed in a straight line over the pit. The purpose of the vent is to control odours and prevent insects

from entering the pit (Chariar & Sakthivel, 2011:114). If the pit releases bad odours it attracts insects and flies. Sawdust can be poured over the contents to minimise odours. Once pits are filled up they should be covered with soil for composting. There are two types of VIP latrines, namely single pit and alternating pit. VIP latrines have the advantage in that once pit number one is full it can be closed up and pit number two can be used (Abarghaz *et al.*, 2012:213). By the time the second pit is full, the faecal matter in the pit has become fully decomposed. According to Andersson *et al.*, (2001:24) if necessary, and space is an issue, substances in the full pit can be removed and that same pit can be reused. And so the process will be repeated.

2.8.3.1 Design

According to Kramer *et al.*, (2011:14) pit designs differ due to the vagaries of the particular terrain. Most pits are designed to be between 1.5 and 2.5 metres deep. A single pit is expected to fill up in a period of approximately two years.

2.8.3.2 Operating principles

Urine filtrates away into the soil. The faecal matter is broken down into smaller particles by biological digestion (Buckley *et al.*, 2008:2). The gas released from this process escapes through the vent over the pit and in this way prevents odours from remaining in the pit.

2.8.3.3 Applications

According to Buckley *et al.*, (2008:2) single pit VIP latrines are appropriate for use in rural areas where the soil is deep and the necessary funds to be invested in constructing a waterborne sanitation system are not readily available. Double pit VIP latrines are suitable for installation in urban areas where people are more likely to have the financial resources to afford a latrine that does not have to be moved after a few years of use. However, it is important to note that when using the toilet one must apply hygienic practices including proper hand washing. Education to this effect must be provided where necessary by the relevant authorities. The installation and use of ventilated pit latrines have certain advantages and disadvantages as shown in the table below.

Advantages

Disadvantages

<p>The advantages of pit latrines include that they are:</p> <ul style="list-style-type: none">▪ easy to construct;▪ require little training and recipients can be unskilled;▪ do not cost much (Alcock (1999) cited in Sesani (2005:36);▪ require no water for their operation (Boot, 2008 :);▪ promote air circulation that is necessary to reduce odours and fly breeding problems (Mack 2006:61);▪ easy to maintain and operate; and▪ are user friendly to any kind of anal cleansing materials.	<p>Disadvantages of the pit latrine include:</p> <ul style="list-style-type: none">▪ separate washing facilities and wastewater management is necessary (Mack, 2006:61);▪ unlined pit walls may collapse (Tsinda <i>et al.</i>, 2013:6940);▪ they may lead to groundwater pollution (Boot, 2008:4);▪ excreta are visible to the user; and▪ once the pit is full it must be left undisturbed for at least two years this can be a problem for disadvantaged communities with limited space (Werner <i>et al.</i>, 2004a:23-30); and▪ increased odour outside.
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2.8.4 Aqua Privy

According to Boot (2008:6) the conventional aqua privy is essentially a small septic tank located directly below a squatting plate. It is fitted with a drop pipe that extends below the liquid level in the tank to form a simple water seal. Kramer *et al.*, (2011:22) explain that the material that must be placed over the faecal matter in the tank is carbon sourced it should be as fine as possible to ensure that it covers the faeces completely. This application will reduce access for disease vectors such as flies and mosquitoes which breed readily and can become a nuisance in the toilet. It will also help to prevent odours.

However, to ensure that the water seal is maintained (i.e. that the drop pipe is below the liquid level in the tank) sufficient water has to be added via the drop pipe each time the toilet is used to replace any losses. The excreta are deposited directly into the tank where they are gradually decomposed anaerobically in a process similar to that which occurs in a septic tank. An enclosure or housing in the form of a shed is built over the tank. A vent pipe with a fly screen at the top is attached to the housing. A watertight tank is desirable to minimise losses into the surrounding soil (Buckley *et al.*, 2008:3). An effluent (overflow) pipe should also be installed above the level of the drop pipe.

2.8.4.1 Design

When designing this type of EcoSan system, certain considerations must be taken into account, such as the capacity/volume of the tank. This should be calculated on 1.5 litres per day per individual plus 4.5 litres per day (in other words 6 litres per person per day) to

maintain the water seal of the drop pipe beneath the level of the liquid in the tank.

The contents of the tank can be discharged into a soak-away pit or be left to infiltrate into the soil.

2.8.4.2 Operating principles

Before the toilet can be used the tank must be filled with water up to the level of the outlet pipe. About six to eight weeks later, the decomposition process will achieve its desired level of operation.

2.8.4.3 Applications

The aqua privy is suitable as an eco-friendly sanitation system in areas where water resources are scarce and where the high cost of installing a waterborne system is not feasible.

Advantages

Disadvantages

<p>The advantages of the aqua privy include that the system:</p> <ul style="list-style-type: none"> ▪ cannot be blocked easily due to anal cleansing materials; ▪ produces minimal odours and insect problems; ▪ can be changed to suit the owners' needs; and ▪ does not require piped water supply, because human excreta falls directly into the tank (Boot, 2008:6); and ▪ low effluent quality. 	<p>The disadvantages of the aqua privy system include:</p> <ul style="list-style-type: none"> ▪ the water seal may break when it is being cleaned; ▪ users must receive appropriate training and demonstration on how the system functions; ▪ the tank must be cleaned every two to three years; and ▪ emptying the system may become onerous (Boot 2008:6).
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2.8.5 Pour-Flush Toilet (PFT)

The pour-flush toilet has a basin with a water seal trap. Still and Louton (2012:1) claim it is hygienic and requires minimal water (1 or 2 litres) for flushing away urine and faeces. Faeces are flushed away with water that falls into a container or scoop. Different containers or bowls can be used to collect faeces and urine. Leakages must be prevented because leaks will mean loss of water and the objective here is to save water. The toilet can be installed inside or outside the house depending on the wishes of the users. A pour-flush basin can also be used with a compost privy; VIP; aqua privy; or a public toilet. A 36 litre water tank can be installed inside or outside the enclosure of the toilet; the tank should be filled up from a nearby water source (Still & Louton, 2012:14).

2.8.5.1 Design

Pour-flush basins can be made of different materials (for example shaped concrete) and can be squat type or have a seat. According to Spuhler (2010:15) the structure around the toilet must be a minimum of 1.2 x 1.2 m. It should have hollow block concrete walls 1.5 m high and G.I. sheet roofing. It can also be constructed with non-permanent type local materials.

2.8.5.2 Operating principles

According to Mara (1990:3) this system can be designed to function satisfactorily using between 2 and 3 litres of water per flush. Urine and faeces filtrate into the ground and the soak away pit. A water seal trap prevents the excreta from releasing odours and there is no opening where insects can enter.

2.8.5.3 Applications

The pour-flush toilet is adaptable; it can be installed inside or outside the home. According to Mara (1990:3) pour-flush toilets can be used in high density areas.

Advantages

The advantages of the pour-flush include, among others:

- it can be placed inside or outside the house (Alcock, 1999 cited in Sesani, 2005:38);
- water required for operation is only about two to three litres per flush, or even less;
- it can be upgraded;
- hygienic and easy to clean because it reduces the chance of disease by minimising pathogen transfers (Mack, 2006:59); and
- it is convenient and relaxed for the user.

Disadvantages

The following are possible disadvantages of the system:

- According to Mack (2006:59) the system relies on water supply for operation and maintenance;
- it blocks easily if large quantities of anal cleansing materials are used;
- it requires suitable infrastructure to manage wastewater.
- it is more expensive to install than similar types; and
- a higher level of skill is needed in the manufacture of the plastic pan.

2.8.6 Water bank system

According to Lange (2014) for this off-site sanitary system to function successfully a pour-flush toilet that uses 2 litres of water per flush must be installed at each dwelling, along with a 200 litre tank. The tank is filled up once a day. Residents must manage with 200 litres a day (i.e. 6000 litres per month) which is compliant with the Free Basic Water (FBW) allowance.

Advantages

Disadvantages

<p>This off-site sanitation system offers the following advantages to its users:</p> <ul style="list-style-type: none">▪ increased user comfort and security, in particular for women and girls (Lange, 2014);▪ pit latrines or bucket systems are eradicated;▪ there is control over the family's own consumption;▪ improved Free Basic Water control; and▪ uses only 2 litres per flush.	<p>Consideration must be given to disadvantages, including the following:</p> <ul style="list-style-type: none">▪ needs political will and cooperation of residents;▪ requires reliable water supply;▪ needs a septic tank or leach pit and;▪ if there are any leaks then there will be a reduction of the volume of water in the tank.
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2.8.7 Community ablution blocks (CABs)

According to Boot (2008:8) ablution blocks which serve as public sanitation facilities should be constructed near the marketplace, bus parks and informal settlements. The system functions with septic tanks, a sewer network, bio-digesters and/or anaerobic baffled reactors. Most ablution blocks in low-income urban areas are built with the support of NGOs, faith based organisations and municipalities. The facility may include toilets, showers, hand basins and wash troughs. According to Dedekind (2010) one CAB is sufficient for an area with a population density between 50 to 75 households. Distance plays a significant role in the provision of shared sanitation facilities (CABs). The CABs must be placed within a maximum walking distance of 200m to 250m from all households.

Advantages

Disadvantages

<p>The following advantages can be associated with CABs:</p> <ul style="list-style-type: none">▪ it is a cost effective way for the provision of sanitation facilities to large numbers of users;▪ CABs can be used for many services, such as water kiosks, toilets, urinals, showers, shoeshine and small shops; and▪ they can lead to improvement of youth employment opportunities in the operation and maintenance of the facilities (Mballo, 2012).	<p>The CAB system has a number of disadvantages:</p> <ul style="list-style-type: none">▪ there is a high capital cost;▪ placement of the CABs is important especially for women and children when they have to use it them night (Mballo, 2012);▪ they require a source of water for proper hygienic operation; and▪ According to Mballo (2012) these systems are known for having blockages.
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As shown in the case of each sanitation system discussed, they all have certain advantages and disadvantages. It is of vital importance to seek advice from the users of these systems, the people themselves, to ensure that they have access to a system that is feasible for their particular needs. These last two types of sanitation systems will be discussed in greater detail in later chapters.

2.9 Conclusion

This chapter has reviewed different theoretical perspectives on ecological sanitation. In doing so, factors contributing to ecological sanitation and sanitation systems were identified and analysed from various literature and other sources of information. Throughout this chapter a distinction has been made between different sanitation systems. Different categories of sanitation systems have been identified in an attempt to find out which system can be implemented successfully in informal settlements in the southern African context. In addressing the perspectives on ecological sanitation the concept ecological sanitation was discussed extensively and linked to other sanitation approaches. The international and local experience of EcoSan was explored and the advantages and disadvantages of different ecological sanitation systems were identified.

Chapter three goes on to provide an in-depth discussion on the case study area with reference to matters of current sanitary conditions at the Barrage informal settlement (BIS). Cooperation and consultation with users is an important aspect for this study. The research aim is to achieve buy in from different stakeholders.

CHAPTER 3

The current sanitary conditions at Barrage informal settlement (BIS)

3. Introduction

This chapter will feature a background description of the study area. The discussion is based on data gathered during fieldwork, which was an integral part of the research process. The candidate conducted extensive investigations, specifically on the current status of sanitation systems at the Barrage informal settlement (BIS). Despite the fact that in this mini-dissertation sanitation refers to the means of disposing of human waste, this chapter also includes related aspects such as matters of water supply, wastewater and garbage disposal. These all are components of the issue of sanitation and are important in that they are often closely associated with health-related matters. The objective in this chapter is to provide an overview and categorisation of the types of household sanitation facilities available at the BIS; to discuss the level of understanding of the community members on matters related to their health and hygiene practices; and to assess the challenges facing the community with regard to the type of sanitation system they currently use.

3.1 Research methodology

This section discusses the methodology used in collecting information and how the research study was designed and conducted. The research method used was primarily qualitative in nature.

3.1.1 Methods used

A mixed method approach was used. This included transect walks through the settlement; focus group discussions; field observations; questionnaires and key informant interviews. Quantitative data was gleaned on sanitation facilities by using a structured questionnaire. A qualitative research method was used to find out more about the problems and constraints to improving the current sanitation and the potential acceptance for introducing an ecological sanitation (EcoSan) system in BIS (Terre Blanche & Durrheim, 2006:78). The research project was executed in three time periods. The first period was one of literature review and the collection of data. The second period involved fieldwork and the preparation of semi-random structured interviews in the BIS. There were also random interviews and informal talks during the fieldwork sessions. In the final phase, collected data was used for the construction of a narrative discourse.

3.1.2 Literature review

According to Blaikie (2000:183) relevant literature sources should be scrutinised for content and insight on theory, methodology and empirical examples. The primary focus in this study was on secondary sources such as books, journals and other publications. Also included were national reports about slums development, sanitation and ecological sanitation issues in informal areas in South Africa and other parts of the world. The review endowed the author with an understanding of relevant theory and deeper insight into the research problems. It also facilitated the search for answers to the research questions and potential conclusions.

3.1.3 Field observation

Observation formed an integral part of the research conducted while on fieldwork excursions. Data extracted from empirical circumstances in the field was of substantial value. Observations paved the way to securing information on technological hardware of local sanitation facilities and to test the demand for sanitation within the community. Several fieldtrips were made to families living in BIS.

3.1.4 Selection of the sample dwellings

Since the aim of the study was to observe sanitation conditions in BIS, sample dwellings were selected based on two principles. Firstly, there was a random selection of dwellings; and secondly it was necessary to secure permission from a household head (owner) before including the domestic property in the research project (Gray, 2004:170). The latter step was essential, to gain accurate information on the dwelling from the member who knew the BIS, its history, its establishment and the subsequent promise of a relocation process. According to Varkevisser *et al.*, (1991), when a researcher seeks the participation of community members in a project of this kind, the owner/resident of a dwelling has to sign a consent form, giving the researcher permission to take pictures of the dwelling and to take measurements such as the placement of the latrines and the dwelling size. This permission proved to be of vital importance because some local residents were wary of participating in the study. For example, some did not even want to attend meetings to hear what the researcher had to say. They explained that in the past many people had come to BIS and promised them the world, but their situation had not improved. The precise location of dwellings was also something that had to be taken into consideration. For example, the survey had to include dwellings on the periphery of the BIS, close to the surrounding veld and the bushes, as well as those householders who lived in dwellings in the central area of the settlement.

3.1.5 Selection of respondents and sampling process

Random sampling strategies for selecting respondents were based on volunteerism. The engagements with residents were primarily in the form of face-to-face engagements, with respondents responding orally to questionnaires. Criteria for categorising information included whether the respondent was:

- head of household/owner;
- his/her age and language;
- gender and race; and
- additional factors such as poverty and health threats.

3.1.6 Survey schedule

The gatekeeper, Ms Martha Ntuze, introduced the researcher to the community and told locals the nature of the study and what the researcher planned to do in BIS. This process made it easier for the researcher to conduct the project because the gatekeeper was a resident in the community. A schedule was drawn up on how interviews would be conducted and the specific times they would be held. The schedule was in accordance with the availability of the gatekeeper and the respective household heads. Most of the interviews were conducted in the afternoon after 15h00 when the gatekeeper returned from work. A typical session lasted up to about 18h00. The chosen time slots were most suitable because natural daylight allowed the researcher to take quality photographs. The time schedule was appropriate because from 15h00 many community members arrived home from work. Some interviews had to be rescheduled either because the household head or gatekeeper was not available, or both. The gatekeeper was of vital importance to the success of the initiative. She was familiar with everyone and everything in the community.

3.1.7 Interviews

Information about the settlement was obtained directly from the residents who volunteered to be involved in the project. Many had been resident in BIS since the establishment of the settlement. During interviews the researcher asked questions orally and recorded participants' responses. Each day after the fieldwork, the data collected and observations were consolidated. Notes were filed and edited in the researcher's personal archive to ensure that the information was orderly and categorised. Interviews with minors were conducted under the supervision of the parent/s and the gatekeeper. Interviews with participating community members took place on various days of the week.

In the last phases of consolidation the relevant documentation was formatted and stored for later use, in terms of the guidelines provided by Leedy & Omrod (2001:101). Qualitative research design was used for this study with the objective of securing a better description and understanding of the living circumstances in which the people found themselves. In addition to conducting the interview/s, each day the researcher managed the interview data by keeping a research diary. Here she recorded additional personal information provided by the respondent. In general this information would be matched with the research questions and then the data would be ordered, based on the responses of participants.

3.1.8 Data collection for the demographic and socio-economic survey

The demographic and social survey was conducted in order to form a better impression of:

- characteristics of the living conditions of informal settlement residents in BIS;
- livelihood patterns;
- residents' coping mechanisms;
- population dynamics of the settlement; and
- how people used their available income.

The study was carried out in two parts. The first included photographs, interviews and questionnaires. Questionnaires were designed with a view to collecting information related to the above-listed characteristics of the residents of BIS. The questionnaire was completed during one-on-one interviews with 20 caregivers (consisting of the father, mother or the grandmother) of the household concerned. They had to be local residents of BIS who volunteered to participate in the random sample selection and subsequent interviews.

Questionnaires were completed with the assistance of the researcher and the gatekeeper, who communicated in various indigenous languages of South Africa. The head of household, or another identified adult, had to answer the questionnaire on behalf of the household. The information collected from the demographic and social survey was used to gain a thorough understanding of how residents of BIS survive regardless of personal economic difficulties. Questionnaires designed specifically for interviews with municipal officials were different from those used for community members. The purpose of these interviews was to obtain information on the type of sanitation systems currently in use in informal settlements elsewhere. They were also asked if they would be willing to promote EcoSan for informal settlements in South Africa. Did they have any feasible solutions for the dire sanitation shortage in informal settlements?

The second part of the research fieldwork consisted of making observations, conducting group discussions and drawing basic sketches of dwellings to determine the placement pattern of latrines. The researcher was personally responsible for the conduct of interviews and filling in of the questionnaire, while Prof. JWN Tempelhoff assisted the researcher in taking the necessary photographs. Interviews and questionnaires took 10 to 15 minutes to complete. An average of six interviews and questionnaires were done each day. The total sample consisted of 30 dwellings.

3.1.9 Data analysis

The first part focused on general observations of sanitation conditions in BIS. This included the physical structure of the dwelling and the latrine. In this process the researcher made use of sketch plans, as well as photographs. The aspects observed included: location of the dwelling; location of the latrine; and the activities of people in the domestic environment of the settlement.

3.1.10 Basis of analysis

It was important to determine the housing conditions in concert with the analysis of the current sanitation conditions in BIS. These factors have a direct impact on the sanitation conditions in the community and the problems related to them.

3.1.11 Mita Mokoena Oral Archive (MMOA)

This was another of the research instruments used to attain information from the respondents with regard to sanitation facilities and local water supplies. The interviews allowed respondents to give specific and/or general information on the question under discussion. The archive, compiled by the researcher, reflects the status and/or name of the particular respondent and the date on which the interview took place. It is indicated by the acronym MMOA in the text. In the bibliography to this mini-dissertation the MMOA is listed under the heading 'Primary sources'.

3.2 Water and sanitation at BIS

For the purposes of this study it was necessary to investigate the current sanitation provision services at BIS and at the same time to devise a strategy for developing an ecological sanitation (EcoSan) system. At the outset it is important to point out that living conditions in BIS are unsanitary and unsafe. The situation poses a definite health risk and is not suited to reasonable and safe human habitation.

Inadequate sanitation facilities mean that the community is exposed to health hazards. Adults and children alike resort to coping mechanisms such as defecating in the bushes on the outskirts of the settlement, or even in open spaces among the dwellings within the settlement.

There are a few key areas that have been identified for more detailed evaluation on the current sanitary condition in BIS:

- living conditions in the informal settlement;
- water resources and availability;
- sanitation conditions at BIS;
- existing sanitary system in BIS;
- problems of the current sanitation system;
- impacts of the inadequate sanitation;
- sanitation usage for women, men and children; and
- coping strategies.

3.3 The study area: Barrage informal settlement (BIS)

3.3.1 General background history of the settlement

The Barrage informal settlement (BIS) was established in the years between 1985 and 1990 (Du Preez, 2014). The community originally lived in the deserted buildings of the Old Barrage Road House, formerly a popular stopover venue for travellers between the Transvaal and Orange Free State. The roadhouse was situated on the national road across the famous Vaal River Barrage Bridge and was in use until the N1 motorway opened to traffic further downstream of the Vaal River in 1968. The only brick structure on the premises where the informal settlement arose, was a red-brick building occupied by Mohammed Amin Choonara and his family (see the court records on *Barrage Investments (Pty) Ltd v the unlawful occupiers of portion 91, 2007*). All other occupiers of the premises were informal residents, of whom there were about 45 families. On or before about 1 October 2006, the occupants came to an agreement to vacate portion 91 (a portion of portion 54) of the farm Kaalplaats 577. This portion was 21, 4133 hectares in size. The occupiers agreed that the period of notice was fair. The Wits Law Clinic, acting on their behalf, undertook to purchase a new property for them, an area which had already been located. It was envisaged that the informal occupiers would relocate to the new premises. The owner of the property agreed to provide transport to move them to the new property, a process that was envisaged would

take about five days. Miss Alina Nhlapo was the last person to move to the new site (MMOA, A. Nhlapo, 14.12.2014). Community members claimed that when they asked Mr Maarten du Preez (the property owner) why they had to move, he explained that he was in the process of selling the piece of land where they had been living previously (Du Preez, 2014).

3.3.2 Brief overview of the study area

The Barrage informal settlement (BIS), like any informal settlement, has its own unique socio-economic, political and ethical characteristics. It also has traits that are common to other informal settlements throughout South Africa. BIS is characterised by high levels of poverty; a high rate of illiteracy; unemployment; poor housing. The settlement lacks access to quality health care, transportation, and has an unhealthy environment. Informal settlements are characterised by high population density and have a history of on-going neglect by public authorities.

For the most part, dwellings in informal settlements are situated on land that is unsuitable for residential purposes – either in flood plains, on agricultural land or on sites near hazardous industrial activity (Cousins & Lagardien, 2004:186). These characteristics are typical of many informal settlements worldwide. Local unemployment is substantial, and levels of illness and disease is high, with a prevalence of childhood diarrhoea, teenage pregnancy and HIV/AIDS. Since the re-established of the settlement in 2006, no adequate sanitation facilities have been provided; there is no running water, no electricity supply, and no waste removal service. These circumstances are similar to the state of affairs in settlements of this kind in other parts of South Africa (Higgins & Krieger, 2002:4), heightening the vulnerability of local residents. According to Lane (2004:76) inadequate sanitation is known to hold back the development and progress of the government's Millennium Development Goals (MDGs). The BIS is located in the Democratic Alliance (DA) controlled Ward 25, under the jurisdiction of Emfuleni Local Municipality (ELM). The settlement has about 74 self-made inhabited informal structures commonly known as shacks. Community members have personally erected these structures.

BIS residents are essentially people in need of a place to live, but they are unable to find accommodation due to a variety of factors, of which affordability is the paramount obstacle. For some years residents have been promised that they would be relocated to another area. Their occupation of the land, classified as agricultural land, is therefore in effect unlawful (MMOA, M. Nhlapo, 14.12.2014). The problem is that community members do not know when, if ever, they will be relocated. A number of promises made have never been fulfilled.

This means that while still waiting for the municipality and land owners to come to an agreement or find a solution, the residents continue living without basic services. Community members say they do not want to relocate. Some residents of the BIS work nearby employed in the local construction sector. Others do gardening or are employed as domestic workers. At this late stage, relocation to a new area will be a problem for many. The absence of proper transport is their main complaint. And those families who have children who attend the local school adjacent to the settlement, will also experience great difficulty if they are moved to another site (MMOA, A. Rakhetsi, 12.12.2014; and MMOA, M. Montshi, 10.12.2015).

In respect of sanitary matters and water supply services, the BIS residents resort to using the nearby bush on the outer perimeter of the settlement as a sanitation facility. Alternatively they use their pit latrines that are prone to fill up very quickly. In this way the domestic environment of the settlement is exposed to potentially dangerous and harmful circumstances, especially for women, children and the elderly. The United Nations' Children's Fund (UNICEF, 2001:15) indicates that relieving oneself in the bush has a negative impact on people's privacy and dignity. It is apparent that for people in South Africa resident in informal settlements in a phase of rapid urbanisation, there is indeed an acute awareness and a self-consciousness about the lack of dignity and privacy in circumstances where there are no sanitation facilities. Patients in the informal settlement currently receive their health care treatment from a government sedan vehicle. This mobile clinic, which calls at the BIS on a Thursday, only gives attention to minor conditions like flu, and also allows for the collection of chronic medication for diagnosed conditions such as tuberculosis (TB), high/low blood pressure and diabetics. However, as recently as this year (2015), to the disappointment of many members of the community, such as pregnant mothers, certain patients have been told to go to the Johan Heyns Clinic in Vanderbijlpark or to a Quick Shop clinic that is about five kilometers from BIS on the road to Stokkiesdraai. This is inconvenient because it means that residents of BIS have to travel long distances to secure essential medical services, and they lack the necessary transport (MMOA, M. Moya, 11.02.2015).

The main source of transport for residents is the minibus taxi industry (MMOA, P. Mabote, 11.12.2014). These taxis call at the settlement intermittently, sometimes at long intervals. The only other alternative for transport is to ask for lifts from passing motor vehicles and trucks on the main road. Further public amenities include the nearby Barrage station of the South African Police Service (SAPS) and the Barrage Primary School, accommodating approximately 285 children. More than 30 children from the settlement attend this school (MMOA, M. Ntuze, 11.12.2014).

The necessary steps have been taken to subdivide the property to ensure that the school is kept separate from the section where the shacks have been erected. The Department of Education has already taken over the running of the school, which was the initial reason for subdividing the school property from the informal settlement. Next to the police station is Rand Water's Barrage works. The water utility oversees the management of the Barrage, an extended mechanically-controlled weir across the Vaal River. Informal settlements generally continue to grow exponentially, without any planning and these settlements are strictly-speaking illegal; they fall outside the formal town planning processes (Huchzermeyer, 2004:1-2). This type of uncontrolled housing development may also cause disaster risks. For example, there have been cases where unsustainable development practices have created wealth for some unscrupulous money-grabbers at the expense of innocent people who have been saddled with unsafe working or living conditions and in the process there has been degradation of the environment (Tsinda *et al.*, 2013:6941, cited in Tsinda & Abbott, 2012) and (DWAF 2002:5).

If and when development takes place in informal settlements it is possible to reduce sanitation related diseases. Such action should include providing access to adequate drinking water, food, waste management and secure dwelling conditions for local residents (Forsyth, 2002:229). Trade and technology can also reduce poverty. Investing in financial mechanisms and social security can cushion residents against vulnerability (Forsyth, 2002:299). At a social level this can be accomplished by building community cohesion, recognising these excluded individuals and providing opportunities for greater involvement in decision-making. There is little doubt that enhanced education and health capacity increase resilience.



Photo 1: Ground plan of the study area (Source: Google earth, 2015)

3.4 Living conditions in Barrage informal settlement (BIS)

The people who come together to form informal settlements typically ignore the laws and regulations that are in place with regard to construction of roads and buildings (RSA, 2007:106). They identify whatever piece of land they see is available and defiantly set up their houses there – hence the descriptive name Baipei (those who put themselves where they are). When the dwellers first settle they construct shacks out of corrugated iron sheets, wooden boxes and a variety of scrap materials. In BIS the water, sanitation systems as well as storm water drainage systems range from non-existent to very poorly maintained facilities.

When thunder storms hit the area, the ill-constructed streets turn into muddy tracts of land with pools of water, which means that sources of drinking water are immediately at risk of contamination. Furthermore, heavy rains destroy sanitation infrastructure, which in turn leads to the disruption of normal water supply and rudimentary sanitation services. People resort to unhygienic alternatives which in turn, lead to ill health. The impoverished residents, who lack medical aid and are struggling constantly to cope with inadequate sanitation, have to contend with potential waterborne illnesses such as diarrhoea, and even more dangerous disease such as typhoid fever and cholera which may escalate to pandemic proportions (Tissington, 2011:13).



Photo 2: Types of common housing in BIS (Source: M. Mokoena, 2015)



Photo 3: Big stones placed on top of the dwelling (Source: M. Mokoena, 2015)

Residents interviewed in the BIS have been living in the settlement for more than 10 years; most of them are males (Grobler, 2014). The majority of households have three to four dependents and the breadwinner's income has to pay for all their most important needs, including food, transport and school fees for the children. Research undertaken in the BIS by Grobler (2014) shows that 73.94% of breadwinners are employed, but those households have an average monthly income of between R501 and R1200. The income per household is generally determined by the educational background of the breadwinner/s. Most community members in BIS have only a secondary school qualification. Due to the almost complete lack of basic services the residents have resorted to coping strategies of living without electricity, adequate sanitation and waste removal services.

Only the domestic use of water was taken into consideration for the purposes of this study. In the BIS it is common for people to sit on chairs outside their shacks with the doors open and talk to neighbours and people passing by in the streets. The streets within the settlement serve as playground areas for children and are safe from traffic (of which there is little) and they are under the watchful eyes of community members and people they know well. The majority of dwellings in BIS have rudimentary side and back fences made of scrap

materials such as wooden stakes and recycled tin sheets, or even bushes. In most cases the fences have been there since the establishment of the settlement. If they have no washing lines, residents often hang their laundry on the fences.



Photo 4: A laundry line solution (Source: M. Mokoena, 2015)



Photo 5: Fence used as a washing line (Source: M. Mokoena, 2015)

The majority of residents in BIS have a small vegetable patch in their yards. They plant cabbages, spinach, carrots and pumpkins; others have planted one or two rows of maize. The occasional peach tree or indigenous trees provide what little shade there is in the settlement. Some households have small gardens with a lawn; others keep chickens (for the eggs) and have pet dogs (MMOA, D. Mothapo, 12.2014). The large tree at the main entrance of BIS, next to the local spaza shop (informal shop) has become the main meeting point for the community. It is the place where women come to shop, meet, and interact on a daily basis. General community meetings and the exchange of information occurs here (MMOA, M. Ntuze, 11.12.2014). It is also the place where women are able to air their views. For men the local shebeen (informal tavern), is the main meeting place during weekends and after work (MMOA, J. Mabote, 11.12.2014).



Photo 6: A vegetable garden planted with spinach and pumpkin (Source: M. Mokoena, 2015)



Photo 7: Man cutting his lawn with a garden scissor (Source: M. Mokoena, 2015)

3.5 Dwellings and their surroundings

Structures in informal settlements vary largely depending on the perceived likelihood of eviction and the availability of building materials used to erect them.

From observation it is evident that not all the houses are located close to the bush. This is

because of the way each household selected the location for their dwellings when they first arrived. The placement of the house also has an influence on sanitation. Some dwellings are made of stronger materials and have concrete flooring but the large majority has no proper flooring. To protect shacks against strong wind, large stones are often placed on top of roofs. Some, but by no means all shacks have provision for ventilation.

Smit (2003:7 cited in Thomas, 1997) explains that flimsily constructed shacks with earthen floors are strongly associated with dampness. Although the evidence is somewhat contradictory, damp housing can be seen as a contributory factor to residents suffering from rheumatism, arthritis and respiratory diseases such as pneumonia, bronchitis and upper respiratory infections. Since the floors inside the dwelling are not plastered cement, sweeping causes the dust to rise and unplastered floors lead to sneezing. The size of shacks in BIS varies considerably. Size is determined by the number of household members, the available income and whether there are any tenants. Having tenants is for the purpose of generating extra income. The size of dwellings ranges from about 12m² to between 24² and 27m² and there are generally one or two rooms. A female participant in the project said that when the wind is very strong residents hide under the bed in fear of the shack collapsing (MMOA, A. Rakhetsi, 12.12.2014).

3.5.1 Affordability

Living in informal settlements is cheap. The price of a 'zozo' (also known as a shack) made of corrugated iron sheets, varies when put up for sale. A one-room zozo costs about R2 300; a one-and-a-half room sells for about R2 700; while a two-room shack may cost as much as R3200, depending on whether it has windows or not. Apart from the cost of the materials for building the structure, the only additional cost to the resident is for lighting and cooking (in most cases candles and paraffin) and food. Water supply is free in BIS. Paraffin usage comes to approximately R102 per month (Grobler, 2014). For people in BIS there are no rates payable; there is no property tax or other service charges that have to be made. Residents buy most of what they need at the spaza shop.



Photo 8: A one room zozo without any windows (Source: M. Mokoena, 2015)



Photo 9: Typical two room zozo in BIS with ventilation (Source: M. Mokoena, 2015)

3.5.2 Activities in the dwelling

The majority of residents live in a two-room shack in which they eat, cook, sleep, wash and live. Curtains are used to separate the bedroom and the kitchen. Dwellings only provide shelter against environmental elements such as rain and the winter cold; and also against negative social elements. Dwellings are reportedly very hot inside during the day in summer because of intense sun radiation, but they are comfortably cool at night (MMOA A. Rakhetsi, 19.03.2015). As a consequence most of the household chores are performed after sundown. Children usually have to sleep in the kitchen and on the floor (MMOA, T. Mabote, 19.03.2015). Smaller dwellings are inconvenient and lack privacy. If possible, parents and children have separate bedrooms. In the interviews, BIS residents explained that furniture and home appliances inside dwellings are placed on bricks to raise them above the soil floors (MMOA, A. Bofelo, 11.12.2014). In the rainy season water comes into houses and this is very disruptive and uncomfortable. Other grievances with their homes include leaking roofs and rainwater that comes through the make shift walls.

People of BIS do not put carpets in their houses; instead they use multi-vinyl or plastic flooring material. Carpets tend to get wet and may cause flu. The kitchen area in the dwelling usually has a table that is used for food preparation and for storing food and eating utensils; the table also doubles as a dining table. The kitchen sink consists of a plastic or stainless steel bucket in which the dishes are washed. Some improvised tables are arranged in the kitchen to hold basins where the clean dishes are dried. At mealtimes the children usually take their plates and sit down on the floor or a bench in the makeshift kitchen, bedroom, and living room. Water containers are placed inside the kitchen area to wash dishes and for drinking. Old plastic paint buckets generally serve as water containers for storage, while, smaller containers are used to carry water inside the dwelling. Water buckets have to be covered with a net to prevent flies and other small insects from getting inside. A typical scene in BIS is both women and men washing their clothes in a front extension of the house either to the left or right of the main part of the shack, depending on where the laundry line is. It also means that residents do not have to do their laundry at one of the local water standpipes. Bathing is done in a portable basin of variable size that is placed inside the dwelling, usually in the bedroom, depending on where there is space available. The bedroom provides some privacy.

3.6 Fuel and power usage

Firewood, paraffin and coal stoves are generally used for cooking. Other less common sources of power include solar power and gas. Car batteries are sometimes used to power radio sets, charge cell phones and provide lighting (MMOA, L. Mofolo 02.03.2015).

Those who can afford it use paraffin for cooking and heating water. The reason for using paraffin is that it is less expensive and can be bought at the local spaza shop, where four litres of paraffin costs R12 (MMOA, 'A', 19.02.2015). Members of some households explained that they go into the nearby bushes to collect firewood. However these coping strategies for fuel come with many side effects. Some residents complained about chest pain and sore, burning eyes (MMOA, S. Mamothau, 11.12.2014). Small children are also exposed to fumes from paraffin stoves and smoke because they are carried on their mothers' backs during food preparation. A female participant in a group discussion held at the squatter camp said that previously she was healthy, but she has now developed a sinus infection because of all the smoke she inhaled (MMOA, M. Nhlapo, 14.12.2014). The reason for using firewood is that it is locally available (MMOA, R.P. Molawe, 11.02.2015).



Photo 10: Car battery charging a cellular device at Mr Mofolo's tavern (Source: M. Mokoena, 2015)



Photo 11: Gas stove used for cooking at the local informal shop (Source: M. Mokoena, 2015)

Using firewood also has its disadvantages, especially in the summer season. Heat from stoves makes the interior of the homes far too warm. Sometimes children get burnt while trying to put firewood into the stove (MMOA, D. Mothapo, 1.12.2014). However, during the winter months the coal stoves help to keep the shacks warm. All the food that is prepared on that day, must be eaten otherwise it goes off. Food cannot be left overnight especially in summer. Two of the respondents indicated that eating food that has been exposed to too much heat inside a shack could lead to food poisoning (MMOA, M. Nhlapo, 14.12.2014; MMOA, A. Rakhetsi, 12.12.2014). In winter food can be eaten over two days due to the cold weather (MMOA, S. Mamothau, 11.12.2014). Even if shops like Checkers have big specials on food, residents cannot take advantage of these special offers because they do not have refrigerators (MMOA, M. Nhlapo, 14.12.2014; MMOA, M. Ntuzze, 11.12.2014).



Photo 12: Paraffin stove used for cooking inside the dwelling (Source: J.W.N. Tempelhoff, 2015)



Photo 13: Candle used as a lighting source inside the dwelling (Photo: J.W.N. Tempelhoff, 2015)

Paraffin is sold at the local spaza shop and stored in two-litre cold drink bottles, which can result in accidental poisoning. Small children sometimes mistake the paraffin for water and drink it (Eberhard & Van Horen, 1996:4). The local spaza shop sells a variety of commonly used consumer goods, for example bags of maize meal, tins of beans and candles (MMOA, 'N', 11.12.2014). The spaza shop is clean and is built on a proper cement foundation. The shop has a large front room that is easily accessible for the owner, but clients have to buy whatever they need through the window.



Photo 14: Paraffin sold in two litre bottles at the informal shop (Source: M. Mokoena, 2015)



Photo 15: A coal stove used inside the dwelling (Source: J.W.N. Tempelhoff, 2015)



Photo 16: A cooking area outside (Source: M Mokoena, 2015)



Photo 17: Chopped firewood used for a coal stove (Source: M. Mokoena, 2015)

3.7 Water resource availability

Similar to the Smithfield informal settlement in Durban, the BIS has a regular water supply, both for drinking and domestic use (Smit, 2003:4-5). The water supply system in BIS is managed by the local Rand Water Works situated nearby next to the Barrage Police Station (MMOA, M. Ntuze, 11.12.2014). There is a water pipeline connection from the Rand Water lines into the squatter camp. Residents fetch water from one of four standpipes and carry containers of water to their homes. When the standpipes were installed, community members had to help dig the furrows for the pipelines. However, residents complain that the water sometimes has too much chlorine.

On other occasions the water has a sandy content (MMOA, M. Ntuze, 11.12.2014). This sediment is clearly seen if the water is left to stand in the container for some time. Water pressure from the Rand Water lines is variable. The four standpipes cannot provide water at the same time. They function in such a way that only one standpipe can supply water at once, so residents often have to wait for another person to finish filling up his/her buckets before they you can fill theirs (MMOA, S. Mamothau, 11.12.2014).

Members of a typical household in the settlement fill up two 20 litre buckets of water per day from the nearest standpipe. The areas around the standpipes are always damp and muddy due to poor drainage (MMOA, 'N', 12.11.2014). When residents collect water they usually place the 20 litre buckets onto bricks to avoid the muddy water on the ground beneath the taps. However, it is worrisome that for many residents, basic hygiene is of no concern. There is a need for education within the community that the collected water must be used with great care. For example, water buckets are not cleaned thoroughly before they are filled. Respondents explained that they merely rinse out the bucket with clean water at the standpipe before they fill them (MMOA, M. Ntuzze, 11.12.2014). Then too, while the water is stored in the containers, small particles of sediment sink to the bottom of containers and the water often becomes contaminated. Such water is unsafe for human consumption because it has lost its pristine or treated quality.



Photo 18: This is one of the four standpipes where residents collect water in BIS (Source: J.W.N.Tempelhoff, 2015)



Photo 19: Damp, poor drainage and stagnant water at one of the communal taps (Source: M. Mokoena, 2015)

For the most part it is parents who are responsible for collecting water early in the mornings and in the late afternoons. Some parents are unable to do so because they return home late from work and in this case older children take over the water collection duties. Children usually wash themselves in the morning to save on time-wasting trips to the standpipes. In the winter months water is collected early in the mornings and again during the day, no later than about 17h00 when most parents are home from work. They cannot leave this chore until dark because of the bad lighting in the settlement. Based on observations of current sanitation practices and general water usage in the BIS, it is very clear that there is a need for basic health education (MMOA, P.S. Ramafikeng, 11.12.2014).

3.8 Waste management

In BIS, due to the lack of formal service delivery, there is no waste disposal, nor is any provision made for waste collection. Community members have to devise their own waste management mechanisms to manage the waste generated. Wastewater from bathing and personal hygiene, washing of clothes, household cleaning, and food preparation are all disposed of in the yard around each dwelling, without treatment. This creates a persistent smell. In BIS solid waste disposal is an ongoing problem and a great health risk. Domestic waste is dumped into the surrounding veld area. Piles of garbage are spread by animals as

they search for scraps of food. The garbage is a breeding ground for disease vectors such as rats and flies (Dummer & Cook, 2007). There is also a high level of danger to health in the refuse itself. This has been the corollary of inappropriate solid waste disposal practices by the people over the years. Most waste is concentrated in the bushes along the main road. On the opposite side of the road is an area that can only be described as a developing dump site. Some residents pour waste into buckets and then into pits. When the pits are full, the waste in the pits is burnt. According to an interview conducted with Mr A. Senooe, community members would be most grateful if provided with big refuse bins or tins where they can dispose of domestic waste (MMOA, A. Sennoe, 11.12.2014).



Photo 20: Dumping side inside a yard (Source: M. Mokoena, 2015)



Photo 21: Baby nappies dumped in a pit (Source: M. Mokoena, 2015)



Photo 22: Plastic dustbin used for waste dumping placed next to the gate entrance of Ms A Nhlapo dwelling (Source: M. Mokoena, 2015)

3.9 Sanitation conditions at Barrage informal settlement

At the beginning of 2015, were only 15 households in BIS that had sanitation facilities. Some 59 households out of a total of 74 had no latrines at all. The major method of excreta

disposal in the area is the use of pit latrines. These sanitation systems fill up very quickly because some of the latrines are used by more than five people. The Department of Water and Sanitation (DWA, 2005:2) stipulates that one toilet facility caters for an average family unit of seven members. Most of the people living in the BIS who do have pit latrines said the unpleasant “smell” was their chief complaint (MMA, M. Nhlapo, 14.12.2014). Three different types of sanitation systems were identified during the study, namely:

- open defecation;
- bucket system; and
- unimproved pit latrine

There are no off-site sanitation facilities in the form of flushing toilets in the BIS. Residents use sanitation facilities that do not require water for operation (MMA, P.S. Ramafikeng, 11.12.2014). Most residents, who use the bushes in the surrounding veld as a toilet, have been living in the settlement for more than three years. Other households no longer have any space in their yards to dig additional pits. This situation finds households having at least two filled latrines in one yard. When the latrine is full it is either covered with soil or pieces of wood. Unhygienic hands expose the residents to sanitation-related diseases, as do flies. Flies come out of the latrines and then go into the shacks and spread germs onto the food. The inability of residents to wash their hands after the use of the latrine and the spreading of germs by flies from the latrine, expose the entire community to diseases. And it is important for the people of BIS to be aware that when water comes into contact with human excreta it becomes contaminated due to the presence of *E. coli* bacteria (WHO, 2000: 18).

The absence of sustainable sanitation services not only results in water pollution, but also provides opportunities for vectors of diseases. According to Hosegood *et al.* (2003:4) a household toilet facility is an important aspect of a household's health status. However, in reaction to this information, BIS residents raised the following reasons why having a hygienic toilet facility was beyond their means. The main issue is that their salaries simply cannot cater for more than basic household goods. The purchase of building materials to improve their latrines is well-nigh impossible (MMA, A. Bofelo, 11.12.2014; A. Senooe, 11.12.2014). Others are of the opinion, especially in the case of single mothers, that they do not know how to construct a toilet facility (MMA, D. Mothapo, 11.12.2014).

Those residents, who do have latrines, have built these themselves. It became clear in the interviews that to have a latrine constructed on one's behalf would cost between R100 and R150 per latrine. According to Musa (2014:46) in Boiketlong informal settlement near

Vereeniging, community members requested assistance from skilled people to help them construct pit latrines. As payment, the residents were asked to make traditional African home-brewed beer. Residents see this as a coping strategy employed in the construction of pit latrines. When someone has constructed a latrine for you, you have to give him beer to drink. In the case of BIS, a young male said that it was too much effort to construct a latrine because the soil was very hard (MMOA, J. Rakhetsi, 12.02.2015). After a downpour of rain in the BIS, water tends to remain in pools for a long period, exposing residents to polluted land-related problems like diseases that are transmitted by vectors and inhalation. There is usually a foul smell that comes from the wastewater that residents throw out on the streets and from overflowing pit latrines in wet weather. The residents say that the unpleasant smell is always there and causes air pollution. With lack of space in the yards, householders are forced to dig pits for latrines close to their shacks (Esrey *et al.*, 1998:100). The distance between pit latrines and the dwelling is often very marginal and householders have concerns about their health and safety. Children are prone to falling into pit latrines (MMOA, M. Moya, 11.02.2015).

3.9.1 Features of pit latrines

- The common pit latrine is usually a hole dug in the ground.
- Most latrines are surrounded by structures made from four corrugated iron sheets.
- These doors cannot be locked and most doors cannot close properly.
- Not all the latrines have been laid out with small pieces of brick tiling.
- There are no water taps in the latrines, so hands cannot be washed.
- Some people use a small piece of chain to lock the door of the latrine when they are inside and after they have used the facility. But not everyone in the community does this.
- Toilets are not ventilated; flies and the smell escape from the toilets to the nearby shacks.
- Pit latrines tend to fill up very rapidly. Placement of pit latrines is often in very close proximity to the home. Digging new pits is repeated until the only space available is the area near the shack.
- Latrines are generally very dirty inside.
- There is a lack of anaerobic activity in the pit.
- Poor construction of the pits and the shelters results in problems with flies and odours.
- Different forms of undesirable non-degradable objects are thrown into the pits.

- Emptying of pit latrines poses significant health risks.
- There is a lack of understanding of what should be put into pits to keep them operating well.
- Most pit latrines have a wooden or plastic seat.



Photo 23: Dirty and unhygienic latrine in BIS (Source: J.W.N. Tempelhoff, 2015)



Photo 24: An unstable pit latrine (Source: M. Mokoena, 2015)



Photo 25: A pit latrine placed behind the house (Source: J.W.N. Tempelhoff, 2015)



Photo 26: Pit latrine under construction in Mr Abiel Senooe's yard (Source: J.W.N. Tempelhoff, 2015)



Photo 27: Pit latrine that has collapsed due to uncompleted construction
(Source: M. Mokoena, 2015)

3.9.2 Distances between pit latrines and dwellings

The researcher measured the distance between a pit latrine and the dwelling by counting her steps (three of her steps are approximately equal to 1 meter). On average the distance that a household member walks to a pit latrine is 5 metres; the closest being 3 metres. Those householders in BIS who do not have access to a pit latrine have to walk approximately 200 metres to the bushes on the periphery of the settlement. Others cross to the other side of the road adjacent to the settlement.



Photo 28: Pit latrine placed behind a dwelling (Photo: M. Mokoena, 2015)



Photo 29: A pit latrine facing south ward of the dwelling (Photo: M. Mokoena, 2015)



Photo 30: Pit latrine constructed on the left side of dwelling (Photo: M. Mokoena, 2015)



Photo 31: Researcher standing in front of a pit latrine in the settlement (Photo: J.W.N. Tempelhoff, 2015)



Photo 32: Mr Les Lange, the researcher and Ms Martha Ntuze (gatekeeper) standing at latrine behind the dwelling (Photo: J.W.N. Tempelhoff, 2015)



Photo 33: Pit latrine standing behind the dwelling (Photo: J.W.N. Tempelhoff, 2015)

3.10 Existing sanitary system in the Barrage informal settlement

In the BIS, there are 14 pit latrines for a population of approximately 300 people. With the lack of adequate water supply in the settlement, residents use on-site sanitation facilities (toilets that do not require water for operation). In addition, there is one off-site sanitation system at the shebeen owned by Mr Lucas Mofolo (MMOA, L. Mofolo, 02.03.2015). He said this system can be used by three to four family members and claims that it helps to control the odour problem and the breeding of vectors. In his interview Mr Mofolo revealed that he uses organic compost activator in the pit to control the smell. And madubula (Jeyes fluid) is poured inside the toilet if there is any smell (MMOA, L. Mofolo, 02.03.2015). Sharing sanitation facilities is not a common feature in BIS (MMOA, D. Mothapo, 11.12.2014). However, in one instance there are seven household members who share one latrine. Some households that volunteered to be included in this study explained that they had a simple pit latrine in their yards. The objective of this chapter is to report on observations made during an inspection of these latrines and their use. Simple pit latrines are seen as an improved sanitation technology because they are private and they hygienically separate human excreta from human contact (United Nations' Habitat Report, 2003:2). According to RSA (2002:13) other benefits of having the use of simple pit latrines include higher percentages of school attendance; higher work productivity; and saving in health costs. This type of latrine can work well if the pit is deep enough and the inside of the structure is dark.



Photo 34: Pavement accessibility strategy to a pit latrine (Photo: M. Mokoena, 2015)

One household in the settlement sprinkles sawdust on the faeces after every toilet use (MMOA, 'N', 11.12.2014). The most common anal cleaning material in this settlement is newspaper. Although some households use toilet paper, this seems to be merely temporary for as long as the limited supplies last (MMOA, L. Mofolo, 02.03.2015). On average, most community members claimed to use the toilet twice a day. These latrines are never cleaned (MMOA, P. Mabote, 11.12.2014). It appears that the nearer the dwelling is to the veld and surrounding bushes, the more likely residents are to defecate directly in the open.

From the map regarding to the current sanitation conditions in BIS. I came to the following conclusion. The current situation in BIS is of such a nature that the dwellings are situated in such a way. That if a hard rain is to pour then all the faeces from overflowing and full pit latrines will flow from the north to the south. I came to this conclusion based on grounds of the sketch. The dwellings situated more on the southern part of the community will sit with the problem of all the faeces. That flow from the northern part of the community to their side. The problem is that the lack to sustainable sanitation can lead to the spread of sanitation related diseases within the community. To do away with the current sanitation system (pit latrines) is to replace it with EcoSan systems. However, the problem can only be solved temporary. To solve the problem permanently will involve proper planning. The current informal settlement must be replaced with residential housing. In case if a sanitation related

disease breaks out it will not only have an effect on BIS only, but on the broad community this will include all surrounding areas around BIS. The disease will spread to other areas around BIS. That is why it is so important to make use of it to solve this problem. There is an Afrikaans saying that says:

“Maak die vuurtjie dood as hy klein is. Want as hy groot is kan hy jou doodmaak.”

This saying holds true for the current condition in which BIS finds itself in at present.

3.10.1 Hygienic practices

In the course of the interviews, the people of BIS were asked for information on their hygienic practices with regard to sanitation in their households, including the way they collect water and store it inside their homes. They were also asked about toilet facilities; defecation position and anal cleaning material used. Observations on toilet use in BIS revealed that both sitting and squatting positions for defecating are practised. The householders who indicated that they were not using pit latrines gave a number of reasons for this, including the following:

- they do not have/cannot afford a pit latrine;
- the latrine has collapsed;
- the latrine is under construction;
- pit latrines in this settlement are poorly structured, making them unstable;
- when the toilet is unstable, it is unsafe for use, especially for children. An unstable toilet does not comply with the dignity aspect of sanitation; and
- households cannot empty contents of the pit; they use the latrines infrequently so they do not fill up so rapidly.

From observations made in the settlement, it seems evident that open defecation is practised by most people. The researcher observed that some households have latrines, but in most cases these are not used. They gave the following reasons for this:

- we cannot use the latrine because it is waterlogged; and
- the iron sheets that we have used are old and have holes, so when it rains water enters very easily (MMAOA, M. Montshi, 10.02.2015).



Photo 35: A full and closed pit latrine of Mr Abiel Senooe (Photo: J.W.N. Tempelhoff, 2015)

3.10.2 Problems with existing sanitary conditions in BIS

There are different factors that contribute to inferior conditions when sanitation is inadequate. These can be categorised into physical, economic, societal and environmental aspects. One objective of the study was to find out what problems residents experience with their current sanitation facilities. The majority said that the greatest problem of pit latrines is the offensive smell they produce (MMOA, A. Senooe, 11.12.2014); (MMOA, M. Ntuze, 11.12.2014) and (MMOA, S. Mamothau, 11.12.2014). The smell is apparently even worse when there is a strong wind. All community members experienced issues of one kind or another related to sanitation. On average, respondents listed between two and six problems.

Those who do have pit latrines claimed that there are other problems encountered with this type of sanitation system, including:

- difficulty of cleaning the latrine;
- placement of the latrine is a problem;
- the latrine is not always available when one needs it;
- personal safety may be compromised; and
- seats are unstable.

The researcher and the gatekeeper began the project by making an unannounced walk through the settlement. While on this transect walk the researcher held informal talks with community members on issues of sanitation; as well as water collection, coverage of containers; and general water usage. The researcher then observed that soil floors in pit latrines had not been cleaned, which prevents the water from draining away in a hygienic, sanitary way. This means that the unclean surface provides favourable breeding grounds for flies. A report by the World Bank (2003:13) explains that most toilets in informal settlements are dirty and this causes health problems such as malnutrition and diarrhoea especially amongst children. Similarly, Lee and Kirkpatrick (2000:198) found that children of school-going age who live in informal settlements often get infection from parasites and flukes that come from latrines. These parasites consume nutrients from the children they infect, aggravating malnutrition and retarding physical development (Tissington, 2011:56). They also destroy bodily tissue and organs in which they live, causing pain and various health problems. In the interviews, some respondents discussed why the latrines were in such an unhygienic condition. One resident said: "How can you clean a hole that is not even lined with bricks? This will only be a waste of money which some of us don't even have (MMOA, P. S. Ramafikeng, 11.12.2014). Others felt that latrines could "collapse at any time".

And they don't see the necessity to do any general upkeep of the latrine since it's only a temporary structure. They are aware that one day it will fill up and they will have to construct a new latrine.

Other complaints were that users have to squat in an uncomfortable position that causes pain in their knees and back (MMOA, 'N', 12.11.2014). Householders who used latrines were asked why they always construct them in a certain way. There were some general responses by users. One member claimed that they don't have the necessary knowledge on how to improve the design and do the correct maintenance of the pit latrines (MMOA, M. Montshi.10.02.2015). One female member said her toilet was adequate but that it had not been properly constructed and does not provide the necessary privacy. She claims that if she is inside, other community members outside can see her and this makes her uncomfortable (MMOA, A. Rakhetsi, 12.02.2015). Another woman participant said she was aware that diseases can be contracted from using dirty latrines and that one can get germs in various ways (MMOA, D. Mothapo, 11.12.2014). Not having adequate running water in the house and soap to wash one's hands once you have obeyed the call of nature was another complaint (MMOA, M. Nhlapo, 14.12.2014).

On the safety issue, (MMOA P. Mabote, 11.12.2014) explained that some pit latrines were made out of scrap material, such as wood collected from the dump and odd-shaped, wrecked iron sheets. People are afraid to use these latrines because they are unsafe and the user runs the risk of falling into the pit. Many community members raised the issue of the road leading to the latrine being muddy and slippery to navigate during the rainy season (MMOA, M. Cherere, 11.12.2014). Safety was raised constantly as a big concern by community members. One elderly man mentioned that he preferred not to use the pit latrine. He recommends other coping alternatives such as using a bucket (MMOA, A. Bofelo, 11.12.2014). Older people in the community agreed that they did not use the latrine on a daily basis. They preferred to use buckets. Relatives would then throw out the waste; it is usually disposed of in the pit ... and if the pit is full the waste is thrown into the nearby veld. Inadequate sanitation facilities have a negative impact on the disabled, children and elderly people because they cannot walk long distances to access a toilet facility or to use the bush (MMOA, R.P. Molawe, 11.02.2015).

For an elderly person who lives alone, the sanitation situation is even worse. Some cannot walk so they have to make do with a bucket. When the bucket is full and they cannot empty it if it is raining or they are sick. They simply have to bear the smell. Elderly people with arthritis and two disabled male members of the community had a different story to tell.

Their main concern was accessibility and placement of the latrines. That people who helped them to construct the latrines made it uncomfortable for the elderly also because some of the latrines were without slabs they found it difficult to sit on it (Human Development Report, 2006:3). And when the latrines are constructed they must not be made too low but a bit higher (MMOA, R.P. Molawe 11.02.2015). According to World Health Organisation (2000:1) gender influences the type of sanitation system that one needs.

Adults and drunkards have a tendency to defecate in the open when they come back at night from the shebeen (informal taverns) (MMOA, A. Rakhetsi, 12.12.2014). This malpractice increases the offensive smell. A number of community members raised concerns about open defecation (MMOA, M. Ntuzze, 11.12.2014). One respondent said: "People in our settlement still practice open defecation in open spaces between houses and in corners." The main culprits are apparently "drunkards, outsiders and kids". Apparently the reasons for this behaviour are that either the pit latrines are full or that the particular homeowner does not want visitors to use the pit latrines on the property because they are filling up. Another reason is that the shebeen where they come from after an evening of drinking does not have a pit latrine. One female community member complained bitterly that early one morning she found faeces at the entrance to her yard (MMOA, M. Nhlapo, 14.12.2014).

3.11 The rubric of the pits and their re-use: knowledge levels of residents

It became obvious from observations and interviews with community members that they were uncertain whether the same pit could be used after a few years. Most had not attempted to do so (MMOA, A. Senoee, 11.12.2014). They indicated that if they were given the necessary education and training on what to do in order to re-use the same full pit latrine they would certainly put this to the test (MMOA, A. Rakhetsi, 12.12.2014). BIS has no strategy in place for emptying full pit latrines or the re-use of pit latrines that have been in use for several years.

3.12 Health conditions, observed hygienic practices and prevailing diseases

The practice of openly disposing of human waste into the ground is considered acceptable. However, while considered hygienically acceptable and satisfactory, traditional pit latrines can be a problem as the population of the settlement increases. There is limited information on the health status of the people of BIS. The response from the randomly selected householders interviewed did not clearly indicate the prevalence of diseases related to poor sanitation and thus cannot be used to evaluate the present health status of the community. In group discussions held with mothers, the predominant sickness affecting children in the community was diarrhoea (MMOA, M. Ntuzze, 11.12.2014);(MMOA, D. Mothapo,

11.12.2014); and (MMOA, P.S. Ramafikeng, 11.12.2014). Currently residents of BIS have only one solution to counteract the prevailing pollution and unsanitary conditions, namely to boil the drinking water before it is consumed.

3.13 Safety factors

The lack of lighting in the informal settlement is a problem for the entire community. Women and children are victims because they are afraid to use the latrine at night. They tend to miss the hole and then defecate on the top of the latrine. Therefore parents do not encourage children to use the latrine at night (MMOA, A. Rakhetsi, 12.12.2014). Doors of latrines cannot be locked. Meaning that there is a lack of privacy, and furthermore creates fear among women that they are vulnerable to sexual assault. Crous (2010) describes an incident where a 62-year-old woman became a victim of sexual abuse. As far as lighting is concerned, general usage of paraffin and coal stoves causes indoor air pollution. According to observations and field observations in BIS and conversations with community members many of them complained about the offensive smell of paraffin that is generally used for lighting and cooking.

3.14 How can the problem of inadequate sanitation in BIS be addressed?

For many residents in the BIS, it is very difficult to improve their circumstances as regards sanitation because of several related issues. Firstly, there is hardly any space for latrines and the yards are very small. Latrines minimise the space available for building dwellings (MMOA, A. Senooe, 11.12.2014). Secondly, community members are of the view that the relevant municipality should assume responsibility for the provision of sanitation facilities (MMOA, P.S. Ramafikeng, 11.12.2014). They point out that the municipality has made no attempt to improve the current systems that are in place or provide the community with mobile toilets (MMOA, S. Mamothau, 11.12.2014), which are safe, reliable, private, protected from the weather and create minimum smell.

The consensus in BIS is that mobile toilets will meet the need for dignity and privacy. These mobile toilets can be kept clean and will minimise the spread of sanitation-related diseases. However, prospects of improvement are bleak. The councillor does not reside in the area; he is clearly not interested in improving the sanitation situation in BIS. Local residents who are employed are not willing to spend any of their hard-earned money (MMOA, A. Bofelo, 11.12.2014). Others say they do not know how long they will be staying in the informal settlement and some see it as a temporary place to live (MMOA, A. Rakhetsi, 12.12.2014). According to UNICEF (2000:17) the situation is similar to conditions in many other informal settlements. Furthermore, the high population density and the ensuing congestion of houses

mean that there is very little space for latrines. Building latrines in soil conditions such as those in BIS can sometimes be very challenging due to the instability of the soil and the difficulty of digging into rocky ground. According to Grimason *et al.*, (2000:175-182) community members see pit latrines with a slab as improved sanitation in its most fundamental form. However, once the latrine is full it no longer fulfils its function (Mtungila & Chipofya, 2009: 338-343). Moe and Rheingans (2006:41-57) and (Gross and Morel, 2005:51-57) state there is a risk of the full latrine overflowing and causing ground pollution because large quantities of excreta is washed out onto the ground. This is a serious problem because it affects the quality of drinking water.

From the findings of this study, a possible reason for this dangerous inconsistency could be that a large number of pit latrines in BIS might be simple pit latrines without a cover and are thus technologically low-grade at reducing smell when compared to VIPs. For example, some parts of Botswana have a high water table, and therefore the country experiences high groundwater pollution. This is coupled with the wide usage of pit latrines in the area. (Bolaone & Ikgopoleng, 2011:486-493).

Latrines in the BIS are generally not lined with bricks and are also vulnerable to collapse (MMOA, M. Nhlapo, 14.12.2014). According to Adubofour *et al.*, (2013:189-207), in informal settlements in Kumasi and Ghana, a coping strategy used for children was to have them defecate into plastic containers, which were later emptied into the latrine. Latrines in BIS do not have lights inside and cannot be locked for privacy when in use, which is another serious drawback (MMOA, R.P. Molawe, 11.02.2015). Prüss and Mariotti (2000:267-273) state that flies and insects are responsible for the propagation of faecal-oral diseases such as gastrointestinal illness (diarrhoea) particularly found in children and toddlers (Graczyk *et al.*, 2005:128-132).

Children are the usual victims because they are the ones who always play in dirty water. Controlling smells, flies and mosquitoes is therefore, a high priority for reducing household and environmental health hazards. Another problem pointed out by some residents of BIS is that children use the same latrines as adults, which they see as a negative issue (MMOA, M. Moya, 11.02.2015). One resident asked why parents of children who are old enough to use latrines allow their youngsters to defecate in the open. Apparently they do this openly and sometimes in the middle of the street just where they will be playing the next day (MMOA, S. Sebonang, 11. 12.2014). Mothers in BIS felt that if they were able to teach their children about hygiene at a very early age then the problem of sometimes defecating in the immediate precincts will stop. Because conditions are currently so inadequate for inculcating

correct sanitary hygiene, this is impossible. Most of the community members in BIS said that the lack of pit latrines in BIS was because most people cannot afford them (MMOA, M. Ntuze, 11.12.2014).

The inability to earn enough money or to save funds to invest in long-term sanitation facilities restricts the choices that individuals make. According to RSA (2000:13) the year 2015 will be a significant one for the government as far as sanitation is concerned because sanitation is an important facet of reaching Africa's MDGs. Financial resources have apparently been set aside to help meet the needs of the poor in this regard. The problem of illegal occupiers of land also affects many of the decisions that must be made before investing in sanitation. This is a challenge for municipalities and donor agencies that want to help the poor.

3.15 The economic, social and psychological impacts of inadequate sanitation

This section deals with some of the effects of the absence of proper sanitation in informal settlements. Working from the literature on the theme, the researcher highlights some issues, based on the information collected in interviews and observations in the settlement.

3.15.1 The economic impact

There may be a negative economic impact because of days missed at work or children who are unable to attend school as a result of ill health (Van Minh & Nguyen-Viet, 2011:66). Poor sanitation, water quality and hygiene practices may exact an as yet unquantified cost. According to community members, when they are sick or a child is ill (MMOA, D. Mothapo 11.12.2014) they have to spend time (which translates into a loss of earning) seeking medical attention either for themselves or the children. Many hours and even days are spent waiting in queues at the clinic and taking care of a sick child or family member. Working parents have to take time off from work and this sometimes results in no payment from employers (UNICEF, 2001:12).

3.15.2 The social impact

The social impact of inadequate sanitation is considerable. According to The White Paper on Basic Household Sanitation (RSA, 2001:9) poor sanitation result in loss of privacy and dignity. Poor or inadequate sanitation causes social disruption which can seriously undermine the quality of life of individuals and their affected community. The social aspects of vulnerability to poor sanitation can be used as tools to develop strategies to minimise risk and maximise the ability of communities to anticipate and adapt to current sanitation and hygiene practices.

3.15.3 The psychological impact

One of the effects of existence in an informal settlement is that life is tenuous. Residents may lose the few belongings they own, and may even lose their lives. According to Dithagiso (2015:16) in BIS in 2014 there were two incidents in BIS where people lost all their belongings. On 15 March 2015, due to a paraffin stove, one of the shacks caught fire and claimed the life of a male resident. The short-term effect was emotional deprivation and of course grief. There may also be longer-term responses that are interpersonal, societal and economic in nature.



Photo 36: Destruction of shack caused by a paraffin stove (Photo: M. Mokoena, 2015)

3.16 Women and sanitation usage

On occasion, girls and women who walk in the area after dark become targets of sexual abuse. If there is no access to sanitation in or near the household, some of these women need to go outside to practice open defecation. The danger that they might be attacked causes tension and psychological problems. There are days when the women of the household are acutely aware of the water shortage, particularly if they are menstruating. This may well be a problem where a household has many members who share one bedroom. If there are no bathrooms and latrines, they feel uncomfortable when they cannot bath for several days and if there is sufficient water, they have to do their ablutions in a limited space.

Women and children suffer most because of the scarcity of water and often children do not bath because of this. UNICEF (2001: 15) indicates that women without toilets are forced to defecate in the open, risking their dignity and personal safety. The old and the sick cannot

manage to walk long distances to relieve themselves. Education suffers too because more than half of all girls who drop out of primary school, do so for lack of separate toilets and easy access to safe water. In many cultures the only time when women and girls can defecate, if they have no latrine, is after dark. Apart from discomfort caused by the long wait until evening, this can cause serious illness. Weeks (2005:42) argue that this can put tension on a person's heart and an over-full bladder may even aggravate heart disease.

3.17 Men and sanitation usage

According to a male respondent, sanitation for men has different implications because they can easily urinate behind their houses and in the open spaces in the settlement (MMOA, J. Rakhetsi, 12.02.2015). Others said that they have latrines in their yards and that they use these despite the smell; they have learnt to live with the unpleasant smell (MMOA, M. Montshi, 10.02.2015; MMOA, A. Bofelo, 11.12.2014). According to some, when they have to obey the call of nature they would walk into the bushes if there is no latrine in their yards. The area generally used is located where the old Barrage Road House was situated previously (MMOA, J. Mabote, 11.12.2014). Another male participant said that he used his neighbour's latrine because his latrine is full (MMOA, A. Senooe, 11.12.2014). Other male participants, especially the younger ones, said sanitation practices for them are not easy because they are at risk of being accosted by thieves or rapists. However, trust in the police and the existence of a police station in the BIS is sometimes of help.

With the assistance of the Barrage Police Station, the community has formed a patrol unit in which community members volunteer to take turns in patrolling the area during the night (MMOA, S. Mamothau, 11.12.2014). If the night patrol sees someone they do not recognize prowling in the area they will take action. Both men and women have volunteered to render this service to the community. Patrols work hand in hand with the Barrage Police Station. They are given a reflector and a torch and when they are on duty they report at the station before being sent to their different points. This makes them visible so that community members can easily see them. However, patrols from BIS do not work in their surrounding areas (MMOA, P.S. Ramafikeng, 11.12.2014). People of the community say there are still those who pimp them. Patrols usually work two hours before they are changed. This system helps because sexual assault and crime in the BIS is not as common any longer.

3.18 Children and sanitation usage

From observations in BIS it is clear that insanitary latrines in the community are a problem for children. School-going children who reside in BIS acquire poor hygiene habits which are difficult to break (MMOA, M. Lerata, 11.02.2015). It was suggested that the way they

practice sanitation at home is often applied when they are at school. If pit latrines at home were improved or more adequate, this problem could be minimised. Then safe pit latrines could become something of which they are proud and would be kept clean at all times. Children mentioned a number of fears they have of using latrines. Some said they are afraid of the dark, or fear that they may fall into the pit; others said they cannot abide the smell (MMOA, C. Ntuzi, 19.03.2015). They do not want to be left alone in the dark so they prefer to defecate in the open (MMOA, B. Maduna, 19.03.2015). Children who do have pit latrines in their yards said that they use the same latrine as their parents (MMOA, T. Rakhetsi, 19.03.2015). But those who do not have latrines defecate in the open (MMOA, M. Rakhetsi, 19.03.2015). A girl who participated in the study revealed that during the night she use a bucket but in the daytime her mother lets her use her grandmother's latrine which is two houses away from their house (MMOA, T. Mabote, 19.03.2015). According to Blackett (2001:29) the most common sanitation related disease found among children is diarrhoea. However, residents of BIS did not mention that children tended to get stomach ailments such as diarrhoea. An interview conducted with Miss Lerata, an educator at Barrage Primary School, with regard to sanitation was as follows:

Basic hygiene and sanitation is part of the school learning programme. This is taught from grade one up to grade seven. However the grade one to three learners have small water buckets outside the class that goes with a hand towel... So when they come in from lunch time they wash their hands before entering the class room (MMOA, M. Lerata, 11.02.2015).

Latrines generally have big holes so small children cannot use them safely. When the latrines are constructed they do not take the needs of children into consideration. This is partly due to poverty – funds are inadequate to construct a child-friendly pit latrine. Households that have babies and toddlers were asked how they dispose of baby nappies and how they dispose of infants' and toddlers' faeces. Some respondents indicated that the parents go into the nearby bush and bury the faeces. Some parents said they allow the dogs of the neighbourhood to eat the faeces, while others said they throw them into a nearby field outside the settlement. There was also a suggestion that there is a tendency to throw out used baby nappies in other people's yards. The parents of older children take them to defecate in the open or allow them to run off on their own. One householder said they used a waste pit on the premises of their yard to dispose of the faecal matter (MMOA, D. Mothapo, 11.12.2014). However, this is a short term solution because once the pit is full; it has to be covered and cannot be used again. When it is bath time and a parent has two to three children, the mothers begin the bathing routine with the oldest child first. The others then take turns to bath in the same water.

Bath water is thrown out into the street and in their yards (MMOA, D. Mothapo, 11.12.2014). This method of domestic use of water can lead to unsafe hygiene practices because if one of the children is injured or is sick with, for example chicken pox or measles, it can be easily transmitted from the sick child to the others. The reasons for this practice is to save water because parents do not want to go to the trouble of having to collect more than three twenty (20) litre containers of water a day.

By way of a summary, the lack of sanitation facilities and poor hygiene affects both girls and boys, although poor sanitation conditions at school have a greater negative impact on girls. All girls should ideally have access to safe, separate and private sanitation facilities in their schools (UNICEF, 2001: 11). When girls start menstruating the need for these facilities is even greater (MMOA, T. Mabote, 19.03.2015). Sanitation facilities should be adapted to the different physical and sometimes cultural needs of girls and boys.

3.19 BIS residents' perceptions of ecological sanitation (EcoSan) system

The objective of developing a strategy for an ecological sanitation system (EcoSan) in BIS is important. For this reason, it is imperative to give the residents an understanding of the advantages of the EcoSan technologies proposed to them. For the purpose of this study, four types of EcoSan systems were selected and the pros and cons of each were explained to them. They were then given the opportunity to choose which one they thought would suit their needs best. The researcher, with the help of the gatekeeper, used illustrations to show residents what each system looks like and she explained how the systems work. Based on this explanation, residents were given a questionnaire based on which they had to choose the particular system they would prefer. This process was followed in group discussions of at least 4 to 5 people. Members of the group had to choose a system which they thought would be most suited to their needs. They were also asked to describe their understanding of EcoSan; its processes; the dynamics of their assumptions; and to give their judgments and suppositions. They were also asked if given the opportunity, they would use EcoSan systems in their homes.

The aim was to conduct trials on ecological sanitation if the residents were keen that these be implemented. The reasons for choosing EcoSan was that such systems make use of a technology that is simple, affordable and environmentally friendly. These new systems would then replace the unimproved pit latrines in BIS. However, in conducting this case study, only four types of EcoSan systems were suggested. They were: the Water Bank system; Community ablution blocks (CABs); the urine-diversion dry toilets (UDD); and the on-site system as used by Mr Mofolo. The next chapter will focus on these four ecological sanitation

(EcoSan) types. User interface was the key consideration for the success of introducing EcoSan systems in the BIS.

It can be concluded that for BIS, EcoSan is appropriate for the following reasons. Firstly, BIS is not a rocky area, therefore there is no need for extensive and difficult digging. The piece of land is reasonably high and the settlement is located on agricultural land. The soil has high productivity and does not require extra fertiliser. If it were otherwise, the community would need a system which aims to recycle and re-use nutrients. Furthermore, the environment is not a protected area because defecation in the surrounding bush has increased so much over the years. Not many cases of sanitation-related diseases caused by poor maintenance of unlined pit latrines have been reported. The situation in BIS is similar to other informal settlement areas near Cape Town, where there is very little space to dig and no facility for emptying the pit latrines. Introducing an EcoSan system may well be the way out because these are cheaper than the conventional system; even the underprivileged people should be able to afford them.

3.20 Coping strategies

Community members in the BIS have employed a range of coping strategies. Pit latrines are a big problem especially during the rainy season when the contents of full pit latrines are washed out into the streets. The most important coping strategy is to make furrows and canals so that the contents of the pits are washed along in the stream of water. So that this faecal matter does not lie in the streets where people walk on a daily basis, residents have employed various means of improving the conditions with a minimum of expense. Other strategies used include the following:

- do nothing about full pit latrines ...simply learn how to live with them;
- do not let the pit latrine fill up to the top so that although almost full it can be covered with sufficient soil to prevent overflow;
- pour sawdust over the contents after using the toilet to minimise the odour problem (MMOA, 'N', 11.12.2014);
- refuse to share pit latrines to anyone outside the household so as to prevent the pits from filling up so fast;
- make paving out of pieces of broken bricks which makes the latrines easier to access and less problematic to use in the rainy season (MMOA, 'A.', 19.02.2015); and
- pour burnt waste on the other side of the settlement.

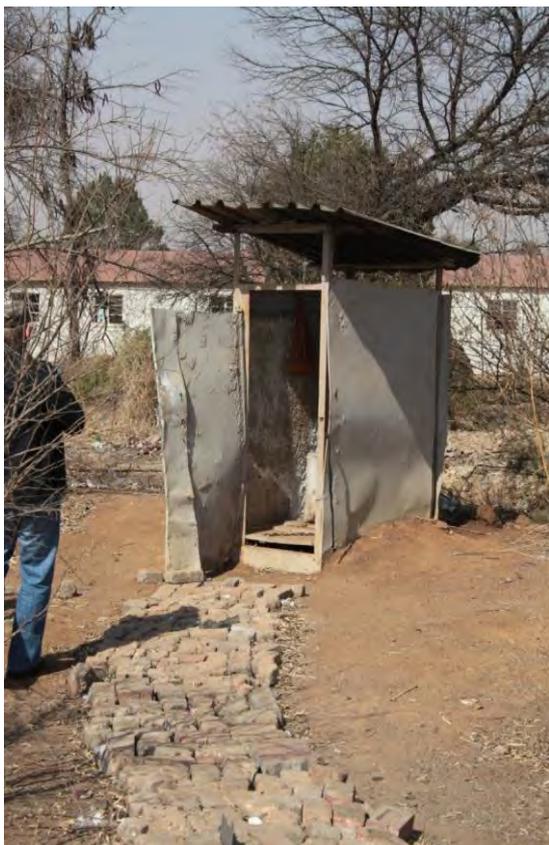


Photo 37: Paving accessibility at the pit latrine of the informal shop (Photo: J.W.N. Tempelhoff, 2015)



Photo 38: The plastic bag inside the latrine of the informal shop containing sawdust. That is sprinkled over the faeces after each toilet use (Photo: J.W.N. Tempelhoff, 2015)

3.21 Conclusion

It is clear from observations in BIS that inadequate sanitation has an adverse effect on the social, psychological and economic wellbeing of the people of BIS. The short and long term responses of the community of BIS will be useful in determining the final choice of how to address the residents' sanitation problems. Most people living in the BIS are uneducated and desperately poor. To a large extent, this study has established that livelihood patterns play an important role in settlement patterns. It is evident that there are varying underlying causes of people's vulnerability; these pose a distinct challenge to improving the living conditions of the poor.

Most people in BIS have little or no access to public services such as the central sewerage system. Inadequate sanitation exposes people to unhygienic practices, which in turn lead to health problems. Good sanitation facilities and practices across the board have vital benefits for individuals, communities and the whole nation. It is the collective responsibility at all levels of governance to ensure that safe sanitation facilities are provided in all households. This study is exploratory in nature because the researcher aims at examining the level of understanding of the residents of BIS with regard to their health and hygiene practices. Unsafe and unhealthy toilet facilities were foremost among the grievances of most residents interviewed. Chapter 4 will provide a detailed discussion of the research results.

CHAPTER 4

Research results

4.1 Introduction

This chapter features an analysis of the various ecological sanitation (EcoSan) systems that could possibly be introduced in the Barrage informal settlement (BIS) and discusses a range of problems that the community may encounter in this regard. It is also emphasised that environmental issues play an important role. The data used in this chapter was generated by means of group discussions and interviews conducted by the researcher and questionnaires drawn up and circulated by her in collaboration with the BIS gatekeeper. In other words, the researcher engaged actively with community members in the research process. Selection of respondents was made primarily on the basis of those community members who earn a reasonable income and have access to water. Importantly, economic data generated by researchers at North-West University's Vaal Triangle Campus have also been incorporated into this chapter to shed light on some critically significant, material issues. All data collected was systematically categorised and coded and in this chapter the research findings are discussed.

The BIS is a small settlement that is still in the process of development. Thus far, attempts by the responsible local authority, the Emfuleni Local Municipality, to relocate the community to another site, have proved unsuccessful. There has also been talk of the provision of services such as access to water supply inside the dwellings; the provision of sustainable sanitation systems; and the possibility of initiating a garbage collection service, but as yet these services have not materialised.

The main question is: can EcoSan systems be utilised as a means of sustainable sanitation delivery? The responses from BIS indicate otherwise. Sustainability of sanitation delivery can be measured in various ways. One of these ways is the respondents' satisfaction with their access to sanitation. According to the data gathered in the interviews, respondents are *dissatisfied* with the delivery of sanitation in the area. Not only is there a lack of integration and coordination but the evidence shows that there is a particularly high level of grievance about the distance that householders have to walk to standpipes to collect water and the distance to the open bush they use as their means of sanitation. They complain that the stand pipes are too far away and thus unsafe to use at night. In BIS it appears that the entire community – certainly all those who were consulted on the issue do not think the municipality is doing enough to assist the residents. Most are still living in shacks and they claim that there has been no improvement at all on sanitation.

A minority of respondents have one or two members of the family who are employed. For these householders it has been relatively easy to construct their own pit latrines. It was notable that respondents' answers were by and large not based on the adequacy of the sanitation system per se, but the proximity of these systems to the home. It appears that the placement of these systems determines the level of satisfaction. Above all, none of the community members in BIS have access to an improved toilet facility. Residents were of the opinion that the municipality was not showing any progress towards the provision of sanitation facilities in BIS.

4.2 The proposed ecological sanitation (EcoSan) systems

This section identifies the aspects (as raised by the respondents) that must be taken into consideration if the proposed EcoSan systems are to be introduced in the BIS. These considerations are based on the initial assessment of each type of EcoSan system. The assessment identifies potential sanitation options for BIS and discusses the probable advantage and limitations of each system. In BIS the type of sanitation people want varies from one household to the next and depends on the location and whether the toilet facility is an on-site or off-site system (Kalbermattern, De Anne & Gunnerson, 1980:3). It appears that in BIS community members favour wet sanitation systems, or those that at least require a consistent water supply for proper operation. There are other factors that also influence the decision in favour of a particular EcoSan system (Still & Foxton, 2012:25). For example, the material used for anal cleaning may be significant. Because toilet paper is not always affordable some BIS residents use waste paper and plastic, which has implications for some EcoSan systems.

According to DWAF (2002:9) the provision of sanitation options should ideally be:

- affordable for the household that will be using it;
- sustainable;
- beneficial to users' health;
- in line with the guidelines to fulfill environmental protection regulations; and
- build the capacity of community-based contractors to implement the project.

4.3 Proposed ecological sanitation (EcoSan) system options

For the purposes of this study, four types of sanitation system were under consideration.

These are:

- Mr Mofolo's system;
- community ablution blocks (CABs);

- a urine diversion dry (UDD) toilet; and
- the Water Bank system.

The following discussion identifies the limitations and potential of these four sanitation systems. It is important to note that the analyses of these systems are strictly contextualised in terms of the BIS environment.

4.3.1 Mr Mofolo's system

Mr Mofolo, a resident of BIS and an informal tavern owner, has developed a workable toilet system. In view of the fact that he is clearly an innovative person, it was decided to ask for the views of local residents on what he has to offer as far as sanitation is concerned. He has a low-volume flushed toilet which discharges into a small drain (MMOA, L. Mofolo, 02.03.2015). Mr Mofolo's sanitation system is an on-site system that requires water to operate. The objective of the small drain is to overcome the problem of frequently having to empty the traditional bucket latrine (MMOA, L. Mofolo, 02.03.2015). The system operates in such a way that an empty 20 litre plastic bucket is filled with water. The bucket is then connected to a toilet cistern into which the water is poured after every use of the toilet. The reason for doing this is that such cisterns often leak (and thus waste water) and this system aims to minimise the leakage problem. Because of the capacity of the drain only grey water is allowed. Although many residents opted for this system as being practical and workable for their needs, they had a number of reasons why they would not buy into this system.

Firstly, the researcher asked the selected residents if they would be willing to pay R200 for the construction of the system. Some said 'yes' while others responded with a 'no', because 'we do not earn enough money' (MMOA, M. Montsi, 20.07.2015). However, all agreed that if toilet systems similar to Mr Mofolo's could be constructed with the help of donor agencies the community would be most appreciative. Having the use of a basic toilet is an almost insurmountable problem for the entire community of BIS.

Respondent M. Ntuzze had a useful suggestion, saying: 'We would like it if Mr Mofolo could show the youth how to construct these systems ... this would lead to employment opportunities because they [the youth] will be able to construct this system for other people who can afford it in the community and other informal settlements that lack sanitation' (MMOA, M. Ntuzze, 10.07.2015). The application of this system in BIS is environmentally feasible because the system can be built above ground. Other factors favouring this system are: its feasibility in BIS with a relatively small total population; community members would

not be required to deal personally with waste; and the system requires a minimal water supply.

However, the application of the system does have its drawbacks. Major issues raised by residents of BIS were the need for a waste collection service; and that a regular collection service would require the backing of a reliable organisational system. Normally, large collection vehicles would be required to empty the drains (Still & Foxtton, 2012:52). But in the case of BIS, where cumbersome vehicles cannot gain access to all the dwellings, such collection would be impossible. Other alternatives such as improvisation of the collection vehicle might, however, be considered. In areas where access is difficult, smaller collection vehicles, such as hand drawn carts with manually operated diaphragm pumps, or small mechanically or electrically operated vehicles fitted with mechanically operated pumps, could perhaps be used (Oxfam, 2008). Another alternative is a pipe connection to an accessible communal vault, but to transport human waste, networks of sewer pipes consume enormous volumes of water, which is not always available.

The conclusion reached is that the application of Mr Mofolo's system is feasible as long as there is reasonable access for waste collection (MMOA, M. Ntuze, 10.07.2015). Conversely, this type of system needs to be emptied regularly and its effectiveness depends on a reliable emptying service. Furthermore, the drains must be accessible for the emptying vehicle. An added limitation is the frequent costs of emptying which would have to be paid by the users. The effective application of this sanitation system clearly relies on an appropriate level of organisation and management and for this reason; such sanitation technology does not appear to be feasible in the BIS at present.

4.3.2 Community ablution blocks (CABs)

CABs are public ablution facilities that are shared by people in a gender format. CABs can also be designed for use by both male and female users, but in this case the layout of the facilities inside the unit varies (Roma *et al.*, 2010:590). From a personal point of view, CABs can be considered suitable as a low-cost alternative for providing sanitation in informal settlements. Community ablution blocks are geared to serve many people and are more economical on a per capita basis than individual household facilities. According to Crous, Haarhoff & Buckley (2012:362) these blocks can serve a population of 50 to 75 households, or those households within a distance of 200m from the CAB. Each unit comprises a number of latrine cubicles and in some cases they are also fitted with showers, laundry troughs and clothesline facilities (Roma *et al.*, 2010:590; Crous, Haarhoff & Buckley, 2012:362).

The downside is that misuse and poor maintenance can occur since the facility is not owned by a single household (Roma *et al.*, 2010:591).

According to Roma *et al.*, (2010:593) a study carried out in the eThekweni municipal area (which includes Durban), respondents indicated the importance of privacy and the safety of community members who make use of CABs. Research by Lane (2004:2) shows that better sanitation provides greater privacy, convenience, safety, and preserves the dignity of users. These factors are particularly important for women. Kalbermattern *et al.*, (1980:44-45) explain that the World Bank studies on sanitation have identified basic approaches to the design of communal ablution blocks (CABs). Special considerations include:

- determining the location of the facility;
- monitoring the right of entry;
- ensuring close proximity to households, especially in the case of ablution facilities;
- proper use and maintenance of the facility, especially if the ablution system is set aside for the exclusive use of a group of households; and
- the separation of facilities between male and female users.

In the case of the BIS, some community members indicated that CABs were unacceptable (MMOA, A. Rakhetsi, 10.07.2015; MMOA, M. Moya, 10.07.2015). Many residents of BIS did not favour this system, arguing that the placement of the facility would be a problem for some householders and the lack of electricity in the settlement would make accessibility not only difficult but possibly also dangerous. However, others said it could work because the CAB system is not subject to major breakdowns (MMOA, D. Mothapo, 10.07.2015). Certain residents felt that the CABs would create the need to install solar lighting in the settlement (MMOA, A. Rakhetsi, 10.07.2015).

To make CABs accessible during the night, Gounden and Kee, (2012) explain that the placement and location of CABs are important factors that should be dealt with in the planning and design phase.

Furthermore, attention must be given to issues such as obtaining permission from land owners; the willingness of the community to relocate; the size of the informal settlement; and the distance of the settlement from a water supply. According to Crous, Haarhoff & Buckley (2012:362) the units must also make provision for ventilation to keep them cool, and should rely on natural light because in informal settlements there is no supply of electricity.

BIS residents indicated that they were uncertain how the CAB system could be successfully applied. Who was going to act as caretakers? Who would volunteer to do the general maintenance of the blocks (MMOA, M. Moya, 10.07.2015; MMOA, M. Ntuzze, 10.07.2015). Taking on the task of caretaker would surely imply being employed and receiving a wage. They also wanted to know who was going to pay for the proposed sanitation service.

Roma *et al.*, (2010:590) suggest that the caretaker should indeed receive remuneration in the form of a voluntary pay-per-use scheme, and that some of the money received should also be used for maintenance. Pay per use is a good system because it means that there will be regular caretaker attendance, cleanliness and therefore satisfied users. Potential users interviewed were of the opinion that some residents do not practise (or simply do not want to practise) good basic hygiene habits, even in their own homes. Some residents were sceptical about the general cleanliness and health status of residents and said that this was why they refused to share their toilets with others. This issue took on troubling and even dangerous proportions because of the high level of disease which prevailed in the settlement (MMOA, M. Montshi, 20.07.2015; MMOA, 'A'. 20.07.2015).

This perception is also highlighted by Tissington (2011:13) who states that poor sanitation promotes the spread of preventable diseases like diarrhoea and cholera. BIS residents were of the opinion that some local residents were uncooperative and were unconcerned about spreading dirt and disseminating disease in the community. According to residents, these conditions could lead to the spread of infectious and transmittable diseases (MMOA, M. Montsi, 20.07.2015). Community members also raised concerns about who would be supplying all the cleaning materials for the upkeep of the system (MMOA, P. Mabote, 10.07.2015). The municipality under which the informal settlement resorts has to date not been reliable. According to Roma *et al.*, (2010:593) having trust in the municipal authority is important. The local officials literally need to win the trust of BIS residents who have no experience of local government. There was also the view that sharing facilities would lead to rapid decline of the CAB facility system; it would not be well looked after (MMOA, D. Mothapo, 10.07.2015). An examination of the prerequisites for constructing CABs in the BIS indicates that the householders' right of entry and propinquity of CABs to the all the residents are among the most important factors in the acceptance/rejection of this sanitation system.

Other problems raised by community members include:

- people in our community do not like the option of sharing sanitation facilities so CABs will not be widely used;
- each household will not have its own individual toilet;
- the intention of the CABs is to provide two blocks – one for male and one for female residents, which may result in low usage because some dwellings are too far from the particular facility they require;
- the sharing of sanitation facilities, where the units can be locked at night won't work because the people responsible for opening and closing the facilities may sometimes be absent;
- since there is nobody who is prepared to volunteer as caretaker of the units, they may well fall into disrepair; and
- shared facilities cannot work because there is no show of commitment from either the community or the local authority. Without the means to ensure sustainable solutions, how is the proposed system going to function?

By way of a summary of the research findings and a consideration of the available literature, gaining easy access to a sanitation facility is a major problem associated with CAB technology. As already mentioned, there is a decided reluctance on the part of household members to share sanitation facilities with other community members. Toilet activities are considered very private and sharing such facilities with strangers is not favoured at all. Boot (2008:8), and Crous, Haarhoff & Buckley (2012:361) agree that problems associated with the use of CABs include insufficient access to all users; poor maintenance over time; and resultant non-usage of the facility. When CABs become an acceptable option, the location of the facility is essential. BIS lacks access to electricity which means that the capacity of the facility and the distance the user has to walk from his/her home to the toilet, are among the important factors to be considered. The closer the location of the facility to some residents' homes means that they are more likely to use it. Furthermore, the success of this type of sanitation system depends on whether there is an accountable party that will assume responsibility for the operation and maintenance (O&M) of the CAB. Brikke (2000:45) provides a possible solution for O & M by positing that this issue can be overcome if there is a strong sense of community responsibility and ownership towards the maintenance and operation of the system. Boot (2008:8) states that CABs can work if the user group is defined and is involved in the planning and management of the facility, and if the residents employ the caretaker.

The CAB system is not without positive features. According to Crous, Haarhoff & Buckley, (2012:361) citing the Department of Human Settlement (DHS, 2009), the national government assures South African residents that they can regard CABs as an interim upgrading strategy rather than the final level of sanitation they will eventually receive. An advantage of this sanitation system is that it can be easily transported and redeployed (Grant, 2013:36). For BIS this is important if the settlement is to be relocated to a new housing area in the future. Crous, Haarhoff & Buckley (2012:362) citing Roma & Buckley (2011) maintain that because CAB units can be locked at night this prevents possible crime and vandalism. Crous *et al.* (2012: 361) also point out that CABs have been recognised in the Millennium Development Goals (MDGs) as a form of improved sanitation. However, it is undeniable that CABs are known for poor maintenance; low usage; and that generally speaking, no one wants to take responsibility for their upkeep. At the time of the focus group discussions (focus group consisting out of five people), residents were asked to vote on whether or not they would share such facilities. The results were definitive: in the one group only 3 of the 5 members accepted the idea of sharing facilities, while in the other group only 4 of the 5 rejected the suggestion.

4.3.3 Urine diversion dry (UDD) toilet system

A UDD sanitation system requires handling of waste and re-use of excreta (Peasay, 2000:12). The waste matter that must be transported is decomposed excreta. The UDD sanitation system involves the handling/transporting of decomposed excreta making the system more prone to unsanitary waste handling. However, the handling of waste is only necessary when the excreta has been transformed into non-offensive, less harmful humus (Austin & Van Vuuren, 2001:31). Culturally, the most important distinction with this system is if the community sees excreta as a resource or a distasteful and hazardous waste product (Winblad, 1980:23).

According to Makaya *et al.*, (2014:468) a UDD toilet system consists of two receptacles, each below its respective hole. One is used for defecation and the other for urine. In the UDD system ash can be added to the fresh excreta to accomplish a suitable carbon-nitrogen ratio which will eradicate odour and prevent the presence of flies.

The system also involves the separation of urine and faeces without the use of water (Peasay, 2000:5). Urine is collected in a separate container to which ash or soil can be added. After a few days this still standing urine can be used as a garden fertiliser. The UDD toilets must be of the correct design and are convenient to use. Users must be vigilant and take time to understand how the sanitation system works before they give the system their approval. The main advantage of the UDD system is the non-disposal of waste into the

ground below and the possibility of constructing the vault above ground. However the success of this system relies on careful use and maintenance of the toilet. It is of vital importance that community members must be involved in the operation and maintenance of the system (MMOA, M. Nhlapo, 20.07.2015).

The BIS community welcomed the idea of this EcoSan sanitation system as a possible solution to latrine construction on their premises because of its permanence, simplicity, durability, affordability and its environmentally friendly nature. They were also aware of its safety in terms of hygiene as compared to the traditional pit latrine. Re-use of nutrients for agricultural purpose was also seen as a positive element. However, community members still recognised that there would be challenges in educating residents of BIS on how to use dry latrines, where the faecal refuse must be separated from urine (MMOA, M. Nhlapo, 20.07.2015). They felt that explaining the correct use of the UDD system to first-time users and children might pose particular challenges (MMOA, D. Mothapo, 10.07.2015; and MMOA, P.S. Ramafikeng, 10.07.2015). People are accustomed to the conventional system which is familiar to everyone. When the faeces are mixed with urine, the result is a bad smell, as is the case with a pit latrine. Generally, there was a negative perception towards the re-use of faeces for agricultural purposes (MMOA, D. Mothapo, 10.07.2015).

The research project also evidenced a decided reluctance to handling, treating and/or cleaning of excreta in any manner whatsoever. The respondents had no knowledge of the UDD toilet and did not even know the name of this type of sanitation system. They simply did not like the idea of cleaning the chambers to remove faeces and urine; they said it was 'disgusting'. Surprisingly, the older generation displayed greater acceptance of this type of EcoSan system than originally anticipated, considering that they had a longstanding cultural orientation in matters of sanitation. The discussion in the non-beneficiary focus group yielded similar acceptance trends when participants were asked to vote on their preferences with a show of hands. Three accepted the idea of using treated faeces as fertiliser for growing vegetables, while five showed no support at all for the re-use of treated faecal matter. It appears that in the context of BIS, the idea of handling waste is unacceptable to the residents; they prefer the idea of disposing of excreta right away. When community members were asked about the potential of waste re-use they were evidently uninformed about the possibilities of doing so. This inevitably negates options requiring waste handling.

4.3.4 Water bank (also known as 'comfyloo')

According to Lange (2014) the Water Bank system has emerged from adapting the design standards of conventional sewerage to suit the physical conditions of urban low-income

settlements that have adverse features such as poor ground conditions; high settlement density; and high levels of water consumption. The Water Bank toilet has a water inlet and an outlet into which excreta fall and are then flushed away (Lange, 2014). The system is designed to accept all excreta in its fresh state; this is then flushed away for off-site treatment and disposal. The system consists of small diameter pipes, (normally 100 millimeters) that are laid on flat gradients in shallow trenches (Lange, 2014). These pipes can be laid in the street, backyards and narrow back alleys. They are then connected to a conventional sewer or septic tank (Lange, 2014). The system may also be adapted to have an in-house water connection, but the choice depends on the site.

BIS residents are of the opinion that the Water Bank system is more advantageous for their purposes than any of the other options discussed thus far. Community members favour this system because they see it as providing the required dignity and privacy, which they insist is of primary concern to them (MMOA, 'A' 20.07.2015). Of the sanitation systems included in this study the Water Bank system proved the most feasible to install, mainly because the small diameter pipes can even be laid on sites where there are adverse ground conditions. Each household can then have the use of a pour-flush toilet connected to the small diameter sewer lines.

According to Lange (2014), transportation of the sewage to the waste treatment plant is feasible because the small diameter sewer lines can possibly be connected to the nearby Rand Water main sewer. Failing this, it can be deposited into communal septic tanks built on sites where there are favourable ground conditions. Some BIS residents argued that the construction of central sewerage systems could help to address some of the challenges and thus achieve a sustainable sanitation system. Some residents made the point that introducing the Water Bank system would mean that water taps were in close proximity to their houses – and that they would no longer have to go to standpipes to collect water for domestic use (Lange, 2014). The system therefore appealed to people who arrive home from work late in the day.

Furthermore the Water Bank system comes with a 200-litre tank that will teach community members how to conserve water properly and to use it sparingly (Lange, 2014). Another advantage of the system is that it is an on-site sanitation system, which is readily available whenever needed (MMOA, D. Mothapo, 10.07.2015). It is an on-site and used by an individual household, the toilet will be well looked after. It will not be shared with other members of the community. Individual members of the same household will be able to obey the call of nature whenever the need arises. Some residents made the point that parents

who previously lacked a sanitation system would now be able to teach their children about proper hygiene practices for use in the home and at school (MMAOA, M. Ntuzze, 10.07.2015). Installation of the Water Bank system will also include a wash basin where residents will be able to do their laundry (MMAOA, P.S. Ramafikeng, 10.07.2015; and MMAOA, A. Senooe, 20.07.2015).

According to Lange (2014) for the community of BIS the Water Bank has the following advantages:

- it is a durable sanitation system;
- there is access to improved in-house water;
- it provides dignified sanitation;
- members of households have control over their own water consumption;
- more residents can be given access to adequate sanitation; and
- this EcoSan system provides security as well as privacy.

Other factors favouring installation of this system in BIS include its feasibility in high population settlements and the relatively minimal water requirement. It can be used with a low-volume pour-flush toilet in areas where the water supply is at the standpipe level of service. The system requires no manual handling of waste and allows the use of water for toilet hygiene. Furthermore wastewater (for example water that has been used to wash clothes) is disposed of properly. The focus group discussions yielded general acceptance when people were asked to vote for their preference with a show of hands. In one group all 5 members raised their hands showing their acceptability towards the use of the system. While there was no show of hands of anyone who would not like to use this system. There was unanimous agreement that the Water Bank system was acceptable in group discussions.

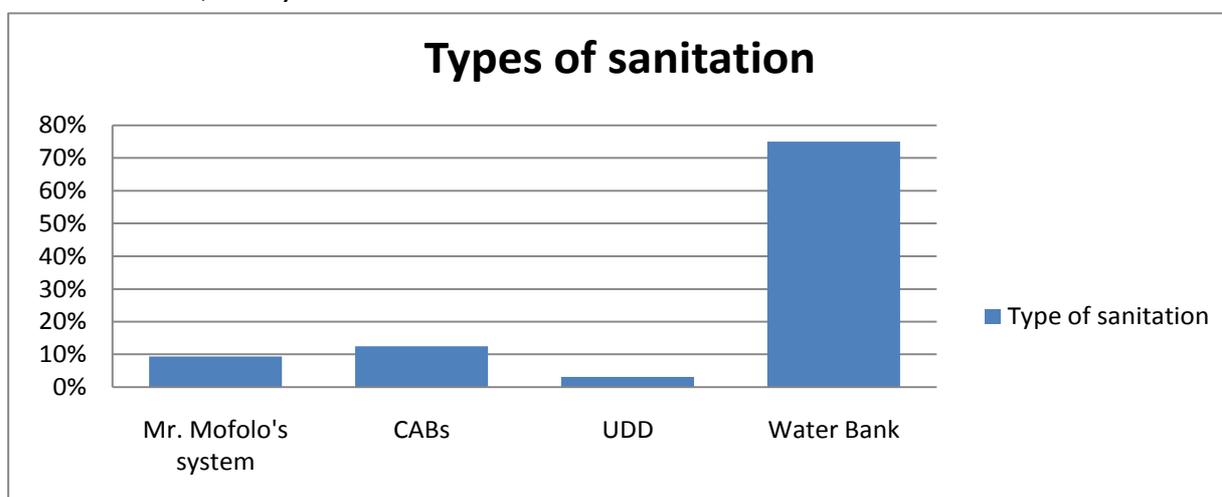
4.4 Community knowledge and attitudes about EcoSan

Of the various sanitation technologies proposed, the Water Bank system gained the most support from BIS residents. Respondents maintained that the Water Bank toilets gave users the same comfort and functional features as conventional toilets. Although the UDD sanitation system found some favour, there were concerns expressed about the necessity of handling/treating of excreta, which was deemed unacceptable. Other objections that were raised about the UDD system include the requirement that both males and females have to sit while urinating; that these toilets are unsuitable for residents of informal settlements

because of their permanency; and that the lack of space would be a drawback for the installation of UDD sanitation.

These responses show that the benefits of EcoSan technology are not yet widely known and understood by the majority of people who live in this informal settlement. Furthermore, introducing something new in any community is of necessity a gradual process and takes time to be accepted; it must be an ongoing process. It is also true to say that lack of community involvement in the monitoring and evaluation process has undermined the ability of the community to learn about EcoSan.

Figure 1: Support for types of EcoSan for use in BIS (Source: M. Mokoena, compiled from field data, 2015)



According to (MMOA, S. Strydom, 23.10.2015) in terms of sanitation provision for informal settlements the municipality have no strategies or action plans implemented. The only provision the municipality provides to these area are water provision within 120 meter walking distance. Up to present the municipality is providing no sanitation systems for people who live in informal settlements. These people have to make ends meet with what they can provide for themselves. In this personal interview conducted with Miss Strydom she revealed that as a manager in Planning, Assets, Projects, Water and Sanitation EcoSan systems is a new sanitation provision to her. So her understanding of EcoSan is that EcoSan is a sanitation system that is environmentally friendly, it does not pollute ground water and will not lead to the cause of diseases for people who live there. The municipality does not take any action to ensure that MDG 7 target 7 C is met by the year 2015.

4.5 Research results

A combination of both quantitative and qualitative research methodology was applied. In quantitative research, the emphasis is placed on variables in describing and analysing human behaviour (Babbie & Mouton, 2001). In conducting qualitative research the author used the approach as suggested by Terreblanche & Durrheim (2006:78) who state that the emphasis should be on feelings and experiences as events/ occurrences take place. This section will present the findings from quantitative data. In total, 40 questionnaires were distributed to BIS households. The variables included age and gender etc. In addition, any suggestions and opinions voiced by respondents were gathered using a questionnaire prepared for this purpose. The focus is on which EcoSan system the residents of BIS wish to use.

As illustrated in figure 1 above, of the 40 respondents, 75% indicated that they would prefer the Water Bank system; 12.5% opted for the construction of CAB unit/s; while 9.37% indicated they would prefer to have sanitation systems similar to that used by Mr Mofolo. Only 3.12% indicated that the UDD system would best meet their needs. The choice of the Water Bank system appears to be based on the benefits and comfort the system holds for them.

It is hoped that the installation of Water Bank sanitation in the informal settlement will be funded by donor agencies and this type of EcoSan system has emerged as the dominant preference for human waste disposal in BIS. However there were still some BIS residents who were sceptical, and said that they did not think that they would benefit much from EcoSan because almost the entire community was still using the bush, and seemed satisfied to continue this practice. However, it must be remembered that EcoSan is a new and innovative technology and hence the community at large might not yet be fully familiar with its advantages.

4.5.1 Community recommendations on EcoSan

Community members raised a number of concerns and expressed their views on matters of sanitation and the possibility of introducing EcoSan in their neighbourhood. Five recommendations were made for improving the management of the EcoSan system, geared initially to all the various types of sanitation still under consideration.

4.5.1.1 Monitoring and evaluation

It was agreed that caretakers would play a major role in the monitoring of the sanitation service and would be required to report on all incidents of concern. For example, it was

suggested that the caretakers should monitor water consumption closely. Electricity consumption, where applicable, should also be monitored so as to ensure that no unauthorised electrical connections were made to the facilities.

4.5.1.2 Education

The necessity of educating the caretaker and the community at large on proper health and hygiene practices and the correct use and maintenance of the chosen EcoSan system was stressed. This is important because the installation of EcoSan sanitation is new in the community. Awareness programmes should be conducted with the assistance of stakeholders such as Rand Water and the Barrage police service to reinforce the messages.

4.5.1.3 Security

Security of the sanitation facilities is essential in terms of preventing vandalism, possible rape and assault and theft. The respondents stressed that ensuring users' safe access to the toilets was of great importance. Some suggestions included the use of the BIS night patrol because this service is already available in the community.

4.5.1.4 Access

The suggestion was made that if it was decided that CABs would be built in BIS the units should be opened and closed on a daily basis (including weekends and public holidays). The maintenance as well as locking/unlocking of CABs would be one of the responsibilities of the caretaker. Recommended opening times ranged from 5h00 until 22h00 while others suggested that from 6h00 until 20h00 would be more appropriate.

4.5.1.5 Fire fighting

Community members suggested that for example CABs should be equipped with a fire hose and fire extinguisher. Should shack fires break out the available fire-fighting equipment could be used to extinguish these fires.

It was felt that the municipality should be held responsible for servicing these facilities on a regular basis to ensure that they complied with the necessary requirements.

4.6 Knowledge, preferences and acceptability of sanitation

There is consensus that the new sanitation technology will provide a shift towards normalising the environment and ensuring access to sustainable sanitation for all. However, the delivery of sanitation including the housing (enclosure) of the toilets is notoriously slow and unsatisfactory in many respects. There are also problems with funding from stakeholders. Stakeholder companies are understandably reluctant to participate in the

provision of sanitation because there are as yet many unresolved legal matters between the community, the municipality and the landowners, all of which give the impression that providing funding might well be risky. For the community of BIS this is a major setback towards achieving a better life for all through sustainable sanitation and progress towards living in a dignified human settlement. Residents indicated that the situation with regard to sanitation and water supply does not seem to have changed for the better since the establishment of the settlement. Many felt aggrieved that they have to make use of old self-built toilets and some still have to resort to relieving themselves in the bush.

Residents agreed that the lack of sanitation exposes them to health hazards and diseases. Open defecation in the bush and open spaces in the settlement is hazardous because flies that settle on the faeces may well carry germs into nearby dwellings when they enter through open doors and windows. These flies transfer germs onto the food that residents then eat. Participants gave different answers on what sanitation means towards meeting their basic needs. Some said it leads to a better life with dignity and self-respect. Other participants mentioned that having to collect water from distant standpipes meant that drinking water was often compromised. In the focus group discussions the point was raised that it seemed as if safe water and proper sanitation facilities were only enjoyed by the wealthy. They feel aggrieved that the illiterate and poor are apparently excluded from access to adequate water supply and basic sanitation. Respondents indicated that EcoSan is an innovative sanitation intervention and technology and that it represents a shift towards sustainable sanitation for all. Participants feel that if and when EcoSan toilets are installed they should be registered under the name of the owner of the house because other members of the community are tenants who live on these properties. The introduction of dry toilets is seen as a valuable contribution to water conservation and sustainability of sanitation for the poor.

4.7 Biographical profile of the respondents

The biographical profile of the respondents presented here is based broadly on a study of BIS residents by Grobler (2014). Respondents for this EcoSan research project were categorised on six different variables, namely: i) gender; ii) age; iii) number of people in household; iv) duration of stay in BIS; v) employment status; and vi) sources of income. For the percentage distribution of each variables, see the tables provided below.

Table 4.1: Gender of head of household (Source: W.C.J. Grobler, 2014)

Gender	Percentage
Male	73.0%
Female	27.0%

Table 4.1 shows that most of the respondents who were consulted in this research project were men (73.0%). It is not surprising that most heads of households are males, because this is traditionally the norm. Comparatively speaking, very few women head up households. Females comprised 27.0% of the EcoSan respondents. The general trend in an informal settlement such as the BIS is that men are more likely than women to urinate at any place that suits them best at a particular point in time. This unacceptable and unhygienic practice is perpetuated by men and can be partly linked to their biological make-up as well as the social acceptance by the community of this decidedly unhealthy practice.

Table 4.2: Age of head of household (Source: W.C.J. Grobler, 2014.)

Age	Percentage
Younger than 20 years	1.3%
21-30 years	25.3%
31-40 years	29.3%
41-50 years	20.0%
51-60 years	16.0%
Older than 61 years	8.0%

From Table 4.2 it is clear that the majority of householders fall into the category of 31 years to 40 years of age, which in total represents 29.3% of the young people living in the BIS. The study sampled respondents from each household to be over the age of 18 years. The selection was based on the fact that they were mature and they would provide reasonable responses. The above table indicates that the majority of the respondents in the sample i.e. 25.3% were in the age group of 21 to 30 years, followed by 20% in the age group of between 41 and 50 years. The fourth age group of 51 to 60 years of age, constituted 16.0% of the sampled respondents. The fifth age group, those younger than 20 years constituted 1.3% of the respondents. There were a small number of cases (8%) where the sampled respondents were older than 61 years of age. Traditionally, females play key roles in terms of sanitation, because they are responsible for most of the routine household chores, such

as the preparation of food, collection of water, changing of children’s nappies, etc. Most of the respondents in the study were females.

Table 4.3: Number of people in household (Source: W.C.J. Grobler, 2014)

Number of people in household	Percentage
1-2	39.47%
3-4	42.11%
5-6	14.47%
7 and more	3.95%

From the category in which there are 3-4 people living in the same dwelling, it emerges that up to four people usually live in a one or a two-bedroom house. This implies that overcrowding is common in BIS. Such cramped living conditions mean that infectious diseases can easily spread within in the household, and by the same token, throughout the informal settlement. According to the respondents the type of housing where they currently live does not provide enough living space and they have virtually no privacy. Most of the homes have between two and four rooms in total.

Table 4.4: Duration of stay in BIS (Source: W.C.J. Grobler, 2014)

Duration of stay in BIS (years)	Percentage
1-5	28.95%
6-10	31.58%
11-15	19.74%
16-20	6.58%
21 and more	13.16%

Grobler’s research findings which have been used in this study indicate that 31.58% of the respondents have been resident in BIS for between 6 and 10 years. A total of 28.95% of them have occupied their homes for between 1 and 5 years. And 19.74% have been residing in BIS between for 11 to 15 years. A total of 13.16% of the respondents indicated that they have occupied their houses for 21 or more years. Furthermore, 22% of the respondents claimed that they occupied their homes in 2003. Lastly, 6.58% of the respondents maintained that they have occupied the same homes for between 16 and 20 years. Based on the research findings it is clear that people have lived in BIS for an extended period (at the very least for more than five years) without adequate sanitation

facilities. According to Higgins and Krieger (2002:4) features of substandard housing include the lack of safe drinking water and ineffective waste disposal, and that conditions such as these contribute significantly to the spread of infectious diseases. In the BIS it is very evident that there is a dire lack of housing, as well as dangerously inadequate sanitation and water services. However, none of the respondents mentioned the incidence of infectious diseases.

Table 4.5: Employment status (Source: W.C.J. Grobler, 2014)

Employment status	Percentage
Formally employed	63.02%
Informal activities	21.88%
Unemployed	5.47%
Not economically active	9.63%

The majority of respondents (63.02%) stated that they were formally employed. The type of employment included construction, domestic work and garden services. Further, only 5.47% were unemployed. Provision of sanitation and the type of the facility is determined by the affordability and ability of the households to pay for such services. People may want sanitation very badly, yet it is often the case that they are powerless to express that desire in financial terms (UNICEF, 2000:17). They may want improved sanitation facilities but cannot afford these at the prevailing price.

Table 4.6: Sources of income (Source: W.C.J. Grobler, 2014)

Source	Percentage
Formal employment	73.94%
Pension	5.79%
Grants	4.42%
Family assistance	2.95%
Informal activities	12.90%

It is evident from these findings that 73.94% of community members are employed, while 12.9% are employed in informal activities such as *stokvels*. Pensioners make up 5.79% of the community. A further 4.42%, mostly single mothers, indicated that they depend on social

grants. Lastly, 2.95% of community members indicated that their source of income came from financial assistance provided by other members of the family.

4.8 Conclusion

This chapter discussed the factors influencing the selection of proposed EcoSan systems for the Barrage informal settlement (BIS). These include environmental, social and cultural determinants. Environmental factors such as the condition of the surface water and soil are primary issues in the selection of a particular sanitation system. Social and cultural factors included acceptability of waste handling; hygiene habits; and the required level of privacy. In the proposal of the different sanitation systems it can be concluded that the options for BIS have been narrowed down to a system that can be installed despite adverse soil/ground conditions. It was also established that public education and information campaigns are sorely needed to encourage consistent use of sanitation facilities and to promote social norms in favour of their use. The objective of the study was to indicate that currently unsanitary means of disposing human waste are being practised. It is apparent that this situation must be addressed because there are dire health hazards that may have negative impacts on the health and safety of the community at large and may result in ground pollution that will prove damaging to the environment in years to come.

CHAPTER 5

Conclusion and recommendations

5.1 Introduction

This research project has established that there are very real problems of sanitation service delivery in the Barrage informal settlement (BIS) and this chapter puts forward recommendations which the Emfuleni Local Municipality (ELM) could adopt to address this challenge. Currently, inadequate sanitation in the informal settlement is unacceptable and is both a human rights and a developmental issue. The failure to provide adequate and functional sanitation has negative impacts on the health and social wellbeing of the community of BIS, the environment and, in effect, the economy of the country. Furthermore, the municipality is undermining residents' dignity and human rights because a large number of people still have to defecate in the bushes. The municipality must take greater responsibility in the provision of toilets for this community. The recommendations which follow will increase the efficacy of ELM's current sanitation programme.

As part of the conclusion of this study it is necessary to highlight the important aspects discussed in each chapter.

Chapter 1 indicates that there is a sanitation problem in BIS that needs to be addressed. The current methods of human waste disposal employed by the residents are unhygienic; it poses a major health risk to the community at large.

In Chapter 2 an important objective was to enhance the reader's understanding of what ecological sanitation (EcoSan) is all about. The objective of this chapter was to show that EcoSan systems are sustainable, adequate, appropriate and reliable. These sanitation systems offer a safe method of human waste disposal and solve associated sanitation and social problems. However, the various EcoSan systems also have their own advantages and disadvantages.

Chapter 3 highlights the real problem in BIS with regard to the current sanitation system/s that the community uses. BIS residents, as participants in the research project, indicated their dissatisfaction about the sanitation facilities in their community. Local residents were asked to give their responses in interviews, questionnaires and group discussions conducted during the data collection process.

In Chapter 4 the attention falls on the personal perceptions of BIS residents. They were given the opportunity to indicate their opinion/s and make a selection from the four types of EcoSan systems suggested. It was all about which one of the four systems they felt would be most acceptable for use in their homes. However, gaining the cooperation of the community was not without its problems. Residents were not always willing to participate, largely because of previous unfulfilled 'promises' made to them by the authorities. Residents made it clear that they wanted flush toilets, but refrained from indicating whether they were prepared to make a monetary contribution towards the installation of EcoSan toilets. The chapter also allows for an in depth analysis of each type of EcoSan sanitation system.

5.2 Recommendations

Prior to the outset of this research project, Emfuleni Local Municipality (ELM) indicated that the relocation of BIS does not feature in its future planning. The re-introduction of a government sponsored local Reconstruction and Development Programme (RDP) houses in BIS is out of the question. The same applies to the improvement of the current sanitation facilities. What then is the way out of this conundrum? How can residents of BIS improve their standard of living as far as sanitation is concerned?

Based on the findings of the research, a number of recommendations are suggested which might be followed in the provision and improvement of sanitation systems for Barrage informal settlement (BIS). These are the following:

1. The Emfuleni Local Municipality (ELM) could possibly relocate the community by constructing new housing projects on other land within the municipal area. But to start this process, the ELM will have to control the current growth of the BIS community. By giving existing homeowners' numbers on their houses (this can be done by painting or spraying the numbers in a numeric chronological sequence) the local authority will know exactly which families are eligible to be in line for new houses. This means that if the community is relocated the ELM will build the new houses based on the number allocated to old homes in the BIS.
2. The local authority and property owners should deliberate on the purchase of land by the homeowners. For this to happen there is a need for residents' participation with the objective of finding suitable property, and such cooperation must take place sooner rather than later to avoid unnecessary delays in the construction process.
3. Residents and the local councillor must find a solution to the issue of housing and sanitation by communicating with residents and being more actively engaged in the

community. The ELM should encourage economic development initiatives. It should arrange community meetings, distribute pamphlets, hold workshops and find other means of communicating with residents, such as through local radio stations.

4. ELM should make a concerted effort to improve the current situation by providing basic sanitation systems through the free basic household sanitation programme. For this to happen there is a need for political will on the part of the ELM to ensure that municipal policies, investment priorities and improvement in the provision of sanitation are addressed properly.
5. It is necessary that there be mutual support between non-profit organisations (NGOs) and BIS residents. Together they can form a partnership of mutual collaboration to improve the lives of those who live in the informal settlement. For example Save the Vaal Environment (SAVE) a non-profit organisation that strives to protect and maintain the environmental integrity of the Vaal River can provide some support and mediation with the local authority.
6. Community participation and cooperation is vital for the upkeep of the EcoSan sanitation facilities. Dedicated attention is necessary for the upkeep of these sanitation systems to fulfil the purpose for which they are intended.
7. ELM must show greater responsibility in improving the community's knowledge and understanding of health matters. Residents should be given information that will increase their awareness of health risks and how to take measures to reduce them, including safe methods of waste disposal and hygienic practices such as washing hands after using the toilet; making sure that water containers (filled at the standpipe) are clean; and washing hands before the preparation of food.
8. Residents in BIS want water-based sanitation systems but should first be educated (in community workshops, for example) on the best alternative to choose and what they are able to afford. They must be fully aware that they may have to pay for whatever type of sanitation they choose to install.

5.3 Suggestions for further research

Based on the findings and results of this study, the researcher wishes to suggest that there are many other areas where future research is necessary. These are apparent when one realises that the implementation of an ecologically friendly system (and thus areas that need to be explored) require the ten steps of EcoSan project planning, namely:

1. Raising awareness in the particular community;
2. requesting assistance from all possible stakeholders;

3. launching planning and construction processes;
4. assessing the current status of sanitation in the particular community;
5. assessing the priorities in that community;
6. identifying all feasible options to promote sustainable development;
7. evaluating feasible service and re-use options;
8. consolidating EcoSan plans for the study area;
9. finalising consolidated EcoSan plans for the study area; and
10. implementation of the new EcoSan sanitation system.

5.4 Conclusion

The residents of Barrage informal settlement (BIS) are living in a community that is notable for uncertainty. They do not know what their future holds. Sanitation is a problem and poses a significant health threat; this must be addressed because it has dangerous health implications. The population is increasing in number every day and will no doubt continue to do so in future. This means that the health risk grows if there is no safe sanitation. Pit latrines that the community members use currently do not meet hygienic and safety standards. People tend to dispose of their faeces as cheaply as possible. Human waste disposal is carried out without any large investment in pit latrines. In the absence of sanitation systems the large majority of BIS residents practise open defecation in the nearby open fields and bushes. The proper collection, transportation, treatment and disposal of human faeces are crucial to safeguard the health of the community and to protect the environment. Without adequate sanitation systems these people have no choice but to use alternative means of survival.

As researcher, I identified the problem and made a thorough assessment of the difficulties that BIS residents have to endure. My investigations at the Barrage informal settlement have led me to the realisation that the only short term solution is to rezone this land for formal settlement housing. However, this is a long and costly process, because:

- BIS is situated on agricultural land not well suited for informal human habitation;
- the land has to be purchased from the current owner/s and then it must be rezoned;
- it is private land which does not belong to Emfuleni Local municipality (ELM).

Findings gleaned in the research process were analysed in chapter four. They indicate that the residents of BIS want conventional sanitation systems.

But this type of water-borne sewerage is unsuitable for their purposes because: i) firstly, they do not own the land and ii) the water supply to BIS residents is very limited. This means that the odds are stacked against them. Simply put, the chances are slim that residents in BIS will get access to Reconstruction and Development Programme (RDP) housing any time soon. And even then, the necessary infrastructure would have to be built and developed appropriately. A far more realistic objective is to make use of EcoSan system on a short-term basis until such time as the problem can be addressed on a larger and more permanent scale. I would suggest that we make use of the ecological sanitation (EcoSan) systems that have been developed.

If there is a need to cut costs this can be achieved by setting a certain piece of land apart for the erection of toilets of the EcoSan type which use comparatively less water and are environmentally friendly. I would also suggest that one of the residents who has been living in BIS for quite a while and who is willing to take the responsibility on his/her shoulders, should oversee the maintenance of these community ablution blocks (CABs) and keep these facilities tidy and hygienic at all times. This would only be a short-term solution, until such time as ELM decides to assist these unfortunate people and improve their lifestyle. In this study it can be concluded that BIS is very far indeed from reaching MDG 7, target 7C.

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ANNEXURE A

INFORMED CONSENT AND PARTICIPATION INFORMATION SHEET

To be completed by the participant

Dear Sir/Madam

My name is Mita Mokoena and I am a Master's student at the North-West University (Vaal Triangle Campus). I will be conducting research on a strategy for developing an ecological sanitation system at the Barrage Informal Settlement (BIS). The aims of this research will be to analyse the problems faced by people living in BIS using the current sanitation system with regard to wastewater treatment. Use will be made of participatory approaches to come to a better understanding of the needs of residents and to secure consensus amongst stakeholders about introducing a suitable sanitation service at BIS. The information gathered will be used purely for academic purposes, but the final document will be a public document in the form of a research report.

Participation in this research will be voluntary and you are free to withdraw at any time. In the providing of information there will be no remuneration made to participants nor will gifts be given. Your identity will be anonymous and the information you provide will be confidential. You are entitled not to share information that you feel is too personal or sensitive and you may choose not to answer any particular question/s.

Do you give me permission to take photographs? And do you agree that we can use these photographs if it is necessary.

Yes No

If you are willing to participate in this research, please sign this form:

Signature _____ Date _____ Time _____

Place: _____

Thank you for agreeing to participate in this research study.

ANNEXURE B

INTERVIEW QUESTIONNAIRE: CURRENT SANITATION CONDITIONS IN BIS

The research will be conducted within the framework of qualitative research. Examples of some of the questions that will be asked by the researcher are the following:

Interview guide: Household head questionnaire

Date of interview: _____

Name of the settlement: _____

Name of the household head: _____

Interview Questions

1. What types of toilets are used by householders in BIS?

2. What measures could be taken to improve hygiene and sanitation in BIS?

3. Do you know of any disease caused in BIS by poor sanitation and hygiene?

Yes

No

4. In your view, what are the challenges faced in the use of pit latrine?

5. Do you find it easy to use the pit latrine toilet?

Yes

No

Please explain:

6. What do you use to wipe after using the toilet?

- Toilet paper
 - Newspaper
 - Cloth
 - Water
 - Other (please specify)
-
-

7. If you are woman, where do you dispose of your sanitary pad/tampon?

8. What do you use to cover the faeces in the vault?

- Ash
- Soil
- Lime
- Sawdust
- Leaves
- Nothing

9. Are you satisfied with having to use a pit latrine?

- Yes
- No

10. What is done with infant faecal matter?

11. What measures are being taken in the house to prevent the contamination of domestic water?

12. In your opinion do health problems prevailing in the settlement relate to the non-availability of adequate sanitation facilities (toilets)?

13. What is the usage level of pit latrine?

14. Do many people in BIS have pit latrines)?

15. How many times day do you collect water?

16. What type of container do you used to collect/ store your water?

17. Do you wash your hands after visiting the toilet?

ANNEXURE C

INTERVIEW QUESTIONNAIRE: SELECTION OF PROPOSED ECOSAN SYSTEMS

1. Age:
2. Gender:
3. Have you ever heard of EcoSan system?
 - Yes
 - No
4. Would you like an EcoSan system?
 - Yes
 - No
5. Which EcoSan system would you prefer?
 - UDD
 - Water Bank
 - CABs
 - Mr Mofolo's system
6. Are you satisfied with the level of sanitation service in your community?
 - Yes
 - No
7. Are you employed?
 - Yes
 - No
8. Do you know the name of your ward councillor?
 - Yes
 - No
9. If you don't use an Ecosan system currently would you use it in the future?
 - Yes
 - No

10. Do you know how any of these EcoSan systems work?
- Yes
 - No
11. Who do you think should be responsible for cleaning these systems?
- Household head
 - Caretaker
 - Children
12. Do you have any interest in gardening/growing vegetables?
- Yes
 - No
13. If yes, would you use the UDD system as a source of fertiliser?
- Yes
 - No
14. Would you be prepared handle/transport safe/treated human faeces and urine?
- Yes
 - No
15. Would you like to be trained on how to use and maintain the EcoSan system?
- Yes
 - No

ANNEXURE D



PO Box 1174, Vanderbijlpark
South Africa, 1900

Tel: (016) 910-3111
Fax: (016) 910-3116
Web: <http://www.nwu.ac.za>

Mr Sam Shabalala
Municipal Manager
Emfuleni Local Municipality
Vanderbijlpark

For more details please contact
Prof. Johann Tempelhoff
Research Niche for the Cultural Dynamics of
Water (CuDyWat)
South African Water History Archival Repository
(SAWHAR)
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21899444@nwu.ac.za

9 December 2014

Dear Mr Shabalala

RE: REQUEST TO CONDUCT A RESEARCH ON SANITATION: BARRAGE INFORMAL SETTLEMENT

Ms Mita Mokoena (Student number 21899444) is a postgraduate student in Water Studies working for a Masters degree in Public Administration at North-West University Vaal Triangle Campus. She is currently undertaking a research project that forms part of a mini-dissertation. We hereby request permission for Ms Mokoena to conduct academic research within the local municipality's area of jurisdiction.

The theme of her research is "A strategy for developing an ecological sanitation system at the Barrage informal settlement". The aim of the research is to use participatory engagement with stakeholders to seek consensus on sanitation at the Barrage informal settlement (BIS). Households will be involved as participants in the research study. Ms Mokoena will, for example explore strategies to promote hygienic sanitation practices and see how more effective interim measures can be introduced to make existing toilet facilities more dignified and effective for human use.

The participation of Emfuleni's Metsi-a-Lekoa to participate in the proposed research is of vital importance. It would be appreciated if you would provide me with permission to proceed with the research. It is hoped that the results of this research will benefit the municipality, stakeholders and the residents of the informal settlement.

Ms Mokoena's project has been tabled in the NWU ethics system (FH-BaSc-2014-0012). Your approval for the research is one of the requirements needed for clearance by the university. Should you require any more information, please feel free to communicate with me at the points of contact listed in the letterhead.

We would sincerely appreciate the opportunity to conduct the research.

Yours faithfully

Prof. Johann Tempelhoff

Original details: Navorsing nagraadse students Mokoena Tempelhoff - Shabalala.docx
9December 2014 Do not type here

ANNEXTURE E

**APPROVAL LETTER FROM THE GATEKEEPER EMFULENI LOCAL MUNICIPALITY
(ELM)**



Vaal River City, the Cradle of Human Rights

**Office of the Deputy Municipal Manager:
Corporate Services**

Tel: +27 16 440-7742/6
Fax: +27 16 950-5243
E-mail:

P.O. Box 3

Vanderbijlpark, 1900

Web: www.emfuleni.gov.za

Date: 16 February 2015

Ref: J.S. Roets

File: 10/11/1

To whom it may concern

RE: Confirmation of Research Approval viz. Ms Mita Mokoena

This serves to confirm that Ms Mita Mokoena (Student No.21899444) sought and was granted permission by Emfuleni Local Municipality (ELM) to conduct an academic research for her mini dissertation titled "A strategy of developing an ecological sanitation system at the Barrage informal settlement".

ELM is granting research access to its premises and relevant Department(s) to Ms Mita Mokoena for that purpose only. This research access will terminate immediately upon the completion of the research period as stipulated.

Ms Mita Mokoena will also abide by the rules and regulations that govern all ELM employees whilst on the premises. This includes any confidentiality obligations that may be required to be observed in publication of the mini dissertation.

Breach of any such prescripts will result in immediate termination of the research access and any concomitant mitigating steps may be taken where necessary.

ELM would also welcome a copy of the completed dissertation as a *quid pro quo* if possible.

ELM wishes Ms Mita Mokoena well in her research endeavor.

HR - MANAGER TRAINING: ELM

20/02/2015
DATE

ANNEXURE F

ORAL INTERVIEWS: MITA MOKOENA ARCHIVE (MMA)



CuDyWat

File number: _____

Date of interview: _____

Place of interview: _____

Name of respondent: _____

ID/Passport number: _____

Address of respondent: _____

Email address: _____

Telephone number (W) _____ and (H) _____

Cellular/mobile number: _____

Date of birth: _____

Status: _____

Occupation: _____

Summary of subjects discussed:

ANNEXURE G

INTERVIEW QUESTIONNAIRE: SANITATION PROVISION FOR INFORMAL SETTLEMENTS IN THE JURISDICTION OF EMFULENI LOCAL MUNICIPALITY (ELM)

Name:

Surname:

Age:

Gender:

Occupation:

1. What is your understanding of ecological sanitation as a component in the provision of sustainable, adequate, safe and appropriate sanitation?
2. Do you think that an ecological sanitation system is central to MDG to halve the population without sanitation and water by 2015?
3. As municipalities how do you take action to the MDG target for 2015 to ensure accessibility and utilisation of sanitation services for the poor?
4. Which sanitation technology or application would be the most appropriate tool in the household of informal settlements?
5. Do you have any plans to control future development of informal settlements?
6. What type of basic sanitation systems does the municipality provide in informal settlements that falls within your jurisdiction?
7. Does the municipality, have any approach or strategy used in providing water and sanitation services in informal settlements?
8. Which criteria does ELM use to select the approach in which the municipality must provide water and sanitation services in informal settlements?
9. Are there any means through which the municipality programs accommodate the users in the whole process of providing water and sanitation, and how successfully do they work?
10. Does the municipality have any improvement programs designed to introduce EcoSan approaches or strategies in the provision of sanitation in the future?