A Summary of Lessons and Experiences from the Ethekwini Pilot Shallow Sewer Study

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John Harrison

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Water Research Commission

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Report to the Water Research Commission

by

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Executive Summary

1. Introduction

The Shallow Sewer concept has been successfully implemented in Brazil, Greece, Australia, USA, Bolivia, India and has become the norm in Pakistan, and has proven to be an extremely practical, low cost solution for installing water borne sewage systems within highly dense, informal communities. The technology is intended to develop and uplift communities while enabling governments and service providers to provide greater coverage of sanitation services. This is done through the relaxation of several design characteristics of conventional sewerage and in the process allows for shallower depths, smaller diameter pipes, flatter gradients and community based construction, operation and management.

Besides offering the convenience and health benefits of waterborne sanitation, the methodology with its intensive social programme, is intended to provide people living in communities with the skills to pull themselves out of poverty and to better organise themselves to use their social, intellectual and other capital for their own upliftment, while at the same time reducing the operational load of the service provider.

Ethekwini Water Services (EWS), in a joint venture with Water and Sanitation Services (South Africa) (WSSA) and the Water Research Commission (WRC), investigated, through a Pilot project, whether Shallow Sewers would provide a viable alternative waterborne sanitation system to the urban poor in dense settlements. The practical applications of the Shallow Sewer methodology were evaluated in two Ethekwini communities, Emmaus and Briardale.

1.1 The Ethekwini Pilot Application

With no South African experience of consequence to use as a guide, the implementation and management for the Ethekwini pilot was based on the successful model used in La Paz, Bolivia as imported by WSSA's Project Manager who had had extensive experience of the implementation of this model. The two pilot communities, Briardale and Emmaus, were selected based on the results of a social evaluation of five potential communities in Ethekwini.

The research objectives were to assess the financial, social acceptance, quality of life, technical, legal and institutional management aspects of Shallow Sewers in Ethekwini. In addition, this initiative evaluated the methodology and how it was applied to the La Pas model imported from Bolivia, and discusses the suitability and relevance of such interventions to the South African environment.

1.2 Parameters and Constraints

Emmaus was an existing community with free hold property rights, who had already been upgraded and therefore had already received their Provincial Housing Board (PHB) subsidies. The existing on-site sanitation system had failed. The community consists of 96 households, with a wide range of incomes, which are distributed into a richer and a poorer sector of the community. One third of the community earn is excess of R1800 /household per month, whilst 36% are very poor, with an income of less than R600 /household per month (5).

The Briardale community was a green-fields development made up of 157 households who were the over-spill from other upgrade projects. This development was being undertaken by an NGO using a "self help" scheme, on land being developed under the Communal Property Association Act. The average household income of this community was approximately R700 /month which was normally distributed about the mean (5).

There were two major factors, one at each of the sites, that were beyond the control of the project management, and that had serious consequences on the project.

At Emmaus, during the Local Council elections the aspirant councilor, who was subsequently elected, promised the community "free basic water" which was interpreted to mean that this included all internal plumbing, connection and consumption costs.

At Briardale the developer was unsuccessful at registering the housing scheme, which meant that the PHB subsidies were not forthcoming, which subsequently lead to the collapse of the development.

1.3 Status Quo Report

The final commissioning and operational phase has not been completed on either project due to community pressures.

In the case of Emmaus, a large percentage of the community have not installed the wet core services, including the water connection and sewer connection costs and Municipal charges, citing:

- Lack of funds, despite initiatives put in place to contribute to these costs, through payment to the community involved in the construction.
- The promise of free basic water, and the community's understanding that this included all internal plumbing, connection and consumption costs

In the case of Briardale, the community has rejected all initiatives it has associated with the failed housing development initiative, including the Shallow Sewers.

Both EWS and WSSA are engaged in resolving the commissioning delay.

2. Findings

Undertaking this research in South Africa through the Ethekwini Shallow Sewer Pilot study has revealed considerable insight into the sanitation environment in general, with particular reference to Shallow Sewers. It has also provided an opportunity to guide the development of a range of similar technologies that would be applicable in the South African context.

2.1 Benefits of Shallow Sewer Systems

There are potentially substantial benefits for "Shallow Sewer type" systems. The study showed that Shallow Sewers can provide all the convenience and benefits of waterborne sanitation at half the capital cost of conventional sewers and that they may even compare favourably with the cost of pit latrines.

- **Technical**

  From a technical perspective, there is no apparent reason why Shallow Sewers should not function as well as, nor provide the same level of service to the customer, as conventional ones.

  In densely settled areas where space between buildings and space for the evapo-transporation is limited, thus limiting the use of conventional sewers and on-site sanitation systems, Shallow Sewers may provide the only technical solution. Their shallow depth, reduces the amount of excavated material that is required to be moved considerably, thus allowing access to areas which are not accessible to conventional sewers.

  The approach of reducing the construction standards has positive effects on the construction and maintenance, and consequently the cost, achieved by simply laying the sewer at a shallower depth. Of particular note is that the soil volumes that are handled are far smaller than in conventional

sewers, the pipes are also generally laid above the rock and water table, thus reducing the cost even further. In addition, because of the shallow depth, access to the pipe can be done from the surface thus obviating the reason to have "manholes" large enough for a man to enter. Thus not only the depth of the access point is reduced, but the cross-section dimension too. Access chambers costs were found to be an order of magnitude cheaper than conventional manholes.

In addition the smaller diameter pipes should provide better solids transportation than conventional sewers in situations where low flush volumes are utilised.

- **Community Based Development**
  There were, nationally, a number of similar community based development projects that were running concurrently with the Shallow Sewers project. Within these technologies there were a group that had similar philosophies and tenets to that of the Shallow Sewers, with slightly different techniques of achieving certain specifics. The Shallow Sewer technology could provide the basis for a "South Africanised" development technology, based on these philosophies, where the best of the various techniques are combined.

  Further, the Shallow Sewers technology is not a single technology but rather a suite of technologies. A range of models could be developed to suite a number of different situations.

- **Social**
  Shallow Sewers improve the householder's quality of life by offering the convenience and health benefits of a water supply and waterborne sanitation to each home.

  One of the features of this technology lies in the social development of the communities. Social upliftment skills were provided at a number of levels.

  At household level, health and hygiene and general waterborne sewerage utilisation skills were provided.
  At sub-community level the community is divided into "condominium" which operate a sewer line. The condominiums were taught the fundamentals of maintaining the sewer system as well as the management skills required to keep the condominium sub-community functional.
  Also at the sub-community level certain of the trade skills such as elementary pipe-laying, brick-laying and plumbing was provided to certain key individuals in the community.
  At community level management skills were developed. These included skills such as conducting meetings, handling and managing finances ,etc.
  At a different level participants were taught how to identify and facilitate the solutions to their own problems. They also acquired skills on how to communicate with other community members as well as external parties, and began to understand, that through shared knowledge and human capital, projects can be undertaken even if there are limited resources within the community.

  It was concluded that a social intervention that builds capacity in people to enable them to undertake development for themselves is very important and that perseverance to get the formula right for South African communities could benefit the country enormously. The social aspect is much wider than providing sanitation.

- **Financial**
  Shallow Sewers can be installed at significantly reduced capital costs. The results of the evaluation demonstrated that Shallow Sewers could be installed at approximately 50% of the capital cost of conventional sewers, if the costs are "ring-fenced" to the site of the development (i.e. ignoring the capital costs of the bulk reticulation and treatment works).

The "on development project" capital cost of Shallow Sewers also compares favourably to that of VIPs: i.e. using the same ring-fencing of the costs as above, then the capital costs per household for Shallow Sewers is similar to that of a double vault VIP. The cost of the social intervention has been included in the capital cost for the Shallow Sewers, for the purpose of this comparison.

The provision of Shallow Sewers is compatible with the steps and timing of the Provincial Housing Board's subsidised housing system.

They are also affordable to all, provided that the first six kilolitres per month of water is supplied to each household free of charge.

- **Environmental**
  Environmentally Shallow Sewers have a similar impact to that of waterborne sanitation, protecting watercourses, people and the environment in general from human waste.

2.2 Drawbacks of Shallow Sewers

The Shallow Sewer System potentially provides an excellent sanitation solution in the "water and sanitation package" for South African communities, however there are some primary drawbacks for the South African context.

- **Legal issues**
  Certain issues need to be resolved before Shallow Sewers can become a viable option for service providers.

  Community ownership of the common sewer line is in conflict with land tenure principles. At Emmaus, where the homeowners have title to their individual lots, the legal status of the Shallow Sewer and the necessary requirement that the homeowner must be a member of the condominium is not written into the title deeds and are therefore not enforceable. Briardale has been developed under the Community Property Association Act, and the necessary legal arrangements for the formation of the condominiums have been written into the community property owners' constitution

  There are also contractual difficulties with indigent people. Frustration arises from a lack of enforceability of obligations imposed contractually on indigent parties who, due to lack of financial means are unable to fulfill these obligations.

- **Technical issues**
  Shallow Sewer technology transgresses the National Building Regulations (NBR) in a number of cases, eg pipe diameter and manhole size. The prime one arises due to the unauthorised drainage work undertaken by the community.

  Laying the sewer to a shallow depth obviously changes the risk of damage due to imposed load considerably. Bylaws very often control the minimum depth to which sewers may be laid, and this may conflict with the depth tenet of Shallow Sewers.

  Due to the shallower depth at which the sewers are laid, a number of the appurtenances that have been designed for conventional sewers, are either no longer applicable, do not fit the Shallow Sewers, or their technology is inappropriate for the construction practice. In this particular instance, the conventional gully was replaced by an in situ built, brick grease trap. These grease traps turned out to be very efficient and needed cleaning regularly, which the communities complained about.

Initially the ingress of soil into the sewer system was a problem, which was resolved by raising the inspection chambers by one course of bricks.

- **Institutional**
  This study could not fully evaluate and quantify how onerous the management of Shallow Sewers would be on the services authority. The final consolidation phase, which has taken longer than planned due to the local situation and dynamics, had not yet been completed and Ethekwini Water Services had not taken over the responsibility of retaining the system by the time the research reports were written. However, it was evident that the key to the successful implementation of Shallow Sewers rests in the social intervention, which requires knowledge and dedication on the part of the implementing agency.

  An essential lesson learned from this experience was that, besides requiring extensive participation by the community in the installation and maintenance of the system, this technology also requires extensive support and participation by the service provider, and that technical support and training needs to be ongoing.

  Institutionally, the service provider needs to be structured in a way that it can provide community-based services. An interdisciplinary approach is one of the tenets of the Shallow Sewer system, meaning that community liaison staff and social professionals need to team up with technical staff to provide holistic operation and management solutions. In this instance, it would have been beneficial to have other municipal departments dealing with the housing, treasury and others drawn into the team, to ensure an integrated approach to development of the area as a whole.

  Developmental interventions pressurize the communities, and sometimes polarize sectors of the community. Therefore the community leadership needs to be strong enough and have the community support, to guide its members though the implementation.

- **Social**
  A practical drawback relating to training in a community was associated with finding a time that suited the whole group, as limited time windows were available to those members of the community that worked. Some communications were made through condominium representatives, a strategy that did not always work well. It was important that as many members of the community as possible were exposed to the educational sessions, however it is proposed that at least one senior member of each family received the full education.

  In cases when Condominium leaders changed at Briardale, the new leaders sometimes had not received sufficient training or communication. This may also be attributed to conducting training in a green fields situation where some of the community members have not permanently moved to the site.

  Generally in both communities it was found that the condominium (Iqoqo) leaders did not continue to manage the condominiums well over the research period, although there were exceptions to this at Emmaus. These exceptions could, perhaps, be attributed to the fact Emmaus is a well-established community and therefore they may be more self-reliant.

- **Social and Political Influences**
  Some of the more affluent members of the community at Emmaus wanted a full pressure water supply. The majority of the community wanted semi-pressure and the policy of the Ethekwini Water department was to supply only one level of service into a community. The unhappiness that this created led to one of the condominiums withdrawing from the project.

Local Council elections occurred during the project, and one of the aspirant councilors promised "free water for all". The aspirant councilor and subsequently the community undertook this to mean that all water supplies, at all service levels, including all connection costs, would be provided by the Council free of charge. This undermined the premise under which the project was undertaken and the community would no longer uphold their side of the agreement and make their water and sewer connections.

Certain influences are beyond the control of the implementing team. For instance, there is no mechanism in the political system to deal with political promises that do not align with mainstream understanding or the tenets of the project. In this instance the local government elections, occurred during the project. Even if the project team had foreseen the problem, it is unlikely that they could have done much to influence its impact on the project.

- **Timing Issues**
  An issue that arose in relation to the project management was the mismatch between "deadline" related construction, which implies time related management, and community/social management, which implies that the interventions proceed at the rate of community development. This potential conflict occurs on two levels.

  The contractual arrangements for the Project Manager and the social consultant had time and cost restrictions although both contracts were extended. Both the parties left the project at the end of the works implementation phase when only two houses in each community had been completed and connected to the sewer and water supply, leaving certain critical interventions incomplete. It was also at this point in the development when serious social issues in both communities surfaced. Working with communities in this type of project does not lend itself to such restrictions and these problems may not have occurred if the service provider had the resources to undertake such interventions in-house, at a pace more suited to the pace of skills assimilation in the community. Continuity of management is also important in maintaining community commitment.

  At the political level there is a demand that there should be social development with all infrastructure development. At the same time there is a demand for rapid catch-up of backlogs in infrastructure. Currently there is no guideline to for developers to prioritise between the two. This leads to uncertainty and conflict.

3. Conclusions

At this point in South Africa's development, Shallow Sewers in its pure form (i.e. as intended by the La Paz model) are not applicable to the country in general, although there may be instances where it may work to a degree. This is concluded primarily because:

- Of the mismatches between communities' expectation that the "government will provide" and the self help tenet of the Shallow Sewers, and
- the governments assume that rapid infrastructure development and community social upliftment are concordant.
- The legal conflict between the private land tenure and communal ownership of fixed property on that land and
- The institutional arrangements at local government are not structured for interdisciplinary community development.

3.1 The potential capital saving provided by a reduced depth sewer is enormous, and technically it should not be difficult to develop a reduced depth, conventionally owned and operated, sewer from the lessons learned from the Shallow Sewers pilot.

3.2 This research has provided some understanding of the urban poor market, and some of the lessons learnt from the Shallow Sewer pilot study could be applied to improve the success of other community development projects. In this regard, should it still be the governments intention that infrastructure development should encompass community social development, then the Shallow Sewer methodology could form the basis of a "South Africanised" community development methodology.

4. Recommendations

- As the institutional and long-term aspects of the Shallow Sewer project have not been evaluated, resources need to be set aside for these evaluations to be undertaken.

- In order to diminish the conflicts such as "community upliftment" vs. hardware delivery; "self help" vs. "government will provide" etc., a policy review and upgrading of development policies needs to be undertaken, certainly at local authority level, but preferably nationally. In particular the conflict in policy between rapid service provision and community development must be resolved.

- To facilitate rapid service provision and provide technical advantages over conventional sewers whilst policy issues (above) are being clarified, it is recommended that a reduced depth sewer system, based on the technical advantages of Shallow Sewers, be developed and tested as soon as possible. The development of these reduced depth sewers need to take into consideration the findings of this study, i.e. issues such as the legal conflict regarding land tenure, etc.

As community based development can be used to empower communities, and should the policy review indicate that this is desirable and the process is unfettered, then it is considered that a single uniform methodology would be appropriate to undertake this type of development. In this instance, it is recommended that the Shallow Sewer methodology be used as the basis for this methodology.

A SUMMARY OF LESSONS AND EXPERIENCES OF THE ETHEKWINI PILOT SHALLOW SEWER STUDY

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List of Key Abbreviations

EWS	Ethekwini Water Services	WSSS	Water-borne Shallow Sewer System
WRC	Water Research Commission	CSSS	Conventional Water-borne Sewer System
VIP	Ventilated Pit Latrine	WSSA	Water and Sanitation Services (South Africa)
PHB	Provincial Housing Board	CAP	Community Awareness and Promotions
WHO	World Health Organisation	NBR	National Building Regulations
HPF	Homeless Peoples' Federation	LIMA	LIMA Rural Foundation
		BESG	Built Environment Support Group

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1 Introduction

1.1 Background

The extent of the problem in South Africa of inadequate water and sanitation is well documented. In spite of the recent focus to provide basic water and sanitation services, about 11 million South African urban and peri-urban dwellers still lack adequate access to sanitation. (13) The resultant effects on public health, water supplies and the environment is of major concern to service providers throughout the country.

The installation of Ventilated Pit Latrines (VIPs), recommended as a basic sanitation system according to legislation, has not provided local authorities with a solution to the provision of suitable sanitation services in dense peri-urban environments. In these environments, where the water supplied to the land area is greater than the evapotranspiration from the site, removal of wastewater is as critical from a health perspective as dealing with human wastes.

The Ethekwini Municipality (formerly Durban Metro) provides three levels of water service. The first is the conventional full pressure service that has no physical restrictions. The second level is a semi-pressure supply, which is provided at a much-reduced cost for connection and tariff, but the house must be fitted with a 200-litre roof tank in order to reduce the operational pressure of the water supplied. The lowest level is the 200-litre ground tank that is filled once daily thus limiting consumption to 6kl/month. Ethekwini Municipality's policy is that, for technical and financial reasons, only one type of water supply could be provided to a community.

To date no alternative to full waterborne sewerage had been available to support the semi-pressure water supply as an appropriate service level to densely populated, poorer areas. The Shallow Sewer system indicated promise in fulfilling this void. Therefore, pilot studies on Shallow Sewer systems were run at Emmaus and Briardale.

A report published by the Water Research Commission (13) entitled " The Applicability of Shallow Sewer Systems in South Africa," concluded that Shallow Sewers might provide a viable sanitation alternative for urban and peri-urban settlements in South Africa.

International Experience

The Report (13) outlines the experiences of five Shallow Sewer implementations in lower income communities in developing countries, namely in Brazil, Ghana, Pakistan and South Africa. In Brazil Shallow Sewers have worked well and have become the norm, having been constructed at 60 to 80% of the cost of conventional sewers, with a high rate of acceptance and community mobilization.

In Brazil one of the systems broke down when the local residents were unable to address chronic problems associated with design and construction flaws. At that time the system was not widely accepted by the state water company's technical personnel who ignored it for the first five years. However, once the company's operations staff developed a maintenance strategy, which included a social component, they opted to maintain the system themselves, at a lower cost than for conventional systems.

In Brazil it was also found that "the implementation of Shallow Sewers resulted in significant improvement in environmental health, with incidents of infant diarrhoea being half of that in un-serviced areas". They also found that when people were able to experience a successful pilot implementation they were able to raise funds to extend the system rapidly.

The WRC report highlights a variety of experiences and concludes with an extensive list of important lessons to be considered for the international experience.

Vargas WRC 1146/1/03 (19) states that "Shallow Sewer systems were developed by South American engineers in the early 1980's in an attempt to provide an affordable sanitation alternative for dense urban settlements".

"This model allows for savings in different items, such as length and diameters in pipes, excavation, materials, shuttering, etc. It permits not only to reduce costs for the population served, but also to increase the water and sanitation coverage without increasing projected investment."

" Often practitioners in the sanitation field focus on the Shallow Sewer system's innovations on the modification of some of the technical standards. However the conception of Shallow Sewer systems goes beyond that. Its conception comes from a wider analysis of common practices of service provision, including the role of beneficiaries and institutions, the right to participate in the design and access to information and services."

"Therefore it is not possible to separate the technical issues from the social and institutional aspects that accompany the implementation of Shallow Sewer systems."

The Shallow Sewer methodology requires extensive participation by the community hence capacity building and training are required. The system thus provides not only water-borne sanitation but also water to each household, which results in the upliftment of the community through improved services combined with tools for community development. Besides offering a service "package" of water and water-borne sanitation, this methodology also provides education on installation, maintenance and health and hygiene awareness. It was expected that, because of its essential educational component, the installation of Shallow Sewers would be more successful in the upliftment of communities than conventional water-borne sanitation, which is installed without such an intensive education programme.

Key issues to the sustainable operation of this technology are community participation, financial and institutional management.

A key recommendation emanating from the WRC study (13) was to undertake pilot studies in South Africa in large municipalities with existing water and waste departments, which showed an interest in exploring alternative approaches to service provision. The Ethekwini Municipality fitted the bill and provided a suitable forum to implement a pilot project and to undertake a research study in a joint venture between Ethekwini, Water and Sanitation Services (South Africa) and the Water Research Commission.

It is important to note that this project was not fully implemented at the time of writing this report and that the stumbling blocks encountered continue to be addressed after the research period.

Water and Sanitation Services, in conjunction with Ethekwini Water Services, are committed to findings innovative ways to resolve the political and social issues that have delayed the final stages of implementation of Shallow Sewers in the Briardale and Emmaus communities.

The valuable lessons that have been learned from this experience, however, are reported for the benefit of service providers that are considering the installation of Shallow Sewers as a technical option.

1.2 Ethekwini Shallow Sewer Management Structure

The Partnership
In order to investigate whether Shallow Sewers would provide a viable alternative waterborne sanitation system to the urban poor in dense settlements, a joint venture agreement was set up between Ethekwini Water Services, Water and Sanitation Services (South Africa) and the Water Research Commission.

Roles and Responsibilities of the Parties
The partners agreed to undertake certain responsibilities based on their individual expectations and objectives related to the pilot project. Ethekwini Municipality (formerly Durban Metro) is the Water Services Authority for the Durban Metropolitan area and Ethekwini Water Services is its designated water services provider.

Ethekwini Water Services (EWS) was responsible for ensuring the operation of the pilot system, its commissioning in liaison with the community, and ensuring that the community undertook the maintenance.

EWS retained the overall responsibility for the project, including financial management, project management and implementation, including mobilizing the necessary resources to undertake the successful implementation of the project. EWS also identified suitable communities for the pilot, carried out the design of the sewerage collector system, provided the necessary water supply, established and implemented a tariff, coordinated the research, reviewed the legal aspects and was responsible for commissioning the system and provided general support to WSSA.

EWS also administered the research funds and facilitated the research. They recruited an independent research team to formulate, undertake and facilitate the research programme, based on the requirements of the Steering Committee.

EWS will operate the system once it is commissioned in liaison with the community and its particular maintenance responsibilities as defined during the implementation.

Water and Sanitation Services (South Africa) (WSSA) had the overall responsibility for managing the implementation of the project and the project finances. They also provided financial capital and technical expertise. WSSA accessed the international experience and methodology through their South American project manager.

Their project manager also was responsible for the employment and management of the social consultants, assisting in the commissioning of the system; for providing a six-month mentorship period and as well as proposing success indicators and performing international benchmarking.

WSSA provided R2 million to fund the implementation of the project and was responsible for the project management.

Water Research Commission (WRC) provided the research funds and was responsible for managing the research component of the initiative, as well as disseminating the experience gained through the pilot project.

NASCO, SANTAG and the Department of Housing
The National Sanitation Coordinating Office (NaSCO), and the Sanitation Technical Advisory Group (KZN: SANTAG,) and the Department of Housing provided advice and support for the project, although they did not provide funding.

The National Sanitation Coordinating Office (NaSCO) undertook to coordinate the feedback into central government policies.

The Department of Housing, undertook to support the project by executing leverage on the Provincial Housing Board (PHB) subsidy system.

Steering Committee
A Steering Committee represented by all the above parties as well as the Project Manager (WSSA), the independent Research Manager and Ethekwini Municipality Departments of Health, Housing, Water and Wastewater, provided guidance to the project and the research. The Director of EWS chaired the Committee.

Management Committee
A Management Committee, represented by the three main contracting parties, was convened to provide strategic support and direction to the project.

1.3 Research Component

Objectives of the Research
The research function proposed to research the viability of the implementation of the Shallow Sewer system in Briardale and Emmaus, by assessing:

- The capital costs savings compared to conventional waterborne sewerage
- Whether the costs and implementation can be accommodated within the Provincial Housing Board guidelines
- The legal viability of the system in South Africa
- The effectiveness of conveying sewage in terms of water usage and the use of unconventional construction methods and materials
- The community's ability and willingness to pay for the service
- The maintenance and any other running costs to the community
- Customer satisfaction and improvement in quality of life compared with conventional sewerage
- The community's ability to manage the condominial system and agreements
- The community's ability to maintain the system
- The reduction in environmental health risk conditions
- The operation and maintenance costs to the Ethekwini Municipality and
- The administrative burden on the Ethekwini Municipality.
- Health and hygiene awareness and practices compared to communities with conventional waterborne sewerage.

Not all of the objectives of the research component were achieved due to problems encountered during the implementation of the pilot. These being:
- Health awareness and health practices in communities as well as
- The operation and running costs to, and the administrative burden on the service provider.

Data that was collected relating to health aspects was not analysed in detail due to health professionals not being available to undertake this function. The institutional management elements

could not be researched in any detail because the Ethekwini Municipality had not taken over the management of the project before the end of the period of research.

1.4 Research Outputs

There are three outputs of this research. A summary report or synthesis, a full research report (WRC 1146/1/03) and a video documenting the Shallow Sewer system and its implementation in the Ethekwini Pilot Study, which is available on CD. The video is aimed at service providers who may want to consider Shallow Sewers as a sanitation option.

Structure Of Report

This report consolidates and synthesizes the research findings as well as the implementation lessons and experiences of this pilot study. It has been written for three target audiences, and takes the following format:

- The Executive Summary provides a brief overview and overall conclusions.
- Chapters 1 to 10 provide a synthesis of the components of detailed research captured in WRC 1146/1/03 (19), highlighting the essential experiences and lessons learned from the process. It covers all aspects of the research, providing abbreviated results and findings of individual research areas.

  The format of this report is firstly, an overview of the planning and implementation, secondly the results and findings under the specific areas of research, and, finally, the key conclusions of the Ethekwini experience, and recommendations for applying these findings in the South African context.

2 Shallow Sewer Technology and Design Criteria

According to Vargas, in WRC 1146/1/03, (19) the technology relaxes many design characteristics of conventional sewerage and in the process allows for shallow depths, smaller diameter pipes, flatter gradients and community based construction, operation and maintenance. The concept has been successfully implemented in Brazil, Greece, Australia, USA, Bolivia, India and has become the norm in Pakistan".

2.1 Introduction to Shallow Sewer Technology in South Africa

The technology was developed to service the poorer elements of the community, however in some parts of the world it has been developed as the standard option. It is expected that in South Africa it will, certainly initially, be used for the poorer communities.

This technology is expected to be applicable in South Africa as an intermediate sanitation alternative with a cost between VIPs and conventional sewerage. The WRC Report (13) asserts that "they may be preferable to VIPs in denser (greater than 35 dwellings per hectare) formal and informal peri-urban settlements and that they provide a less expensive alternative to conventional sewerage in low to medium income formal urban residential areas. A significant advantage is that Shallow Sewers systems are appropriate where water use is between 30 and 60 litres per capita per day (i.e. pour flush toilets with yard tanks or yard taps) which may be too high for VIPs and too low for conventional sewerage."

2.2 Shallow Sewer Technical Design Criteria

According to the WRC Report (13), Shallow Sewer systems *"require a relaxation of traditional design and construction standards, and an associated education of the technical personnel who are responsible for their implementation and management.*

- *Technical design standards for sewer systems, such as local authority bylaws, the 'Red Book' (Department of Housing, 1994) (20) and SABS 1200 (1982) (21) need to be relaxed. In particular, the use of smaller diameter sewers (i.e. less than 150mm), shallow block sewer depths (i.e. only 400mm cover), flatter sewer gradients with smaller diameter pipes I.e. 1:167 slope for 100mm pipes) and less stringent access requirements (i.e. inspection chambers rather than manholes).*

- *Building codes for household fittings and house connections should be relaxed, allowing local installation of fittings and connections, with less stringent connection requirements, albeit with quality control in trunk sewer access.*

- *The relaxation of design standards is based on the assumption of high connection rates. Therefore Shallow Sewers should not be implemented where less that 75% of the residents have agreed to connect under the proposed financing and management conditions.*

- *Site specific design of block feeder and trunk sewer system layout should be encouraged to minimise the costs of the system and allow the use of Shallow Sewers in irregular informal settlements.*

- *However the standards should require consultation and user education of residents in cases where traditional standards are relaxed, to increase 'ownership' and ensure appropriate use of the system.*

- *Similarly, community or small contractor capacity building should be required where construction or management of the system is delegated, thereby transferring maintenance skills into the community.*

The last two points highlight the inter-relationship between relaxing design standards, delegating management responsibility and increasing community awareness, all three of which are necessary for efficient and sustainable implementation of Shallow Sewer systems."

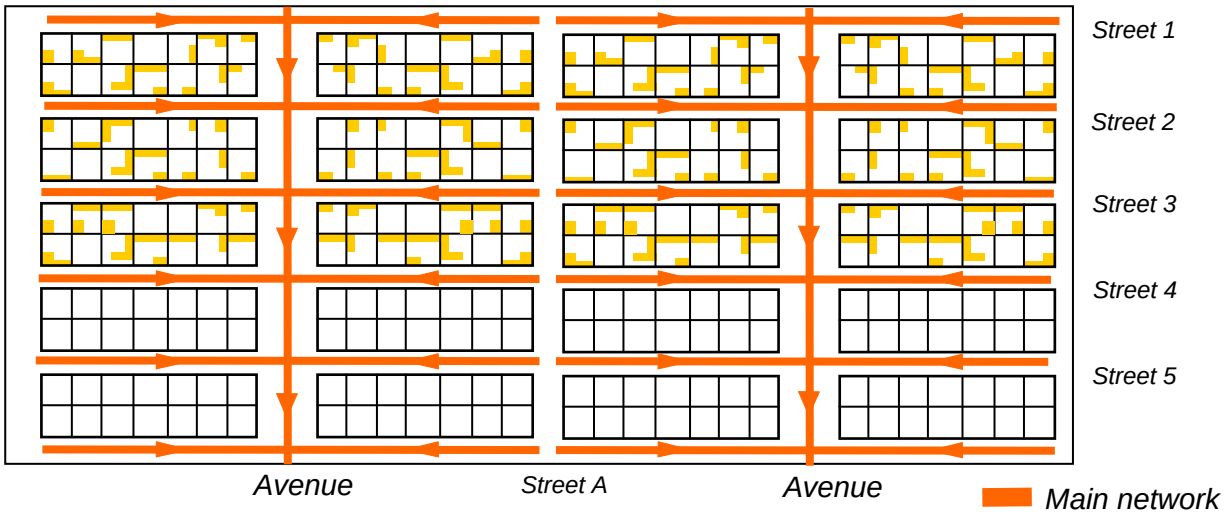
2.3 The Condominial Concept

The fundamental of the Shallow Sewer concept is that a group of citizens who live in a common micro drainage catchment for a sewer will come together and install, manage and operate a sewer system, which is collectively owned by this collection of citizens. The local authority then only supplies one connection to the group of citizens. This group of citizens is collectively known as the "Condominium" or "Iqoqo" (Zulu).

The sewer network consists of three sections each with different owners. The local authority owns the collector sewer which is a conventional sewer draining the collective condominium sewers. The members of the condominium own the condominium or collective sewer jointly. Each member of the condominium then has his own connection to the condominium pipe. The local authority owns, installs, maintains and operates the collector pipes. The condominium pipe is collectively owned, operated, installed and maintained by the condominium. The section of pipe that connects the house to the condominial sewer is owned operated and maintained by the individual house owner. Diagram 1 shows the differences between conventional sewers and Shallow Sewers.

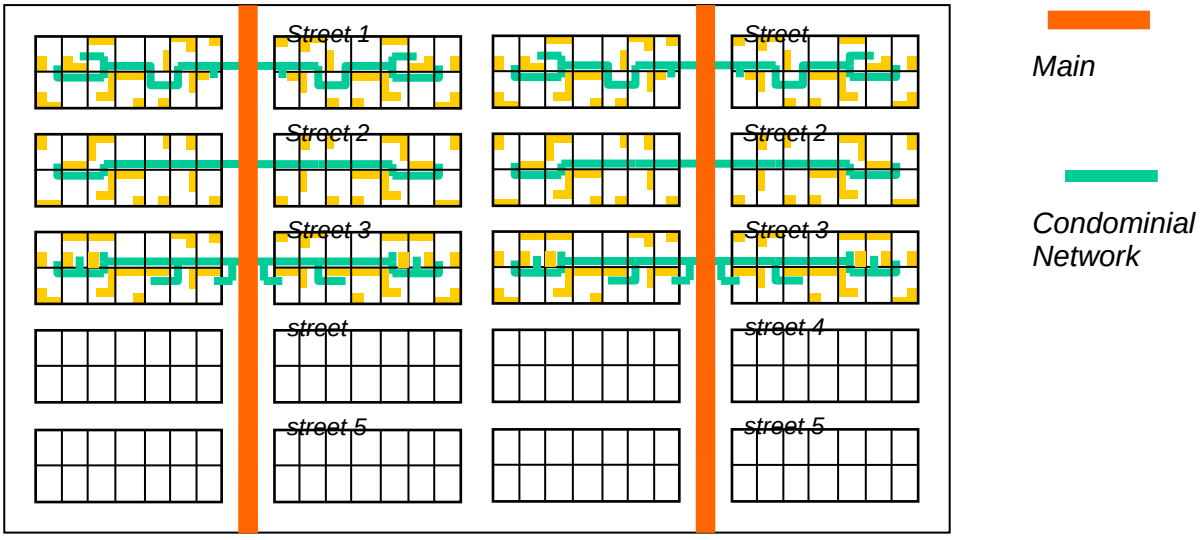
Diagram 1: Comparison of Layouts of Sewers

Conventional System characteristics



Typical layout of a conventional network

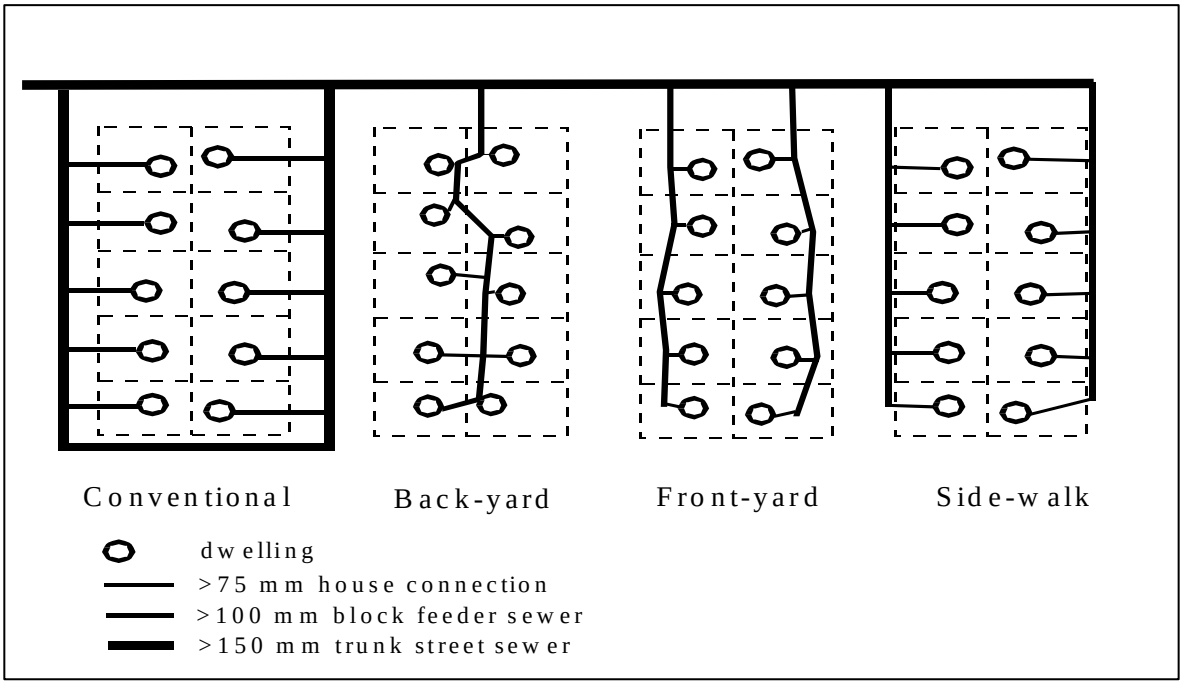
Condominial System characteristics



Layout of a condominial network

There are three options for the positions of the condominial sewer. They can either be laid down the mid block in the back yards of the houses, or in the properties of the houses but in their front yards, or they can be laid under the pavements in the local authorities property. Diagram 2 depicts these options and shows the comparison with conventional sewers.

Diagram 2: Options of Shallow Sewer Configurations compared to Conventional Sewers



2.4 Overview of Technical Aspects of Shallow Sewers

The Shallow Sewer system is a gravity system, which provides exactly the same level of conveniences as a conventional waterborne sanitation system. The collector mains are designed and constructed to conventional full waterborne standards. The condominial sewers on the other hand are designed to be laid in un-trafficked areas that do not carry heavy loads. Because they are laid in un-trafficked they are laid much shallower than conventional sewers. The pipe diameters are also smaller than conventional sewage pipes, which provide better solids transportation with lower flush volumes.

Diagram 3: Comparison of Shallow Sewer with Conventional Sewer

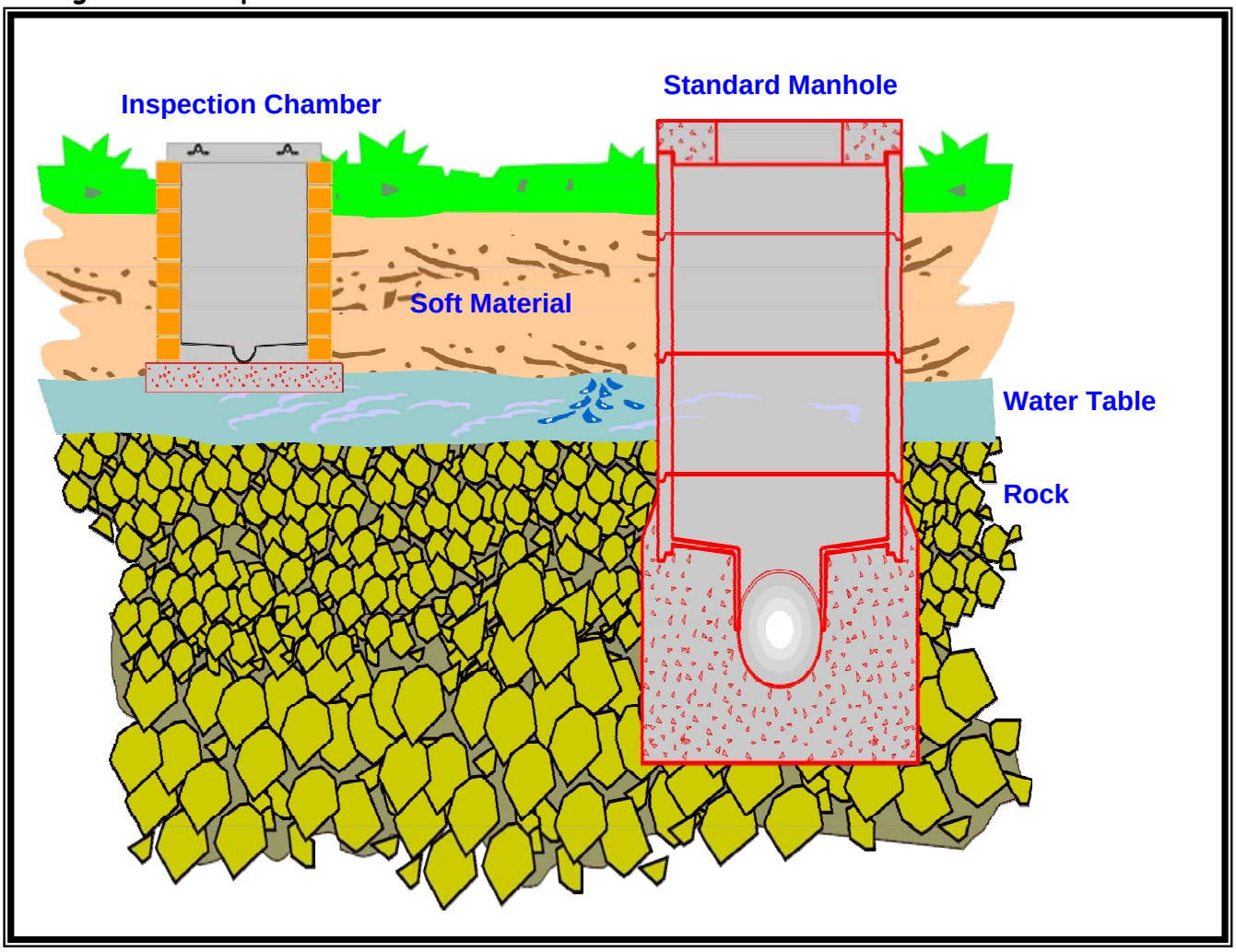


Diagram 3 graphically indicates the differences in:

- Depth
- Size of manhole
- Pipe size
- Volume and type of material excavated

Because condominium sewers are laid shallower than conventional sewers it is not necessary to have manholes in order to gain access, as everything can be reached from the surface. Small access chambers are then provided instead of large conventional manholes.

3 Implementation of Shallow Sewers

3.1 Introduction to the Model used for Implementation

The WRC Report (13) highlights that a number of different simplified sewerage models have evolved. The prime difference between these appears to be how the management of the system has evolved, and these differences apparently evolve due to different local conditions and attitudes.

With no South African experience of consequence to use as a guide, the implementation and management for the Ethekwini pilot was based on the successful model used in La Paz, Bolivia as imported by the WSSA and its Project Manager Miguel Vargas who had extensive experience of the implementation of this model.

The model has evolved out of a community environment with very low access to capital resources, but with a strong culture of "self-help" coupled with a reasonable technical ability in the building environment. The communities have a structured leadership in the form of small local community committees. The commitment to community is strong and community work parties are often seen as a social event as much as a means of achieving an end.

According to Vargas WRC 1146/1/03 (19), the objectives of the Shallow Sewer model go way beyond the mere provision of a sanitation system, and should provide social development and upliftment. This includes community leadership development that encourages communication and therefore reduces mistrust, which ultimately should lead to the pooling of resources and the limited social capital and therefore encompasses many of the principles of poverty alleviation. The methodology is not confined to the development of Shallow Sewers but may be used for virtually any social upliftment program and there is anecdotal evidence of it being used for urban environmental greening and even local crime fighting.

Table 1 shows the steps in the Implementation of Shallow Sewers, based on the La Paz model and gives an indication of the time to implement each step. The size of the implementation will obviously affect these times, but those shown are as they were developed in the Ethekwini pilot.

Table 1: Steps in the Implementation of Shallow Sewers:

1. Institutional and community arrangements (4 weeks) During which community and institutions agree on the scope, involvement and resources provided by each party
2. Cadastral and social characterisation (5-6 weeks) Make investigations to provide a socio-economic survey report including a list of key issues to be considered during later project stages. Undertake technical and geo-hydrology assessment (if applicable) to define condominium groupings.
3. Health and hygiene education and community strengthening (2-4 weeks) Tools and strategies are developed for community interaction. The community is trained in health and hygiene and awareness, using participatory tools that equip them to assess their own sanitary condition. Activities take place to build trust between project team and community. Key people to represent condominiums and institutions are identified and listed.
4. Definitive design, task planning and agreements (8-10 weeks) An agreed layout and design is done in consultation with the community. Community makes an informed decision about the type of services they want and are willing to pay for. Key persons and institutions of supporting community awareness process are trained. A detailed and realistic schedule in developed in agreement with the community. Legal agreements are drafted.
5. Works implementation (10 weeks) The community constructs the condominial branches of the system, has ownership of, and understands the proper use of and implications of abusing the system, having received operation and maintenance training.
6. System consolidation (2-4 weeks) Houses are connected to the Shallow Sewer system. The community starts to use the system in a sustainable manner and evaluates the system. Any problem areas are resolved. This would be the final step requiring funds from the PHB subsidy. At the end of this phase, the houses should have functional wet cores that drain into the Shallow Sewer system. All training would have been completed to enable the people to maintain the system themselves.
7. Systemisation and final evaluation (2 weeks) Results of the implementation of the methodology are analysed. Project experiences are formalized and reported on. Any subsequent modification made to the system would be funded by the community
8. On-going social maintenance (on-going) The cost of this would not be included in the subsidy but would have to be born by the local authority as part of their sanitation services management. This may include any further intervention, such as assistance with maintenance and / or administration; re-training; community structure strengthening; or anything relating to legal agreements. The community who purchase their own materials and tools should do system maintenance. Any further social intervention costs deemed necessary would have to be born by the service provider or be paid for be some other funds.

One of the strengths of the implementation model is that it recognises the need for confidence building between the community and the implementing agent, and vice versa. This is given substance in the model by using "milestones". At the outset of each step a number of goals or "milestones" are set to be achieved in each step. "Milestones" are set for both community goals as well as implementing agent goals. At the end of each step there is an evaluation phase which evaluates the achievements relating to the "milestones". This in-built process serves to build a strong working relationship between the two parties.

Another feature of the model is that if one observes the implementation steps, it is noticed, that in general the cost of each successive step increases. Another purpose of the milestones is to provide the opportunity for the developer and / or the community to back out of the project before too much expenditure is incurred.

At the "milestones", if both parties have not achieved their objectives then only the following options are available.

- The defaulting party can rectify its default.
- The parties can accept the default, but the consequences of the non-compliance need to be thoroughly understood by both parties.
- The implementing agent must walk away from the project. This may be temporary or permanent.

3.2 The Management Structure for Shallow Sewers

A number of different management structures need to be considered, but broadly they fall into two groups.

- Management of the Implementation.
- Operational Management of the Shallow Sewers.

Special mention also needs to be made about the ideal structure for the local authority.

3.2.1 Management of the Implementation

As the Shallow Sewer technology is community-based and is structured to empower the community, community involvement is imperative. At the start of the project, the main component of the community management structure was the Community Committee for each of the sites. Part of the assessment of step 1 is to determine the strength of this management. This Committee is also the introductory point for the implementing team, and it is assumed by the model that such a structure exists and that it is reasonably functional.

One of the tasks during step 2 of the implementation model is to define the condominium groupings. This effectively introduces another subdivision in the social management structure. This subdivision is not politically based but comes from technical and topographical requirements, and provides the community with an authority which is closer to a personal level.

During the implementation phase the condominium structures are used for all the interaction with the homeowners. The community committee is used as the link between the implementing agent and the condominiums as well as providing fora for communication with the community in general. Specifically, tasks like the health and hygiene education are undertaken at community level whereas the tasks excavating and constructing the sewers are undertaken by condominiums. Part of the objectives of the methodology is to reinforce the power of the condominiums and thus develop a strong independent non-political community structure capable of maintaining the sewer system.

It is important to note that the Shallow Sewers have an interdisciplinary philosophy whereby no single party is more important than another, and the whole is more important than any of the parts. Thus, although there are a number of management structures, the style is very participatory, with the aim of finding compromises which are acceptable to all.

3.2.2 Operational Management of the Shallow Sewers

In the La Paz model, the condominium structure is constituted as a legal entity, headed by and elected chairperson. The chairperson was supposed to be responsible for all the activities of the condominium including the maintenance. The Municipality was then supposed to provide a contact person who could be approached by the condominium leader for support. In the model the contact person ideally should have provided primarily a public liaison role rather than a technical one, as in theory, the members of the condominium should be able to solve all their technical problems themselves.

Thus from an operational point of view there are three parties which need to contract with one another in various permutations. These are the homeowner, the condominium and the local authority.

3.3 Local Authority Structure to Manage Condominial Sewers

Community based service provision, is a philosophy and in the ideal a local authority which wishes to implement community based service provision should adopt this philosophy for all service provision. It then requires to structure itself accordingly.

This entails providing a department dedicated to the management of social structures within the communities, thus it includes not only community liaison personnel but social workers and sociologists. The community liaison personnel need to be in close contact with the communities at all times both during project implementation as well as during the on-going operational phase.

The social department should be identifying the needs of the communities as well as identifying the stability and therefore the "ripeness" of a community for interventions. This implies that the social department should initiate the project and should be involved right from inception all the way through to and including the operation of the service.

4. Overview of the Pilot Areas

4.1 Identification and Selection of Communities

4.1.1 Selection of Communities

The Homeless Peoples Federation, an NGO, were in the process of looking to develop a green fields site of Briardale, using their "self-help" scheme. Through third parties they had approached Water Research Commission with the view to using this site as a pilot to investigate the application of Shallow Sewers in South Africa. At the same time Ethekwini Water Services were interested in finding a cost effective waterborne sewerage system to complement their semi-pressure roof tank water supply system. Simultaneously, but independently, WSSA approached EWS with international donor money to be used to pilot Shallow Sewers in Ethekwini. For administrative reasons EWS approached both WSSA and WRC with the view to combining the two opportunities into one project. This was accepted by all parties.

In addition the Emmaus community had approached EWS to solve their sanitation problem, which was that they had installed a patented pour flush septic tank system that was no longer operational. The Emmaus community had already used their Provincial Housing Board subsidies on their development and toilets, so there were no funds to provide them with an alternative system.

Notwithstanding, the approaches by the Emmaus community, EWS prevailed upon Ethekwini Municipality Department of Housing to shortlist a number of potential housing development sites, which were potentially suited as pilot sites for Shallow Sewers. Criteria such as their proximity to existing sewerage, and whether their development timing suited the envisaged Shallow Sewer project timing were used. Built Environment Support Group (BESG) was employed to undertake a social evaluation of the 5 short-listed communities with the view to choosing the preferred sites.

As it transpired Briardale and Emmaus were found to be the most suitable, and as there were sufficient funds available, projects were initiated at both sites.

The social evaluation undertaken by BESG for the selection of the sites was used as the social status quo evaluation as required in implementation Step 2 Institutional and Community Arrangement of the La Paz Model.

4.1.2 Pilot Communities

Emmaus is situated in the Pinetown area, adjacent to the Westmead Industrial area being hemmed in by the N3 national highway and industries, leaving no room for expansion. The community, which had been developed about 12 previously ago, comprises 95 homes, each on its own plot, with no neighbouring communities. Some houses are made of concrete block and some of a fibreglass type material. Some householders have built informal buildings for extra accommodation. In addition the Emmaus community had already used their housing subsidies and therefore did not have funding available to them for water connection fees and materials that they needed to connect to the Shallow Sewer.

The Emmaus community had water supplied through four standpipes. Sanitation was provided in the form of patented septic tanks, and self dug pit latrines. The septic tanks were unable to be serviced by the community and when full caused considerable discomfort and health related problems to the community. There was a "Redibord" electricity supply as well as roads and drainage that were reported to be in an unsatisfactory condition. The area is very steep and hilly.

Briardale is situated in the Newlands West area bordering the road to KwaMashu. The Briardale community consisted of 155 families who were part of a green fields housing development that was

being managed by an NGO, People's Dialogue, in association with the Homeless People's Federation (HPF). People's Dialogue was processing an application to the Provincial Housing Board, through the Ethekwini Municipality Housing Department, for housing subsidies. People's Dialogue were also to act as the developer, to manage and facilitate the housing project, using the "People's Housing Process" where people build their own houses, thereby enabling larger houses to be built for the subsidy amount. By the end of the research period the subsidy application had not been successfully processed for a variety of legal and land issues. However approximately 65 houses were constructed, even without the subsidy, using the people savings and finances organised by People's Dialogue and the HPF. The pilot study intervention was undertaken in accordance with the overall management by People's Dialogue.

The Briardale community had only one communal standpipe and nine chemical toilets. There was no electricity, roads or drainage. The area is fairly flat with few trees.

Emmaus was selected because of its "willing and energetic committee, newly elected and keen to undertake improvement projects", although it was "difficult to assess the potential of the local organisation on account of the very recent election of the committee". Risks identified were physical isolation from other residential areas and that the "new committee had no track record in development implementation."

According to BESG, (1) who undertook the status quo evaluation at both sites, Briardale was described as having a community "organisation with the experience and the commitment to undertake a collective service development project" and "significant organisational experience in implementing a participatory development project". The only risk identified was "that the physical layout of houses may not fall within plot boundaries".

Briardale and Emmaus "ranked sewerage provision in their top three development priorities", it was noted by BESG, (1) that "the areas were cared for with no refuse lying around" and "community structures saw their role as being to improve the provision of services and quality of life in their areas".

Both communities had expressed great desire and willingness to participate in this pilot study.

4.1.3 Control Communities for Research Comparisons

In order to compare Shallow Sewer with conventional sewers it was necessary to find control communities of similar social background as the test communities, who had been provided with conventional waterborne sewerage, in the same geographical areas. Nazareth near Pinetown was selected as a control for Emmaus, and Riverdene in Newlands West, for Briardale.

The controls selected turned out to be good choices. Nazareth has a mixture of very poor to relatively wealthy occupants, as does Emmaus, while Riverdene's population has average to poor incomes, as does Briardale. Also the length of time the people have lived in their homes is similar, with Briardale and Riverdene inhabitants being fairly new (1-3 years) and Nazareth and Emmaus usually having occupied their homes at least 5 years. The type of home in Riverdene, however, is smaller than in Briardale.

4.2 Management of Ethekwini Shallow Sewers

The Ethekwini Municipality is not structured as a community based service provider, but operates by providing a number of service departments operating under clusters. The provision of sanitation to houses does not fall under one single department or cluster, but requires the services of the Housing, Health and Wastewater Management and Water Departments for different facets of the full water service provision.

Under the provisions of the public/private partnership agreement WSSA were to undertake the implementation phase of the project and the Department of Wastewater Management was to take-on the overall responsibility of retaining the system once the final systemisation and evaluation phase had been completed.

A number of factors are pertinent to the management of the implementation phases of the project.

The Emmaus community had already received their Provincial Housing Board (PHB) grants for housing provision. As the wet cores (water connections and storage, plumbing, toilet systems and sewer connections) are considered part of the house and not part of the water or sanitation system, it was the responsibility of the homeowner to generated the funds or provide their own wet cores.

At Briardale where the housing development had only recently commenced, and the PHB subsidies were being applied for, the housing developer was responsible for providing the wet cores. Funding for these was very slow.

The lack of provision of decent wet cores at both communities had serious bearing on the management of the Shallow Sewers pilot project. At the time of writing the consolidation and final evaluation phase according to the La Paz model had not been completed and EWS had not taken over its responsibility.

In terms of the community management of the system, the communities were organised according to the La Paz model with functioning community committees. The condominium structures were also formed and legal agreements drawn up between the condominiums and its members as well as between the condominiums and the Ethekwini Municipality.

However the legal status and enforceability of the legal issues are questionable. At Emmaus, where the homeowners have title to their individual lots, the legal status of the Shallow Sewer and the necessary requirement that the homeowner must be a member of the condominium is not written into the title deeds and are therefore not enforceable. Briardale has been developed under the Community Property Association Act, and the necessary legal arrangements for the formation of the condominiums have been written into the community property owners' constitution.

Not withstanding the above it is questionable whether it is worth contracting when in the case of default the defaulter has insufficient property of value to make any lawsuit practical.

4.2.1 Social Intervention

The social interventions were conducted in line with the La Paz implementation model. The prime method of communication was by conducting workshops and community meetings.

Educational communication, such as health and hygiene education was conducted in small groups. These groups were generally condominium based. One of the problems associated with this form of communication was finding a time that suited the whole group, as limited time windows were available to those members of the community that worked. It is also important that as many members of the community as possible are exposed to the educational sessions, however it is vital that at least one senior member of each family receives the full education.

Decision-making exercises were usually conducted in formal meetings, either in committee or in general mass meetings depending on the nature of the decision. In general where possible the issues of problem identification and problem resolution/solving techniques were developed under workshop fora.

The dissemination of technical information and skill was generally undertaken in small groups. The modus operandi was to identify a few technically skilled people or champions from each condominium and then to conduct skills training for these people, the idea being that these people would then act as team leaders or mini contractors in the community.

In many community-based interventions, education programs are implemented in the local schools to educate the children. As neither Emmaus nor Briardale have dedicated local schools, this form of education was not used in the Ethekwini Pilot.

During the intervention it was reported that the Emmaus Development Forum suffered from "a critical lack of institutional management capacity" which was adversely impacting on the pilot study. VISTA Planning Consultants provided institutional development training to remedy the situation. (18)

4.2.2 Technical Intervention

Step 4 of the La Paz implementation model provides the community with the opportunity to be directly involved in the layout design of the Shallow Sewers. A preliminary design is undertaken which is then presented to each householder who then is expected to discuss his/her plans for home improvements and extensions for the future. As the Shallow Sewer is not confined to servitudes or to run along boundaries the homeowner's input has significant bearing on the sewer layout and design.

As the construction is undertaken by the community at condominium level, supervision is critical as the ability of individuals varies considerably. The skills training therefore needs to be "standards" based. Construction supervision needs to ensure that these minimum standards are achieved.

A specific aspect that both highlights the above comment and has bearing on technical design considerations is the relationship of the size of the access chambers to appurtenances such as bends and tees. As the access chambers are small (600 x 600mm square) the positioning of the chamber over appurtenances is critical to allow reasonable radii on bends etc of the appurtenances as well as providing space for radii on the rodding equipment.

The approach of reducing the construction standards has both positive and negative spin-offs. In general most of the spin-offs appear to be positive, such as all of the effects on construction and maintenance and hence cost, due to simply laying the sewer at a shallower depth. However, certain technical disadvantages to this approach were noticed. For instance the grease traps, which were originally constructed from rectangular buckets to save costs were totally unsatisfactory and had to be changed.

4.2.3 Project Management

The main issue that arose in relation to the project management was the mismatch between fixed term contracts, which implies time related management, and community/social management, which implies that the interventions proceed at the rate of community development.

Both the social consultant and the Project Manager were on restricted time and financial contracts. Hence all tasks had to be completed within a certain time frame. Working with communities in this type of project does not lend itself to such restrictions, and both incumbents were frustrated at having to hurry certain aspects instead of doing them thoroughly. When these parties left the site, certain critical interventions had not been completed, necessitating a change in management at a critical time in the project.

These problems would not have occurred if the service provider had the resources to undertake such interventions in-house at a pace more suited to the pace of skills assimilation in the community. Continuity of management is also important in maintaining community commitment.

4.2.4 Operation and Maintenance

Once the project implementation was complete it was intended that the Systems Branch of Ethekwini Water Services would take over the running of the project. It was planned to train the appropriate Ethekwini staff to sensitise them to the project, the agreements and the roles and responsibilities of both the Municipality and the community. Although this training had not taken place at the time of writing, WSSA continued to make the offer available to the EWS staff.

Reasons for Setbacks

At both sites the implementation process has stalled at the "System Consolidation" phase, Step 6 in the La Paz model, in that the connection rate to the sewers has been very poor. At Emmaus, the community did not have sufficient funds available (see section 4.2.5) to develop their wet-cores, and the Steering Committee has adopted a "wait and see" attitude to see if the community do eventually provide their own wet cores and manage the system.

At Briardale the housing developer under-performed and the housing development has not yet been registered and therefore the PHB subsidies are not available. Although monies were made available to the community, through a loan, to install "basic" wet-cores, which have been completed for the existing houses, the community has rejected all development that it associates with the housing developer, including the Shallow Sewers. This has meant that EWS staff has been excluded from the site.

Not withstanding the above, generally in both communities it was found that the condominium (Iqoqo) leaders did not continue to manage the condominiums well over the research period, although there were exceptions to this at Emmaus. These exceptions could, perhaps, be attributed to the fact Emmaus is a well-established community and, therefore, they may be more self-reliant.

4.2.5 Payment

Although it runs against the general philosophy of Shallow Sewers methodology (as per the La Paz Model), payment was made to the communities for installing the sewers. There were a number of reasons for this. Firstly, at the out set of the project it was realized that the majority of homeowners at Emmaus would not be able to afford the cost of their wet cores as they had already received their PHB subsidies. It was the intent that payment for construction would provide the poorer members of the community with start-up capital for their wet cores and water connections. Secondly, the precedent had been set in that the Ethekwini Water Department provides payments for the construction work undertaken by the communities. Thirdly, there was political pressure to pay for this effort.

In the case of Emmaus it had been the original intention that the monies would be held in trust until payment for the wet cores was required. However there was considerable political and community pressure to make this payment on completion of the construction. When monies were required for the wet-cores very few of the members had managed to save any.

To overcome this problem, special provision was made in the accounts branch of the EWS to allow these potential customers to save for their water connections. Unfortunately very few of the homeowners made use of this facility.

5 Milestones and Achievements of Piloting Shallow Sewers

5.1 Implementation Strategy of Shallow Sewers in Ethekwini

Social Mobilization

The Shallow Sewer methodology proposes to create conditions in the intervention to inform the community about their sanitation problems, to encourage and to give them the tools to participate in solving such problems. The intervention provides training in health and hygiene awareness and team building, as well as technical skills.

The social intervention entailed the execution of all the activities described in the "Social Intervention Model For Implementation of Condominial Sewerage Systems" proposed for the Ethekwini Shallow Sewerage Project (16). Besides facilitating agreements with the communities and the social characterisation, tasks included working with the communities to plan and construct the sewers while providing training and capacity building according to the methodology. Once installed, all households were provided with a simple yet comprehensive instruction book in Zulu on how to maintain the system. (Shallow Sewerage System: Instruction Book) (Available on request)

The implementation of the Ethekwini Pilot Study was undertaken according to the La Paz model, as shown in Table 1: Steps in the Implementation of Shallow Sewers, in section 3.1.

All went as planned up to the end of Step 5 (Table 1) when by November 2000 the Shallow Sewers had been completed successfully in Briardale and Emmaus (apart from one condominium at Briardale that was delayed while a police station was relocated). The project team connected two 'show houses' to the sewer for demonstration and training purposes.

Seven condominiums (Iqoqos) were planned at Emmaus comprising 96 houses, one of which (Iqoqo A with 17 houses) was excluded from the project because they did not accept the semi-pressure water supply. The sewerage system was completed for all condominiums and all houses, except for Iqoqo A, which had no drainage or water.

At Briardale there were ten condominiums, two of which had no houses built and another two with only one house in each. The sewerage system was completed for all condominiums and all 157 plots.

Various delays (See Section 5.2) prevented the expected numbers of connections to the sewers and the use of the system in a sustainable manner (Step 6, Table1)

Social Intervention

The social intervention has been well documented. Reports written after the social intervention and the construction of sewers record the project issues and dynamics encountered in the implementation and highlight the complexities of community development within a limited project timeframe. They also lay a good foundation for the possible replication of this technology in the South African context. More information can be found in the reports WRC 1146/0/03 and by LIMA who produced interim reports at each stage of the intervention and a final report (4), aimed to provide a consolidation of their learning experiences.

5.2 Implementation Problems Encountered Affecting Progress and Delays

The final completion of the project has been delayed considerably. There are three main reasons for the delays.

5.2.1 Management Issues

The contractual arrangements for the Project Manager and the Social Consultants had time restrictions although both contracts were extended. However, both the parties left the project at the end of the works implementation phase when only two houses in each community had been completed and connected to the sewer and water supply. At this point WSSA appointed a quality control engineer who operated on a part time basis. It was also at this point in the development when serious social issues in both communities surfaced. Due to the delays being experienced in the wet core development and system connections and the accelerating development of these social issues, it is understandable that the Project Manager's stay could not be extended any further. However his ongoing presence and interaction with all parties may have assisted in resolving the developing impasse.

In retrospect, because the project took much longer than anticipated, there were significant personnel changes to the project team during the implementation, which affected the communication with the communities.

5.2.2 Housing Issues and Packaging

Water Supplies for Building.

Both test communities had problems with water supply at the start of this project. At Briardale there was only one standpipe for a whole community where houses were being built and water was needed desperately for building. At Emmaus the number of standpipes had been reduced from four to one or two due to non-payment by some of the bailiffs.

Plumbing and Plumbing Training.

In both cases the communities were expected to install plumbing and connect to the sewer. Communities need skilled resources for plumbing and these did not exist in the communities.

Although some plumbing training was provided at Briardale the initial plumbing training provided did not prepare the community for resolving even minor issues and the community complained that training was insufficient for them to install wet cores and plumbing to a satisfactory standard. After more intensive plumbing training the trainees were still unable to resolve many problems and therefore it is suggested that the education be taken one step further to include troubleshooting.

The Shallow Sewer training cannot be expected to provide adequate plumbing skills for a community to plumb their houses to a satisfactory standard. In subsidised housing projects, funds should be allocated for the services of skilled plumbers to install wet cores and make sewer connections as part of the housing package, even when using the People's Housing Process. The Shallow Sewer training should enable the community to understand and maintain their system. The community should participate in the construction of the sewer but under the guidance of a skilled supervisor.

Ethekwini Health officials identified certain technical problems (19) in which were causing odours and possible contamination risks for the owners of the houses in question. These were found to be caused by poor plumbing and building rather than to Shallow Sewer defects. Nevertheless, there were faults with inspection chambers and grease traps that were part of the Shallow Sewer design. Increased support and guidance from the joint venture in assisting the community to resolve their issues may have alleviated some of these problems

5.2.3 Housing and Household Issues.

In the pilot study at both communities housing issues complicated matters significantly.

Although the installation of the sewers was completed on schedule at Emmaus to all condominiums except one, which was excluded, the final stages of the intervention were not completed because only 24% of households managed to make their water connections and 11% their sewer connections. The main reasons was an inability to pay for water connection fees and/or materials needed for wet cores and plumbing.

The Briardale project was inextricably linked to the housing process, which suffered great setbacks with only 42% of the 155 houses actually being built. Installation of the sewers for the entire community of 155 plots was completed according to schedule. Nevertheless, 74% of houses built managed with assistance, to connect to the sewer. WSSA had to step in with financial assistance, delivery of materials and tools, and a plumber to assist the community to make their connections.

The delays in houses being connected at Briardale meant that there was ingress of sand and rubble into the sewer because of temporary measures used to seal the unconnected sewer pipes. Blockages resulted that frustrated the community and WSSA had to hire a contractor to flush out the entire system and to purchase end caps, which the community used to seal the unconnected pipes.

The Emmaus community was offered the same assistance to flush out the system and install end caps but they refused to provide the labour so the work did not take place.

Semi- Pressure Water Supply and Political Promises at Emmaus.

Certain of the more affluent members of the community at Emmaus wanted a full pressure water supply. The majority of the community wanted semi-pressure and the policy of the Ethekwini Water Department was to supply only one level of service into a community. The unhappiness this created led to Condominium A withdrawing from the project.

Local Council elections occurred during the project, and one of the aspirant councilors promised "free water for all". The aspirant councilor and, subsequently the community, undertook this to mean that all water, at all service levels and including all connection costs would be provided by the Council free of charge. This undermined the premise under which the project was undertaken and the community would no longer uphold their side of the agreement and make their water and sewer connections.

As a result the implementation team, after negotiating with the community, withdrew from the project and did not complete the plumbing training and technical support. It was decided to leave the community to their own devices to connect as and when they wanted to. Monitoring was continued and the research program was adjusted to evaluate and quantify the perceptions of the Emmaus community about Shallow Sewers. (19)

Collapse of the Housing Project at Briardale.

The implementing agent for the housing development at Briardale under performed in general. But primarily they failed to get the housing development registered with the Provincial Housing Board, which meant that the housing subsidies were not forthcoming. Initially this caused huge delays with providing funds for the supply of plumbing materials for the wet-cores, which subsequently delayed the plumbing training and plumbing.

This under performance subsequently led to the undermining of the community committee and the collapse of the housing project. With this collapse, the incumbent committee and the community subsequently rejected all development it associated with the previous regime and housing developer.

Included in the manifestations of this problem was that the staff associated with the Shallow Sewer project was and still is barred from site.

5.3 Limitations

It was unknown whether there were sufficient sewer connections to properly evaluate the system as a method of conveyance. At Briardale most of the houses that were built were connected to the sewer system, which may be sufficient to draw conclusions about the system in some condominiums. However at Emmaus there were so few connections that it is unlikely that any conclusion could be drawn about the system.

6 Lessons Learned from the Implementation of Shallow Sewers

6.1 Project Management

An essential lesson learned from this experience was that, besides requiring extensive participation by the community in the installation and maintenance of the system, this technology also requires extensive support and participation by the service provider. It was realised that community project management required that sufficient resources be allocated until the community was able to manage. Perhaps this is specific to the South African context where communities require more guidance and motivation than South America, for example. In this instance, it may have been beneficial to have drawn into the team other municipal departments dealing with the housing, treasury and others to ensure an integrated approach to development of the area as a whole.

In South Africa for a project to succeed it is better to spend sufficient time and effort in the early stages on understanding the community needs, getting their commitment and providing the necessary training and capacity. But once that is done it would be better to get in and complete the project as quickly as possible to prevent delays. If the groundwork had been done well, many of the delaying issues would become irrelevant once the system was operational.

6.2 Management Problems

This occurred due to an unfortunate combination of circumstances in the project management, for which no particular party was to blame. It was, however, a major problem for the project that all parties had moved their direct site management off the Shallow Sewer project from November 2001, with ad hoc visits and meetings thereafter, leaving the communities without the ongoing day-to-day support that would have assisted in resolving their problems.

It is recommended that, to minimise problems, the same project team should be maintained throughout, if possible, to provide continuity. As soon as the players change those who take over do not understand exactly what training and education has taken place and to what extent, or what issues the development has been built on. Reports cannot capture or replace the experience in social interventions.

6.3 Lessons learned about Community Participation

The social intervention is a very important component of the Shallow Sewer methodology. It has merit in that it builds capacity in people to enable them to undertake development for themselves. A tentative conclusion drawn from this research was that people had fewer complaints about their services, even when experiencing difficulties, because of the social component of the Shallow Sewer intervention. This was demonstrated in the report on quality of life and customer satisfaction in the WRC report 1146/1/03 (19), where fewer general complaints were received from people living in Shallow Sewer communities than from those in the control areas with conventional waterborne sewerage.

The Shallow Sewer methodology expects that the people involved will provide their "sweat equity" labour free of charge. This does not seem to be feasible in South Africa. An attempt was made to get the communities to work free of charge but this was refused. BESG (1) reports that all five communities, scanned for suitability in the pilot study, indicated that they would expect payment for their labour.

The social intervention failed in many ways due to the management of the project. No matter how good the methodology was in building capacity in people, there were financial and technical limitations that the community could not overcome without support.

6.4 Condominium Management

Generally in both communities it was found that the condominium (Iqoqo) leaders did not continue to manage the condominiums well over the entire research period, although there were exceptions to this at Emmaus.

At the start of the project, immediately after the workshops, it seemed likely that both communities would use the condominium structures to manage not only the Shallow Sewer system but also other affairs, such as community finances at Briardale. However as time progressed and there was little on-going social support, management by condominium seemed to have lost popularity and fade as a mechanism. There was a particular difficulty at Briardale as the entire community was not already settled there and consequently communication and education did not always reach all those concerned.

6.5 Selection of Communities

The choice of community is important. Both communities selected turned out to be poor choices for Shallow Sewers because of interfering circumstances. Shallow Sewers may not be suitable for green fields developments where the full community is not present. The whole community should be available to participate in all stages of the intervention from establishing agreements, planning and design through to maintenance.

Thus for green fields it may be preferable to install the infrastructure through contractors.

6.6 Revise Methodology for Community Dynamics

In this pilot study community issues and dynamics affected the social intervention to such an extent that it was concluded that this aspect requires far more attention in South Africa than it was given. Communities should be investigated in sufficient detail to be able to predict the changes that the intervention will impose on the community. The social scan was insufficient to provide this degree of understanding. The type of changes that occur are additional stresses on the leadership, such as ensuring that roles are allocated to community members and that allocated tasks are undertaken, that any conflict is resolved and that obstructive people who hamper progress can be dealt with.

Community dynamics plays such a significant role that it was suggested that it be catered for, as an additional category that should be developed in the methodology for South African communities. This should address the management of change and deal with the various power plays, leaders and other motivators.

6.7 Political Influences

Certain influences are beyond the control of implementing team. This was highlighted when the project team did not foresee the potential impact of a new councilor who was not made aware of the details and objectives of the Shallow Sewer intervention. In this instance the local government elections, occurred during the project. One of the prospective councilors made promises of providing free water and sanitation that was taken to include the cost of connections and wet cores. This seriously undermined the tenets of the intervention. Even if the project team had foreseen the problem in advance, it is unlikely that they could have done much to influence the impact on the project. This illustrates that there is no mechanism in the political system to deal with political promises that do not align with mainstream understanding or the tenets of the project.

6.8 Housing and Service Delivery Process

The project team anticipated that the Shallow Sewer intervention would be ideal at Briardale because of the background of the people and their willingness to participate in their own development. However the slow housing delivery process thwarted the enthusiasm at Briardale. The subsidies were not approved during the research period and the housing project ran out of funds. Consequently many people who continued to live in shacks on their plots felt marginalised being deprived of housing, water

and sanitation. In addition the planning issues had delayed the delivery of roads, street lighting and electricity provision, which caused further dissatisfaction in the community. This background was not conducive to the success of the Shallow Sewer intervention.

6.9 Successes

The part of the intervention dedicated to health and hygiene awareness education provides substantially more than that. The social consultants (LIMA) undertook a series of workshops with the communities that, in addition to health and hygiene training, also focused on communication, identification and solution of one's own problems, community development and working together to benefit from pooling their skills and intellectual capital.

In spite of all the difficulties, it appeared the system was operating reasonably effectively from a physical point of view and there was evidence that knowledge transfer on the operational approach took place. However, the lack of capacity, knowledge and "understanding gaps" resulted in the approach to management of the scheme being reactionary with residents merely reacting to problems as they arose rather than being pre-emptive.

The study showed that Shallow Sewers can provide all the convenience and benefits of waterborne sanitation at half the capital cost of conventional sewers and that they may even compare favourably with the cost of pit latrines. (See Section 7.1)

The Shallow Sewer System may be an excellent sanitation solution to providing a "water and sanitation package" to South African Communities. However there are legal issues to be resolved before this becomes a viable option for service providers.

One of the features of this technology lies in the social development of the communities. To achieve this, requires knowledge and dedication on the part of the implementing agency. Key issues to the sustainable operation of this technology are community participation, financial and institutional management, as well as clear, consistent political and leadership objectives and policies.

7. Research Findings from the Shallow Sewer Study

7.1 Capital and Installation Costs

Capital cost Comparison with Conventional Sewers and VIPs
Shallow Sewers can be installed at significantly reduced capital costs. The results of the evaluation demonstrated that Shallow Sewers could be installed at approximately 50% of the capital cost of conventional sewers, if the costs are "ring-fenced" to the site of the development (i.e. ignoring the capital costs of the bulk reticulation and treatment works).

The "on development project" capital cost of shallow sewers also compares favourably to that of VIPs: i.e. using the same ring-fencing of the costs as above, then the capital costs per household for shallow sewers is similar to that of a double vault VIP. The cost of the social intervention has been included in the capital cost for the shallow sewers, for the purpose of this comparison.

A breakdown of this exercise is shown in Tables 2 and 3 on the following pages.

Cost Considerations and Cost Comparisons
When considering the installation of sanitation systems to a community, the local authority considers both the capital installation costs and maintenance costs.

It has proved both costly and difficult for the Ethekwini Municipality to maintain pit latrines hence viable alternatives would be welcomed.

Cost comparisons between Shallow Sewers installed in this Pilot Study and a tenderer's price to install conventional sewers to the same communities, as well as two independent contractors' prices to install ventilated pit latrines and conventional sewers to low cost housing projects, have been made in Table 3.

The difficulty in comparing costs for sewers and sewering is that they are very site-specific. This can be seen from Table 2 by comparing the Briardale and Emmaus costs. Emmaus costs were much higher due to the steep and difficult terrain, which is compounded by the low number of sites at each community. The two contractors in low cost housing who gave information on their costs, which have been used in Table 3, would have not considered either Briardale or Emmaus to be economically viable. They both stated that 200 sites was the minimum number for a project to be economically viable.

The site-specific nature of sewering can be demonstrated by comparing the relative costs of Shallow Sewers to conventional sewers at each pilot site giving the result of 33.7% at Emmaus and 36.8% at Brairdale. This shows that the proportional costs are similar while the total costs vary greatly.

In order to compare like with like, the wet core costs have been rationalized for the different sanitation types and a superstructure cost equivalent has been added into the conventional and Shallow Sewer options to compare them with the separately housed pit latrines. However the improved level of service and convenience of having water borne sewerage that is housed inside the dwelling would favour Shallow Sewers over pit latrines.

The following cost comparisons have been extracted from Table 3, demonstrating that the cost to install Shallow Sewers up to the collectors is approximately 48% of the cost of conventional sewers and that Shallow Sewers and ventilated pit latrine costs are approximately equivalent:

- Cost to install Shallow Sewer at Briardale = R2914
- Cost of Conventional Equivalent at Briardale = R5618

- Cost of Conventional, on same basis, by independent contractor = R5198
- Cost of VIP*, on same basis, by independent contractor = R3000

*(The cost of VIPs refers to EWS experience confirmed by an independent Durban contractor, which includes an educational component cost, but excludes the cost of bulk infrastructure provision).

The Ethekwini Municipality pay for the additional off site costs to service areas that they wish to develop and the on-site sanitation costs are taken from the PHB subsidy (with top up if applicable). Hence the Shallow Sewer costs, being approximately 50% less than waterborne, must be attractive in the scheme used by Ethekwini Municipality Housing and Planning departments. The question would be the maintenance costs and any on-going social costs, which, as yet, have not been quantified.

The main cost savings come from lower material costs, savings in plant, labour and supervision and includes the additional social costs. Maintenance costs and any on-going social costs to the service provider have not yet been quantified because the Ethekwini Water Services did not take over the running of the project during the study period.

The pilot study demonstrated that installing Shallow Sewers instead of conventional sewers might save 45% to 50% of the on-site capital costs, and that there is little difference between the capital costs of VIPs and Shallow Sewers, apart from the reticulation costs to remove the effluent from the property.

TABLE 2: SUMMARY OF COST SAVINGS BY INSTALLING SHALLOW SEWERS

Costs as of November 2000

EMMAUS			
No. of Households	**96**		
	Conventional	**Shallow Sewerage**	**Savings**
1) Survey, Design and Drafting	R 58,018	R 58,018	0.00%
2) Contract (*)	R 635,945	R 98,383	84.53%
3) Contract Administration/Supervision	R 60,000	R 24,682	58.86%
4) Social Intervention		R 127,620	
TOTAL	R 753,963	R 308,703	**59.06%**
Collectors			R 356,680
Cost per household (**)	R 11,569	R 6,931	40.09%

(*) Refers to the construction contract for the conventional and material provision for the Shallow Sewerage
(**) Including collectors

BRIARDALE			
No. of Households	**157**		
	Conventional	**Shallow Sewerage**	**Savings**
1) Survey, Design and Drafting	R 47,540	R 47,540	0.00%
2) Contract (*)	R 539,200	R 94,921	82.40%
3) Contract Administration/Supervision	R 55,000	R 24,682	55.12%
4) Social Intervention		R 127,620	
TOTAL	R 641,740	R 294,763	**54.07%**
Collectors			R 243,058
Cost per household (**)	R 5,636	R 3,426	39.22%

(*) Refers to the construction contract for the conventional and material provision for the Shallow Sewerage
(**) Including collectors

TABLE 3:

COST PER SITE (RANDS) TO INSTALL SHALLOW SEWERS COMPARED WITH CONVENTIONAL SEWERS AND VENTILATED PIT LATRINES

Data from the table of costs reported by M Vargas **(Table 2)** have been extracted and manipulated to enable a comparison of similar cost elements for the sanitation options shown below:

	Materials, labour and supervision **Rands**	Social intervention **Rands**	Internal reticulation, and wet cores **plus** superstructure equivalent **Rands**	**Total** **Rands**	**Savings by using Shallow Sewers** (Compared with **Briardale** cost)	Comment
Shallow Sewer Briardale (157 sites)	762	819	Allow 800 plus 533	**2914**		Cost excluded wet core costs and internal reticulation costs, hence to compare with independent contractor costs, R800 has been added for internal reticulation, toilet, and shower. At Briardale actually spent R2000 on wet core but this gives an unequal comparison as they purchased superior baths, hand basins and kitchen fittings
Shallow Sewer Emmaus (96 sites)	1281	1329	Allow 800 plus 533	**3943**		
Conventional Sewer Briardale (157 sites)	3785	500	Allow 800 plus 533	**5618**	**48%**	
Conventional Sewer Emmaus (96 sites)	7249	500	Allow 800 plus 533	**9082**	**57%**	
Ventilated Pit Latrine Ethekwini Municipality	2300 (Excludes supervision, transport costs)	500	N/a	**2800**	**-4%**	Includes hole, toilet and top structure (Savings compared with Briardale Shallow Sewer cost)
Ventilated Pit Latrine Independent contractor, (minimum 200 sites)	2500	Not done, allow 500	N/a	**3000**	**3%**	Includes hole, toilet and top structure (Savings compared with Briardale Shallow Sewer cost)
Conventional Sewer Independent contractor (600 sites) (minimum 200 sites)	3365	Not done, allow 500	Allow 800 plus 533	**5198**	**44%**	Includes external sewerage, internal reticulation, toilet and shower (Savings compared with Briardale Shallow Sewer cost)

NOTES:

- Excludes water costs of reticulation and connection; collectors and off-site costs; and survey, design and drafting costs.
- Briardale and Emmaus costs at November 2000, other costs at June2002
- The amount of R800 for internal reticulation and wet core was the amount used in the conventional sewer project shown and the same amount was quoted to install basic wet cores at Briardale, although the community opted to pay extra for more up market products
- The amount of R533 was allocated to give a superstructure equivalent of $2m^2$ used for a toilet of a 30 m^2 dwelling costing R8000 (which is the PHB allocation)
- The social intervention costs for Shallow Sewer were also set up costs to produce the training materials and would be lower if the exercise was replicated.
- Costs saving comparisons were made with the Briardale costs because 157 sites is closer to the minimum number of 200 sites needed to make a low cost project economically viable

7.2 Subsidy and it Implications for Shallow Sewers

The Provincial Housing Board (PHB) Housing Subsidy Scheme is the primary housing assistance measure provided by the South African Government to help households to access housing with secure tenure, at a cost they can afford, and of a standard that satisfies the minimum health and safety requirements.

A system of milestones was established in the PHB housing process to ensure that public funds are utilized and paid out only as and when value has been created. However an applicant may propose how to allocate the funds, according to these milestones, in the negotiation stage. Once this is agreed upon the applicant is committed to a contract that is no longer flexible. The Provincial Housing Development Board considers applications with the view to ensuring successful implementations that do not face adverse cash flow consequences.

Flexibility of the Subsidy scheme in relation to the implementation of Shallow Sewers

The results of this research conclude that there is sufficient flexibility in the administration of the subsidy scheme to accommodate the steps of the Shallow Sewer intervention.

Potential risks to the developer, the PHB and the customer

The following risks were identified for consideration:

- Upfront costs of social characterisation would still be incurred in cases where it was decided not to proceed with Shallow Sewers. The PHB subsidy system makes it possible to access an extra R575 per site for social facilitation on the basis of not having to repay this amount in such cases.

- When utilising PHB funding, developers are responsible for ensuring that houses are built to a satisfactory standard, upon which a housing scheme becomes part of the city's responsibility. The same would apply in the case of installing Shallow Sewers as the sanitation option except that the onus would be on the community to maintain the sewers within their own boundaries. If the community did not maintain and take sufficient care of the sewer as agreed, health risks and sewer blockages may occur. Although legal mechanisms exist in the form of agreements, in practice it is difficult to collect payment from a group.

- Developers or subcontractors appointed to undertake housing developments with Shallow Sewers can easily increase their profits by cutting corners on the social and educational intervention, thereby creating potential risks to the homeowner and the local authority. The system needs to be developed to ensure this does not happen.

The cost allocation of PHB funds to waterborne sanitation by using Shallow Sewer system should assist Ethekwini Municipality to install waterborne sewerage in preference to pit latrines to satisfy its health and maintenance policy. By doing this they should save on both capital and maintenance costs.

The findings indicate that the Shallow Sewer System can be implemented within the costs and timing constraints of the PHB subsidy system. There appears to be sufficient flexibility in the administration of the Provincial Housing Board subsidies to accommodate the steps of the Shallow Sewer intervention as described in the methodology used in the Ethekwini Pilot Study.

From this research no major obstacles could be foreseen, either time wise or cost wise, to PHB subsidy funding being used for a project that included Shallow Sewers as an alternative to conventional sewerage or ventilated pit latrines, provided that the Local Authority would foot the bill for the off-site reticulation of the sewage.

7.3 Legal Implications

Legal shortcomings and incompatibility between the Shallow Sewer technology and South African

legislation were identified. These relate mainly to land issues, contractual issues and changes to the National Building regulations. In some cases there is legal incompatibility and in other cases the legal solution would be prohibitively expensive.

Investigations undertaken by the Ethekwini Municipality Legal Department reported in WRC 1146/1/03 (19) showed that the legal mechanisms available are the same for both sewer systems and are not cheaper for the Shallow Sewer system. However the risks associated with installing Shallow Sewers are higher.

The situation may arise where the Municipality requires a legal mechanism to intervene and, in this case, it is recommended that "omnibus servitudes", in favour of Ethekwini Municipality, be put into the plan prior to approval. The omnibus servitude allows flexibility and Shallow Sewers may be expected to follow new, unplanned routes over a period of time. Once the area was stable, these could be replaced by fixed servitudes, parallel to boundaries, if required. There are costs to register servitudes but these may be managed if undertaken during the formalisation of lots.

It was proposed that the findings of this report be used as the basis of wider research initiative to find a legal solution for implementing Shallow Sewers and other novel, appropriate technologies in South Africa. So as to be cost effective, this process should be taken forward by a multidisciplinary team through a university. Legal models should be investigated to accommodate the range of "Shallow Sewer type" technologies in terms of ownership and servitudes (or similar). (The interdisciplinary approach would be particularly useful in this regard). The scope of such research could include other technologies with similar legal issues, such as (ventilated) pit latrines.

In light of the high cost of time of people in the legal profession when acting in a commercial basis it was suggested that this team be invited to proceed with further investigations into the aspects mentioned above in terms of the Shallow Sewer system.

7.4 Technical Evaluation

- **Pipe Diameters**

  At the head of a sewer pipe the mechanism of solids transportation is one of "hop and settle" as the slugs of flushing volume passes the gross solids. In essence the solid blocks the sewer allowing the sewer to fill behind the solid. This has two effects, firstly the hydrostatic pressure builds up behind the solid and, secondly, as the solid is submerged it becomes more buoyant reducing the frictional resistance. While the lateral pressure is greater than the frictional resistance the solid will migrate down the sewer until such a time that the flushing fluid has passed the partial obstruction. Therefore from a hydraulic conveyance point of view the smaller pipe diameters used should facilitate the movement of waste through the system, as the volume of water in a smaller pipe will provide more lifting and carrying potential.

  However, there were some concerns raised about the diameters of pipes used. The technical team assured the community that the pipe sizes were adequate provided that the correct wiping materials were used.

  Prior to the intervention, only 50% and 33% of Emmaus and Briardale residents respectively made use of toilet paper only as a wiping material. The balance used a combination of other materials that may be less suited for use in a waterborne system (5). After much emphasis was placed on stressing the use of toilet paper as a wiping material during the implementation of the project, later results showed that most people were using a combination of toilet paper and newspaper. This is the reality for poorer communities in South Africa and all sewers for such people should accommodate the use of newspaper, telephone book paper in addition to soft tissue toilet paper.

- **Inspection Chambers**
  The community complained that when they opened up the chambers there was debris collecting which smelled. However it is normal for sewage not to be evacuated at once causing some temporary sedimentation, which should be washed away with high peak water usage. Normally this would not be evident to the user, as it was in this case, because manhole lids should have been sealed using a weak concrete mix to secure the chamber lids, which would have prevented residents inspecting the chambers regularly. Inspection chambers should be opened only when there are problems, thus avoiding unnecessary smells and health risks.

- **Grease Traps**
  Complaints of smelling grease traps at Briardale were found to be caused by some construction and plumbing faults with certain grease traps. Some grease traps that were poorly constructed and leaking on to the ground caused bad odours and mosquito breeding. These faults should have been recognised by the implementing team and the community should have been assisted to rectify problems they were unable to solve alone. However
  EWS and WSSA decided not to intervene in an attempt to evaluate the extent of the social support required.

  During the design phase, the Project Manager insisted that easily accessible grease traps for the collection of oils and fats from the kitchen be installed such that householders could identify and clean blockages with minimum effort. However, the experience suggests that South African residents would prefer a closed system such as that used when building to the National Building Regulations, whose standards include a grease trap in the form of an "S-bend" which normally requires identification and clearing by a plumber

- **Blockages**
  In spite of all the shortcomings of the construction and management of the project there were not many blockages. Most blockages occurred on the condominial lines rather than the household lines. Ten condominial line blockages were recorded in total, five from each community. These were clearly caused by inspection chambers being left open thereby collecting debris, by mud from ingress of storm water and by building materials collecting in the construction process and through the poorly sealed pipe ends.

  The Briardale system had to be flushed out to remove debris consisting of building materials and sand. Once this had been done there were no further reports of blockages at Briardale during the research period, which was a further two months.

  There were only five household line blockages recorded in total, one at Emmaus and four in Briardale. Inappropriate wiping materials probably caused these, although two cases were attributed to steel wool and a facecloth.

- **Other Related Problems**
  Many other problems were raised that were not directly Shallow Sewer issues. These have been separated from the Shallow Sewer problems as they could also relate to other communities. These included internal plumbing faults where p-traps were not installed under kitchen sinks, allowing odours to permeate back up the pipes from the grease traps in the houses. There were several complaints of poor toilet flushing, low water flows as well as cisterns not filling sufficiently for them to flush properly.

  In one of the houses at Emmaus there was very low flow from the kitchen taps. On investigation it was discovered that this was a plumbing design problem related to using roof tanks. The roof tank

had been positioned above the cistern for optimal use there but in a big house such as this there was very slow flow to the kitchen that was far away. It was found that communities view all related problems such as plumbing and water issues as part of the Shallow Sewer "package". People who design Shallow Sewer systems should be aware of this.

- **Water Usage and Operation of the Shallow Sewer System**
  According to WRC Report (13), Shallow Sewer systems can typically be used without blocking due to frequent flushing and small diameter pipes with a low water usage. Successful operation has been observed with an average household usage of 25 litres per capita per day.

  At Emmaus and Briardale the Shallow Sewer system has been installed to all houses and sites but the number of actual connections and usage of the system was low. Whether or not there is sufficient water flushing these systems is not known at this stage but it is likely that the condominiums with few houses connected could be at risk of blocking.

  However if the number of people estimated to be using the system is related to the total water used by those households, then the approximations available from this research indicate that all condominiums have an average flushing in excess of 25 litres per capita per day. This result implied that blockages would not be caused at Briardale and Emmaus by insufficient flushing with water. However many households who do not have their own water supply, purchase water from those with water meters, hence it is difficult to estimate how much water actually enters the sewers.

  It was unknown whether there were sufficient sewer connections to properly evaluate the system as a method of conveyance. At Briardale most of the houses that were built were connected to the sewer system, which may be sufficient to draw conclusions about the system in some condominiums. However at Emmaus there were so few connections that it is unlikely that any conclusion could be drawn about the system.

  The results indicate that undue blockages should not occur due to insufficient use of water because the per capita volume use exceeds the requirement of 25 litres per day for the estimated number of people using the system.

  The low connection rates prevented the evaluation of surcharges occurring due to the inability of the system to convey water at the flow rates generated by normal domestic use. At the rate of connection in the pilot study surcharging was infrequent and the known cases were attributed to other factors.

  The potential for blockages was reported as a result of the use of unconventional designs and methods in the construction in the inspection chambers and grease traps. The condominial line blockages were directly attributed to the construction methods and design where there was ingress of mud, debris and building materials from open inspection chambers, grease traps and inspection chambers that were flush with the ground and unused pipe ends that were not properly sealed.

  The designs of grease traps and inspection chambers should be reviewed in the light of the results of this study and community lack of enthusiasm to clean grease traps. Amendments to the design of the system may be necessary, once the quality and functionality of the system at Briardale has been assessed. If it is found that the communities are still dissatisfied with cleaning their grease traps consideration should be given in the design to make the task less onerous.

  One of the most significant findings was that the Shallow Sewer methodology provides plumbing training to enable the community members to build their own sewers, fit wet cores and make sewer

connections. It is highly unlikely that the standard of plumbing with this type of training could enable the community to undertake these tasks to normal building standards as required by the National Building Regulations. However funding for such projects would normally come from the PHB subsidies, in which process funds will not be released unless certain standards are met. Hence there may be a conflict with the Shallow Sewer methodology, as it stands, and the South African legislation for housing and the funding of housing.

7.5 Ability and Willingness to Pay

The aspiration for communities for high quality water and sanitation services coupled to the inability and unwillingness of people living in low-income areas to pay for these services is of major concern worldwide to service providers. From a potable water perspective, in urban areas, this problem has largely been resolved for Ethekwini's poorer communities where the Ethekwini Municipality is able to provide a semi-pressure system at a reduced cost.

The Shallow Sewer technology is installed as a "package" of water and sanitation services together and it was not attempted to separate them in this evaluation. The communities with Shallow Sewers pay for sanitation as well as for water in their monthly services account. The sewerage tariff for the "test" communities, Briardale and Emmaus was set at 10% less than for conventional sewerage.

Costs that are incurred by the communities supplied with Shallow Sewers include monthly water accounts and sewerage accounts as well as all expenses related to maintaining their system, including hiring outside help if required. Charges are made for water and sewerage only when the volume of water exceeds 6kl per month. Sewerage is calculated at 70% of the volume of water consumption.

Ability to Pay

Miguel Vargas quotes an unconfirmed World Health Organisation benchmark that the water and sewerage service bill should not be more than 8% of income. This benchmark was used to evaluate the ability to pay. 8% of income per each household was calculated, for communities with both shallow and conventional sewers, as a maximum payment for water and sanitation services.

According to another unconfirmed reference provided by EWS Water department, the World Bank proposes that for urban poor, the preferred figure of 4% of the household income be used as the threshold for affordability of water services (excluding sewerage). This figure was also used in the comparisons.

Ability to pay was evaluated using both 8% and 4% of the household income as benchmarks of affordability.

- Based on WHO benchmark of 8% of household income, 98.5% of people were able to pay their water and sewerage accounts
- Based on the World Bank's ceiling of 4% of household income, 92.3% of people were able to pay their accounts. Some of those whose accounts exceeded the 4% were selling water to their neighbours
- The above results demonstrate that, based on the unconfirmed WHO and World Bank benchmarks almost all of the Emmaus and Briardale community using the Shallow Sewer system could afford to pay for the service
- The category at risk of not being able to afford the system was those whose monthly income was less than R300 per month

Running costs, i.e. basic repairs etc, could not be quantified adequately because the system was not fully implemented hence this evaluation should be made later. The average monthly costs are not expected to be high but occasional high, once-off costs may be difficult for individuals to meet.

The amount of water required per capita for the operation of the Shallow Sewer system (25 l per person per day) was also found to be affordable and within the subsidised quota, for an average number of 5 persons per household.

However this position would change dramatically should the 6kl per month subsidy fall away. The actual value of the 6kl subsidy for water and Shallow Sewers was R22.24 and those that used 15kl would be charged R56.79 without the subsidy. In that event the percentage of communities that would not be able to afford the service would increase to 21.5 % and 47.5% respectively.

Willingness to Pay

The actual payments made per household were compared with the ability of that household to pay and by establishing whether the account was in arrears or up to date.

Willingness to pay was evaluated by comparing the ability to pay with actual payments made as well as conducting surveys of the householder's perception of satisfaction and value for money. If the account was in arrears by more than two months but they were able to pay according to the WHO benchmark of 8% then this would provide an indication that they were not willing to pay.

It is recognised that this is a simplistic view of the subject but that further investigations were beyond the scope of the study.

65% of households at Briardale and Emmaus were up to date with payments indicating that most people were willing to pay for the service. Only 6% of all households exceeded R100 in arrears.

There did not appear to be any correlation between non-payment and satisfaction or good value. Most of households were satisfied with their Shallow Sewer sanitation and said it was good value for money. However those that were up to date with payments expressed greater dissatisfaction than those who had not paid. This may indicate that those who have paid feel more free to express their views. It is notable that in the category that was up to date with payments, the 23% that were not satisfied with Shallow Sewers did not say they were not good value for money. Only 2 households out of 48 in both categories said that the system was not good value.

71% of households with Shallow Sewers indicated that they were satisfied with them but only 4% said they were not good value for money, hence it was concluded that non-payment was not due to a negative perception of the value of the system.

Water Sellers and Bailiffs

Both test communities had problems with water supply at the start of this project. At Briardale there was only one standpipe for a whole community where houses were being built and water was needed desperately for building. At Emmaus the number of standpipes had been reduced from four to one or two due to non-payment by some of the bailiffs.

The shortage at Briardale was alleviated when water was supplied to approximately fifty houses as part of the intervention. The water bailiff then had financial difficulties when his account did not decrease even though demand and sales dropped. It appears that this hiccup may have been due to estimated usage for preparing the accounts or otherwise may have been due to a financial management error on the part of the bailiff. The community members with their own water supply would probably have been able to offer neighbours water at a reduced price thereby undercutting the official bailiff.

Similarly at Emmaus certain households began to sell water to their neighbours to make a living. One of those at Emmaus is believed to have run into difficulties paying the water account because of the inclusion of the sewerage tariff. This family since appears to have since stopped selling water.

It was concluded that affordability is not an issue based on the WHO and World Bank criteria. Based on WHO benchmark of 8% of income and on the World Bank's ceiling of 4% and the results from this study it appears that virtually all people in these income categories should be able to pay their water and sewerage accounts. Those who earn less than R300 were the only category that may not be able to afford it and these people have the option of free water and sewer supply by limiting their water usage.

It was found that people in all communities were generally satisfied with their sanitation systems. 86% of people with conventional sewers were satisfied with their systems, whereas 71% of those with Shallow Sewers were satisfied. This could, perhaps, be considered as a factor in willingness to pay the monthly Service accounts. However only by re-testing once the system has been in operation for some time will it be clear whether this increase in dissatisfaction was due to teething problems.

At present only the communities with Shallow Sewers actually pay directly for sanitation because those canvassed in the control areas should have been charged through their rates but, as their houses are valued at less the R30 000, they received 100% rebate. 27% of the test communities could not afford 15 kl water per month whereas if they were not paying the Shallow Sewer charge for sanitation, only 19% would not be able to afford it. (A poor household that has internal plumbing may have difficulty managing on the 200 litre free quota per day and would be more likely to use around 500 litres per day (15 kl per month) if they were trying to limit their consumption. This is deemed by Ethekwini Water Services to be a comfortable usage for such households).

It was found that 74% of households in Briardale and Emmaus over the period of study limited their average water usage to 10 kl per month. (45% of households used on average 6 kl or less per month).

It was found also that 78% of households should be able afford running costs but have not connected at Emmaus because of connection and wet core costs.

From an administration point of view the municipality concerned, needs to consider a system that can cope with the small group of people that cannot afford to pay for the Shallow Sewer (or other) system. Within a community there will always be a small group that cannot pay and for whom a management strategy is required.

Anecdote from an Emmaus resident

A widowed lady, who is able to afford to pay for water, has nevertheless kept her water consumption to below the free limit of six kilolitres per month. Having done this for approximately 16 months, she reported that she has been able to save a substantial amount of money. Prior to having her own water supply she collected water from the standpipe at the prevailing rate of R0.25 per 25 litres, i.e. at a cost of R60 for 6 kl. With these savings she was able to purchase building materials to add on two bedrooms for her sons. She was also able to take driving lessons, which she said she would not have afforded otherwise.

In addition she has persuaded her mother, who lives elsewhere, to use the semi-pressure system instead of the full pressure system that she was using. (We did not delve into this issue but presume that she is now using her roof tank to control her water usage as many people in other people by-pass their roof tanks illegally because they do not like them.) The result has been that the mother, who was previously spending R100 per month on her water bill, has free water and now does not have to keep asking her daughter for money for transport and groceries

The widow has told this to the Emmaus community, encouraging them to make good use of the free water. However some of the community cannot believe this could be true and say that she must have won the lottery!

7.6 Quality of Life and Customer Satisfaction

The results of two surveys that were undertaken to compare the responses of people using Shallow Sewers with those of people using conventional sewers are recorded below.

Conventional and Shallow Sewers were both received favourably by the communities surveyed. 86% of households surveyed in the communities, Nazareth and Riverdene were satisfied with their conventional sewers and 92% said they were easy to maintain. By comparison 71% of households surveyed in the communities, Briardale and Emmaus were satisfied with their Shallow Sewers and 77% said they were easy to maintain.

More people with shallows sewers perceived the benefits of improved status and increased value of property than their counterparts with conventional sewers.

The other satisfaction indicators measured, ease of use, savings in time, improved health, and convenience were similar for both conventional and Shallow Sewer communities. All communities agreed that there were savings in time by having waterborne sanitation but found it difficult to quantify.

100% of people interviewed stated that their health was improved by having the Shallow Sewer system. Only one householder said in the second survey that this was not the case.

After using the Shallow Sewer system for a ten-month period, slightly fewer people said that they were easy to use and maintain or that they were good value for money. This was while they were having teething problems

The following changes in the perceptions of people using the Shallow Sewer system since they first connected (2000-2001) and mid-2002 were recorded.

Positive responses increased from

- Convenience: 82% to 97% and status: 53% to 91%
- Value of property: 71% to 85%
- Savings in time: 94% to 97%

The following minor negative changes were recorded:

- Ease of use: 88% to 85%
- Ease of maintenance: 83% to 79%
- Good value for money: 71% to 67%

Probably the most significant result was that satisfaction of people with the Shallow Sewers, who were re-interviewed, increased from 59% to 76% over the ten-month period in spite of the teething problems that were being experienced at the time of the second survey. During this time the neutral and negative responses dropped from 41% to 24%.

These positive trends may have been influenced be the training and education provided. Throughout the period November 2000 to November 2001, Water and Sanitation Services (WSSA) provided a staff presence for regular liaison and assistance. During this time ten community members were given intensive plumbing training for seven days to provide skills to the community.

It was interesting to note that such high percentages of householders were satisfied with their systems in spite of the teething problems and the general housing problems at Briardale.

Households in Briardale and Emmaus used substantially more water after the Shallow Sewer intervention but paid less for it.

It was notable that significantly more householders with conventional sewers (78%) had additional complaints about water and sanitation than those with Shallow Sewers (38%). This may be a direct consequence of the training and depth of social intervention employed in the Shallow Sewer methodology.

The leading complaints in both controls and test communities were that water/rates/toilets were too expensive and that they had structural problems, such as sewers being too close to the house, that toilets were outside (controls only), that pipes were too small and that they experienced low water pressure and leaks.

The Shallow Sewer system overall appears to be a promising alternative to conventional sewers in terms of providing customer satisfaction and improvement in quality of life, although the indicators of satisfaction and ease of maintenance should be reviewed to confirm this, once the housing problems have been resolved.

7.7 Social Evaluation

Rules and Agreements

Some understanding of the agreements to maintain the systems existed in both communities and most of the principles of the agreement between the community and EWS were recognised and to a degree were adhered to. It was found that the communities administered the Shallow Sewer system in an extremely informal fashion.

At Briardale there was clearly a widespread lack of understanding regarding legally binding agreements, in particular, the consequences of the scheme being declared a failure. If community members knew that VIPs would be installed as a consequence, the incentive to ensure the success of the scheme may have been greater.

It was verified that there was no understanding of the sewerage tariff. The 90% who said they had not received a bill or were not connected, also had no understanding of the sewerage tariff. There was also extremely limited understanding of the water tariff (5%).

Perceptions at Emmaus

The implementation did not materialise as planned, with few connections being made by residents to the Shallow Sewer. The vast majority of residents surveyed, however, were positive towards the system and that 90% would connect if they had the opportunity. Financial constraints were preventing 75% from doing so.

Although there was disagreement about the water supply at Emmaus, only 10% said the reason for not getting a water connection was that they did not like the semi-pressure system. 69% said they could not afford the connection fee. As far as dealing with faults was concerned it was encouraging that, in spite of the low connection rate, 78% of interviewees had received Shallow Sewer training and 80% understood what was involved.

The overall picture presented by all the data was that the people of Emmaus understood about the system and were capable of installing and maintaining it.

Faults Handling and Maintenance Skills

An important maintenance issue was that the communities were not looking after the inspections chambers satisfactorily, especially at Briardale. There were several cases of lids going missing or being damaged, usually by passing vehicles through sewer areas, which were not designed to accommodate such traffic.

In spite of difficulties that arose, the condominiums were able to identify and solve most problems although in some cases the response time was not acceptable. Communities followed the agreed systems of dealing with faults, but no written reporting or recording was undertaken. No formal management or administration procedures were in place in any condominium, nor did formal meetings of condominiums take place on a regular basis. Recognised chairpersons managed the condominiums by being communication links and ensuring that faults were attended to by means of maintenance equipment that was kept safely in the communities. On occasions external parties were called in and paid for by the community to assist with difficult problems.

The Emmaus community was surprisingly positive and responsible even though there was little intervention after the initial training. The community seemed pro-active in maintaining their system, whereas at Brairdale they gave up on resolving their problems and complained that they no longer were interested in the Shallow Sewer. If access to funds (i.e. micro finance) was made available to the 90% of Emmaus households wanting to connect the Shallow Sewer, the system at Emmaus should prove to be a success.

Tenants

Results indicated that tenants had a very poor understanding of the Shallow Sewer system and that negligible transfer of information had taken place.

Recommendations

In addition it is recommended that future projects consider the following:

- Carefully evaluate the community situation to ensure that the project will be financially viable and sustainable
- Understand the community dynamics in sufficient depth to be confident that the community is truly ready for such a project
- Ensure that external parties with influence over the community are identified, educated and monitored
- Establish an overarching development committee, drawing in all parties involved with the development of housing, services, health, treasury and regulation to co-ordinate and monitor all development of the area, i.e. a holistic management approach.
- Re-evaluate the Shallow Sewer methodology in terms of community dynamics

8 Discussion on Shallow Sewers and Relevance to the South African Environment and the Ethekwini Experience

The Ethekwini Shallow Sewer Pilot Study produced a wealth of information about the Shallow Sewers and service provision to poorer communities.

8.1 Benefits of Shallow Sewers

Although some aspects were not directly measured in the research, experience on this project has shown:

There are potentially substantial benefits for "Shallow Sewer type" systems.

- Shallow Sewers can be installed at significantly reduced capital costs
- They allow easy access into confined spaces where it is impossible to install conventional sewers and on-site systems are likely to fail
- They are able to deal with wastewater from an unlimited water supply to small sites whilst allowing for a wide range of operational flows
- Their provision ties in well from the PHB subsidy system, both in terms of timing as well as allocation of monies for sanitation.
- From a technical perspective, there is no apparent reason why Shallow Sewers should not function as well as, nor provide the same level of service to the customer as conventional ones. In addition the smaller diameter should provide better solids transportation than conventional.

8.2 Drawbacks of Shallow Sewers

The following primary drawbacks were noted for the South African context:

8.2.1 Social

- There is a mismatch of the Shallow Sewer methodology of community "self help" approach vs. community expectation of "government will provide"
- There is a mismatch of the political expectation of a high service delivery rate which conflicts with community development / upliftment which implies community controlled rate of delivery
- The wide range of affordability and expectation within a single community makes delivery of a uniform service to a community difficult.

8.2.2 Legal

There are legal issues to be resolved before Shallow Sewers can become a viable option for service providers. These include:

- Community ownership of the common sewer line is in conflict with fundamentals of land tenure principles
- There are contractual difficulties with indigent people. Frustration arises from a lack of enforceability of obligations imposed contractually on indigent parties who, due to lack of financial means are unable to fulfill these obligations.
- Conflicts currently exist with the National Building Regulations

8.2.3 Technical

A number of potential technical disadvantages were identified:

- Due to the small dimensions of the access chambers relative to the size of bends and T-junctions. This requires very accurate positioning of the inspection chambers over these appurtenances in order to provide sufficient space for radii. The knock-on effect of this is that should formal blockage clearance equipment be engaged to remove blockages there may not be sufficient space for access

- The transfer of expertise to new homeowners, i.e. those that were not there during the implementation phase, remains a challenge
- A situation may arise in relation to payment for expert help that may be required to remedy occasional problems. The meeting of expenses by the condominium for services to the Shallow Sewers will always present a challenge in an indigent community.

On-going education and liaison with the community is likely to be required to ensure that the service provider's operational standards are met. This could be onerous on the service provider, especially if the service provider is not structured for community service provision

8.3 Plumbing Standards and Appurtenances

Poor plumbing standards in the houses have caused problems, which the communities have perceived to be associated with Shallow Sewers. The National Building Regulations may need to be revised along the lines of a minimum requirement for economic, self-help applications.

Further, when reduced depth and standard sewers reach the point of being implemented on a mass scale it will be necessary to review the menu of appropriate appurtenances, and where necessary redesign the existing appurtenances to accommodate Shallow Sewers. For instance, the depth that the Shallow Sewers are laid precludes the use of standard gullies. It is anticipated that should the production volumes of these appurtenances warrant, the commercial opportunity will fulfil this need.

8.4 Selection of Communities

The choice of community is important. Both communities selected turned out to be poor choices for Shallow Sewers because of interfering circumstances. Shallow Sewers may not be suitable for green-fields developments where the full community is not present. The whole community should be available to participate in all stages of the intervention from establishing agreements, planning and design through to maintenance.

Thus for green fields it may be preferable to install the infrastructure through contractors.

Criteria need to be developed to assist in determining whether communities are "ripe" for development. From the experience gained on this project, it is apparent that better assessment than is generally done at step 1, (Institutional and Community Arrangements), of the La Paz model, is needed. The depth of investigation needs to go down at lest one level below that which is done at present. For instance, it is more valuable to know why a previous intervention was successful than it is to merely know that it was successful.

8.5 Mismatch in Philosophy and Expectation.

The experience on the Ethekwini pilot indicates that there are a number circumstances present:

- In the make up of the communities
- The way the Local Authorities are structured from a service delivery perspective,
- Inconsistencies in the political and community expectations, that suggest that, at present, the implementation of Shallow Sewers according to the full La Paz model are not likely to be accepted or sustainable in the vagaries of community politics.

8.5.1 Community Diversity.

Ideally consideration should be given to the different strata in the customer base and levels of service offered should be appropriate for the customer who is paying for the service, implying different levels of service for each local enclave. However in reality this is uneconomical and impractical as diversity of income and social circumstances within the Ethekwini communities is large.

In societies that have long histories of adequate service provision, communities have naturally evolved to the point where each community has uniform expectations and these are consistent with the services that are provided in that specific community. If an individual's circumstances (affordability and expectations) are different from that standard he/she generally migrates to areas with service levels appropriate to his/her circumstances.

In the Ethekwini communities this uniformity has not developed, and only limited migration occurs. It is surmised that the affluent portion of the community which are dependent on the community for their status (both socio-political and economic) do not migrate from the community. From a social management perspective this is desirable as it maintains the economic and organisational base of communities, which could otherwise degenerate into abject poverty. However, from the service provision perspective this is problematic as it makes meeting the expectation of this diversity impossible or at least uneconomical. For this reason it is apparent that an autocratic approach to level of service is necessary. In determining this authoritarian "Package" the level of service needs to be affordable and acceptable to the vast majority of the community in order to be sustainable.

8.5.2 Time Basis vs. Community Based Management

The measurement criteria, used to determine the delivery of services, are often based on the rate of delivery. In general, this mode of measurement conflicts with the implied measurement criteria for community based service delivery, which are generally related to issues of community upliftment. The speed at which communities can and are uplifted in community based projects, are generally determined by the community circumstances. Time related contracts therefore tend to be in conflict with community based service delivery.

Authorities should be conscious that time related budgets such as the annual budget structure of local authorities and other government departments, conflict with community based service provision. This also applies to political expectation of a time related backlog catch-up program that includes community and social development.

8.5.3 Institutional Management

The key to success in this technology is the social intervention, which requires knowledge and dedication on the part of the implementing agency. This research may have gone some way to understanding the market, or at least providing guidance for further investigations. It was clear that this type of project requires significant social intervention from the implementing agency on a continuous basis. Technical support and training need to be maintained until the community is capable of running their system with minimal assistance.

Community based management systems and philosophy needs to be embedded in the corporate culture in order to provide community based service provision. Aspects, such as implied by sections 8.6 and 8.7, should form major structures within the management structure. Management should be non-hierarchical encouraging participants from different disciplines to work together on an equal footing. This implies an interdisciplinary approach, as opposed to the multidisciplinary approach (WRC 1146/1/03), (19). This approach aims to produce integrated solutions and plans considering the connections and interactions among technical, managerial, political and social elements of the situation. All professional disciplines necessary to undertake community based service provision, including water, wastewater, social, legal, housing and health representatives, should be incorporated to work as an interdisciplinary team. This implies that a single department with all this expertise is necessary, and from this department appropriate teams are constituted for each project.

Most of the established local authorities historically have been structured to undertake rapid contract based service provision. Community based service provision requires not only major changes in management structures but also a change in philosophy. None of the larger local authorities have

actually embraced the change in philosophy and structure yet, although some have made token gestures in this direction.

8.6 Shallow Sewer Management Models

From the WRC Report (13) it is apparent that there is a range of implementation and management models for reduced standards Shallow Sewer type system. The technology ranges from traditional Shallow Sewer, as represented by the La Paz model, where the community "own, operate and maintain" the sewer, to what would amount to a reduced standard conventional sewer. The reduced standard sewers allow for reduced diameter, shallower depths and relaxation of other appurtenance standards, but are owned and operated by the local authority.

Assuming that, in the interim, rapid service delivery is the priority, it must be concluded that a "South Africanised" sanitation system must be developed to maximise the benefits and minimise the drawbacks of Shallow Sewers. This implies a system of reduced standard sewers, which are owned and operated by the local authority rather than the Shallow Sewer system as envisaged by the La Paz implementation model.

If these sewers are laid in "standard width" servitudes, parallel to property borders, and which are registered when the property is registered, a number of the legal and social issues will disappear.

Should circumstances change as implied by section 8.5, then a Shallow Sewers implementation model based on the La Paz model would probably be more appropriate than the reduced standards sewers as discussed here.

8.7 Holistic Approach to Social Interventions

The social aspect is much wider than Shallow Sewers. It is proposed that the lessons learnt from the Shallow Sewer pilot study could equally apply to improve the success of other community development projects.

A more holistic approach to social interventions should be considered. The social implementation of the Shallow Sewer methodology is fairly complex and is certainly not specific to Shallow Sewers or even sanitation. It has become obvious that many departments within the Ethekwini Municipality as well as many Government departments already provide various types of social intervention and upliftment as part of the implementation process of other service provision.

Nationally, social interventions appear to be taking place in an uncoordinated and fragmented manner. Using a service provision intervention to educate and uplift communities is a laudable and achievable ambition. This should hopefully enable them to mobilise and empower themselves to undertake self-development. However a coordinated, holistic approach with a uniform methodology is required. Within these community based service provision methodologies there seems to be a core of similar methodologies of which Shallow Sewers is but one. These need to be evaluated and, if necessary, modified to include the best aspects of all the methodologies to form a single methodology that will form the core for the social intervention for all service provision.

The La Paz model is fundamentally a good one and has some powerful attributes such as:

- The modularized format, and the logical sequence of development interspersed with "milestones" which provide a compulsory check on the process.
- It is robust and flexible in that it can be adapted to any type of development, and has been used for suburb beautification and crime fighting.
- It is educational and empowering and is compatible with self-help poverty alleviation strategies.
- The condominial subdivision is apparently valued by the community.

8.8 Issues Particular to the Ethekwini Pilot.

The small scale and local conditions of the pilot study may have influenced this project. These are highlighted below.

- The small scale of the project did not allow flexibility of timing for communities to resolve their issues.
- There was confusion in the minds of the community about the "package" of the options. In light of the people's affordability, the full pressure water supply should perhaps not have been offered as an option.
- The training provided to the community was not always sufficient and required follow-up, which should have been done in a more controlled manner.
- Monitoring of the shifts in attitude should have been managed better, in particular the external parties with influence over the communities should have been identified, educated and monitored.
- At Briardale the management of the Shallow Sewers was inextricably linked to the management of the housing project and when that project encountered difficulties the community could not disassociate the two problems.

8.9 Long Term Benefits for South Africa

There is potentially enormous benefit to be gained from the implementation of Shallow Sewers, not only in the field of sanitation and health improvement but could also include poverty alleviation, education and other aspects of social upliftment.

Costs Comparisons with conventional sewers and VIPs

The pilot study demonstrated that installing Shallow Sewers instead of conventional sewers might save 45% to 50% of the on-site capital costs, and that there is little difference between the capital costs of VIPs and Shallow Sewers, provided that the capital cost of the bulk infrastructure is accounted for elsewhere.

Findings indicated that the Shallow Sewer System can be implemented within the costs and timing constraints of the PHB subsidy system. There appears to be sufficient flexibility in the administration of the Provincial Housing Board subsidies to accommodate the steps of the Shallow Sewer intervention as described in the methodology used in the Ethekwini Pilot Study.

From this research no major obstacles could be foreseen, either time wise or cost wise, to PHB subsidy funding being used for a project that included Shallow Sewers as an alternative to conventional sewerage or ventilated pit latrines, provided that the Local Authority would foot the bill for the off-site reticulation of the sewage.

9 Key Conclusions

From the discussion on long term benefits for South Africa it must be concluded that there are major benefits in providing either Shallow Sewers and/or reduced standard sewers. The two main benefits are the saving in capital cost and the provision of access to sanitation in communities where there is insufficient space for conventional sewers or on-site sanitation.

- From the discussion above it must be concluded that at this stage in the socio-political development of the country a shallow type, reduced standards sewerage system, which is owned and operated by the local authority and which is implemented in such a manner as to reduce the social disadvantages that arise due to South Africa's current stage in its historical development, must be developed. This reduced standards Shallow Sewer system should be developed and promoted as the "standard" or norm for low cost and high density subsidised housing systems with access to bulk sewerage systems. From the affordability studies it is apparent that the majority of the community receiving this benefit can afford the operating costs.

- Shallow Sewers methodology provides a systematic structured approach to a general community-based service provision with a number of special attributes such as the "milestones" evaluations. This methodology is compatible with community upliftment, and poverty alleviation. However this methodology can be improved and "South Africanised".

  There are a number of technologies with similar philosophies to the Shallow Sewer being used for service provision implementation in South Africa. The best aspects of these can and should be incorporated into a single methodology / social technology. The Shallow Sewer could provide a sound platform to build this technology on.

- There are two fundamental approaches to service provision: the "helter skelter" rapid construction approach and the community-based (possible "self help") service provision. The two approaches are mutually exclusive. The institutional management structures for the approaches are significantly different and it is extremely difficult to implement community-based service provision under a rapid "construction" based service provision. This implies that local authorities wishing to provide community-based service provision need to radically restructure themselves if they are currently structured for rapid construction, or have a legacy of rapid construction.

- There are currently serious inconsistencies in policies and philosophies in service provision in the country including:
  - Political wish for rapid service provision, but at the same time there is a political demand that there be community upliftment, social development and poverty alleviation.
  - There is a mismatch of the Shallow Sewer methodology of community "self-help" approach vs. community expectation of "government will provide"

  These unclear leadership goals are hampering the service delivery, as the implementing agents cannot easily identify priorities.

- Should the assumption that the priority is for rapid service delivery be incorrect and the priority is assumed to be community upliftment, then it is concluded that a "South Africanised" version of the La Paz model must be developed in accordance with the lessons and experience gained from the Ethekwini Pilot. In conjunction with this development the local authorities need to restructure to accommodate this community service provision. Likewise the political expectation of rapid service delivery needs to be adjusted.

10 Recommendations and Further Investigation

- **Develop clear policies**

Significantly clearer policies which will diminish the conflicts such as "community upliftment" vs. hardware delivery; "self help" vs. "government will provide" etc. needs to be developed, certainly at local authority level, but preferably nationally. In particular the conflict in policy between rapid service provision and community development must be resolved.

- **Development of a reduced Standard Sewer System**

On the assumption that the priority is for rapid service provision, it is recommended that a reduced standard sewer system, based on the technical advantages of Shallow Sewers, be developed and tested as soon as possible. This will provide technical advantages over conventional sewers while the provisions of the previous recommendation are being resolved.

The existing Shallow Sewers at Ethekwini could be used to pilot the system where appropriate.

- **Develop a range of Shallow Sewer Management Models**

Should the priority be to empower communities, then the Shallow Sewer methodology will need modification to accommodate the findings of this study before it can be installed on a mass scale in South Africa. Once the environment has been created interdisciplinary teams can work within that framework to develop a range of "Shallow Sewer type" technologies, using an integrated approach and the findings of this research. The development of the range must accommodate the range of community needs, aspirations and affordabilities.

- **Test the newly developed Management Models**

These proposed technologies that will have been developed especially for the South African social, legal and technical environments would need to be evaluated.

In parallel with the above developmental work further evaluations of Shallow Sewers should be undertaken at the existing pilot communities to provide data to draw conclusions in the longer term:

- Once teething problems have been rectified, an investigation in to the relationship of the quality of workmanship of community-trained "artisans" and the available appurtenances is required. This needs to be undertaken in relation to the National Building Regulations, taking note of whether these are issues relating to plumbing, water or sewers.

- Long-term studies on water requirements and transportation to establish the technical effectiveness in terms of the capacity of the system is required.

- Technological variations and / or legal models, to accommodate the range of "Shallow Sewer type" technologies in terms of ownership and servitudes needs to be developed. The interdisciplinary approach would be particularly useful in this regard.

- The existing Shallow Sewers at Ethekwini may provide pilots for the reduced standard sewer system.

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