Pour Flush Trials in the Western Cape

Report to the
WATER RESEARCH COMMISSION

by

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The publication of this report emanates from a project entitled *Pour Flush Trials in the Western Cape* (WRC Project No. K8/1018).

EXECUTIVE SUMMARY

WRC project K5/1887 saw the development and testing of a pour flush toilet pedestal design, based on pour flush squat pans used successfully in many parts of Asia. The previous WRC project involved pilot studies at several households in KwaZulu-Natal which successfully demonstrated this technology.

The pour flush technology provides a viable alternative to current sanitation systems and has the potential to be installed inside a dwelling and can be flushed using available greywater. It is considered that the pour flush design has the potential to make a significant contribution to the sanitation backlog in South Africa and further afield.

The objectives of the Western Cape Pour Flush Pilot study are as follows:

1. *To trial pour flush toilets in high density urban / peri urban settlements of the Western Cape.*
2. *To trial pour flush toilets as an alternative to conventional flush toilets at the Sustainability Institute.*
3. *To evaluate the suitability of using pour flush technology in medium to high density settlements.*
4. *To raise awareness and interest in pour flush technology as a viable sanitation option in the Western Cape.*

The Pilot study was successfully implemented in three communities within the City of Cape Town, Stellenbosch and Tweewaterskloof Municipalities. A total of 14 toilets were installed and are working well without blockage.

The following points are the keys highlights and conclusions of the pour flush trials to date:

- *In the case of Enkanini a willingness to contribute to the maintenance of the facility.*
- *Communal pour flush toilets at Klein Begin working and being kept clean, despite failure of previous flush toilets due to lack of household servicing.*
- *Two litres is commonly used to flush and clean the toilet.*
- *Stellenbosch Municipality is considering incorporating Pour Flush into their standard specifications for informal settlements.*
- *The pour flush design works well with a simplified sewerage network.*
- *The low volume flush of the pour flush toilet is complementary to anaerobic treatment systems where hydraulic retention time is a key factor.*

ACKNOWLEDGEMENTS

The authors would like to thank the following for their involvement in this project:

The community members from Enkanini, Klipheuwel and Klein Begin who embraced this new technology and were willing to give it a try.

Stellenbosch Municipality, Theewaterskloof Municipality and the City of Cape Town for enabling installations at the different pilot sites.

The student and staff at the Sustainability Institute, in particular Lorraine Amollo and Lauren Tavener-Smith for your valuable ideas and input at Enkanini and beyond, we look forward to many sanitation engagements in the future!

Terrence Ward, Tobie Marnewick, James and your co-workers for going the extra mile with the installations.

Daz Muir from The Lighthouse Mission.

Cobus Coetzee from Biocycle.

Luan Schoeman from Sustainable Engineering Solutions.

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WRC project K5/1887 (Still & Louton, 2012) saw the development and testing of a pour flush toilet pedestal design, based on pour flush squat pans used successfully in many parts of Asia. The previous WRC project involved pilot studies at several households in KwaZulu-Natal which successfully demonstrated this technology.

The pour flush design overcomes several of the challenges associated with current sanitation initiatives, namely:

- *Dry sanitation / VIP Latrines – Maintenance of these latrines can be complex and unhygienic as the faecal waste must be stored directly below the toilet. The absence of a water seal also means that odours may be apparent unless the toilet is very well maintained. The presence of odours, plus the need for waste to be stored beneath the latrine normally prohibits a toilet being installed inside a house.*
- *Standard flush toilets – requires mains water and connection to a sewer or septic tank system. The large volume of water used to flush a conventional toilet may place a strain on limited resources and may be unaffordable for the household.*

Figure 1.1: Pour Flush Pedestal (from Still & Louton, 2012)

Figure 1.2: P-Trap Design (from Still & Louton, 2012)

The pour flush bowl slopes steeply towards the small diameter outlet at 48 degrees to the horizontal. A minimum 25 mm water seal is provided by the long radius P-trap fabricated from 63 mm diameter fittings. The small volume of water within the P-trap and the gradual bend of the P-trap enables to the toilet to flush effectively on 1 to 2 litres of water.

The pour flush technology provides a viable alternative to the above systems, which has the potential to be installed inside a dwelling and can be flushed using available greywater. It is considered that the pour flush design has the potential to make a significant contribution to the sanitation backlog in South Africa and further afield.

Maluti GSM was appointed by the Water Research Commission to conduct a Western Cape pilot study of the Pour Flush toilet technology already trialled in KwaZulu-Natal. This report documents the findings of the pilot study.

The pour flush technology, although not new, is relatively unknown, and is also untested in the high density areas common to the urban and peri-urban settlements of the Western Cape.

1.2 Objectives

The objectives of this study are as follows:

1. *To trial pour flush toilets in high density Urban / Peri Urban settlements of the Western Cape.*
2. *To trial pour flush toilets as an alternative to conventional flush toilets at the Sustainability Institute.*
3. *To evaluate the suitability of using pour flush technology in medium to high density settlements.*
4. *To raise awareness and interest in pour flush technology as a viable sanitation option in the Western Cape.*

2 IMPLEMENTATION PLAN

2.1 Toilet Manufacture

2.1.1 Pedestal

Due to the cost and time associated with ordering the pour flush pedestal from the current manufacturer in Pietermaritzburg, we approached a local fibreglass manufacturer based in Cape Town, to replicate the design of the current pour flush toilet.

2.1.2 P-Trap

Due to the high cost of injection moulded fittings, we will consider alternative options for fabricating the bend from heat bending PVC pipe or alternative low pressure drainage fittings.

2.2 Pilot Sites

2.2.1 The Sustainability Institute

The Sustainability Institute is an educational facility located near Stellenbosch. The Sustainability Institute offers post graduate studies in Sustainable Development and provides a space for people to explore an approach to creating a more equitable society that lives in a way that sustains rather than destroys the eco-system within which all society is embedded. For this reason it is the perfect place to trial the pour flush technology in an environment where conventional full flush toilets are also available.

Pour flush toilets will replace existing toilets, giving the user free choice of which toilet to use. Water meters fitted with data loggers will enable monitoring of number of users and volume of water per flush. This will enable investigation into user preference and the volume of water that is actually used to flush waste. Cleaning staff will also be interviewed to evaluate the extent of soiling and blockage of the different toilet designs. Metering will commence before the toilets are installed to establish the baseline of cubicle preference and water consumption.

The male toilets have three cubicles; one pour flush toilet will be installed next to one remaining conventional toilets. The female toilets have seven cubicles; one pour flush toilet will be installed alongside the conventional toilets.

2.2.2 Klipheuwel Informal Settlement, City of Cape Town

Klipheuwel is a township situated on the R304 about 30 km west of the town of Stellenbosch. It is relatively new and well-spaced out township. There are several roads in

and out of the township and a number of the residents have space for gardens around their properties. At least 6 people are managing subsistence gardens within the confines of Klipheuwel itself.

Approximately 80% of the community is served with AfriSan dry composting toilets, serving individual households. The toilets are installed inside precast concrete structures outside people houses. The maintenance contract between AfriSan and the City of Cape Town has ended, with maintenance now being undertaken by the City. Waste is collected in plastic bags which must be emptied every two weeks. The indications are that the waste does not dry in accordance with its design principles.

Figure 2.1: Aerial photo of Klipheuwel

Figure 2.2: Existing EcoSan Toilets

We understand that the City is seeking alternative solutions for this community and has given permission for AgriProtein to conduct some research using the Black Soldier Fly (BSF) larvae for the treatment of faecal waste from Klipheuwel. The pour flush technology will enable effective collection of faecal waste without excess water, such that it can be effectively treated using the BSF larvae.

Five pour flush toilets will replace the existing AfriSan toilets and will discharge to soakage pits. The solids will be retained in a container for periodic emptying by AgriProtein.

Figure 2.3: BSF Lavae

Figure 2.4: Typical View of Klipheuwel Settlement

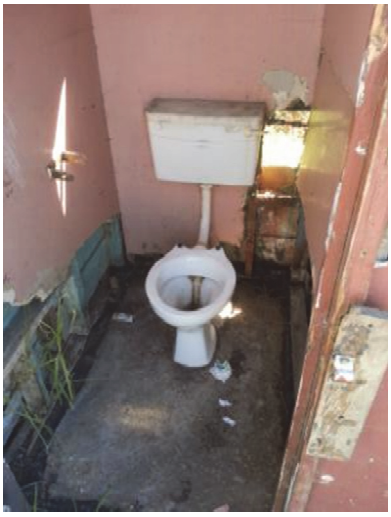
2.2.3 Klein Begin Community, Grabouw, Theewaterskloof

Figure 2.5: Map of Klein Begin

The community of Klein Begin own the land on which they reside. As private land owners, the municipality does not provide free basic water services to this community. They have good access to water via a borehole and rudimentary reticulation to yard taps. The existing communal toilet blocks discharge to a septic tank and are in a poor state of repair.

The Lighthouse Foundation has established a crèche in the community and is involved in several upliftment initiatives within the community. They have been donated a biodigester to which we will connect two toilets to serve the crèche. Another 3-4 toilets will be installed inside people's homes and connected to soakage pits or the biodigester.

Figure 2.6: Existing Toilet **Figure 2.7: Typical View of Klein Begin Timber Building**



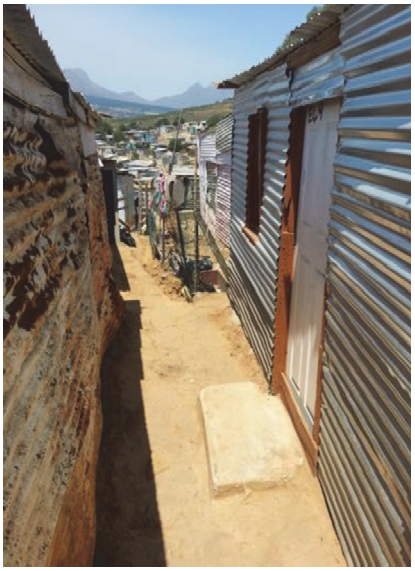
2.2.4 Enkanini Informal Settlement, Stellenbosch

Enkanini is a rapidly expanding informal settlement on the outskirts of Stellenbosch. In recent years the municipality has maintained a boundary fence which has resulted in increased densification of the community. The municipality provides communal toilet blocks at various positions in the site which are connected to a municipal sewer, this sewer frequently surcharges due to blockage and stormwater ingress.

The Sustainability Institute has an established relationship with the people of Enkanini and has conducted several research projects in this community, including the well-publicised i-shack project. Initial plans for the Enkanini pilot was to connect five toilets to a condominial sewer, discharging to a conservancy tank at the Sustainability Institutes 'resource centre'. The density of this community is too high, and the dwellings too small to enable the installation of private toilets or the construction of soakage pits. Five toilets sites have been identified where there is sufficient space and suitable topography to enable the construction of the condominial sewer. The toilets will be shared between 3 to 5 households who will take responsibility for their maintenance.

The conservancy tank was originally deemed necessary due to avoid the need for connecting to a municipal sewer. However, subsequent permission was given by the municipality to discharge into the sewer on a trial basis. This enabled the installation of a biodigester with the supernatant discharging into the municipal sewer approximately 30 m from the site.

Figure 2.8 & 2.9: Typical space constraints and access between shacks



2.3 Implementation Programme

Table 2.1: Scheduled Implementation Plan

ITEM	07-Jan	14-Jan	21-Jan	28-Jan	04-Feb	11-Feb	18-Feb	25-Feb	04-Mar	11-Mar	18-Mar	25-Mar	01-Apr
Identification of Pilot Sites													
Implementation Plan													
Detailed design													
Pilot 1 – S.I.													
Pilot 2 – Klipheuwel													
Pilot 3 – Klein Begin													
Pilot 4 – Enkanini													
Monitoring													
Project Report													

3 INSTALLATIONS

3.1 TOILET MANUFACTURE

3.1.1 Pedestal

Due to the cost and time associated with ordering the pour flush pedestal from the current manufacturer in Pietermaritzburg, the Cape Town based manufacturer, Arlindo's Fibreglass was contracted to replicate the design of the current pour flush toilet. Switching to a new manufacturer presented a few challenges to ensure the manufacture of a good quality product was achieved, but the manufacturer was able to produce a good quality replica fibreglass pedestal at a saving of approximately R300 per pedestal compared with shipping the pedestals from Pietermaritzburg.

It was also necessary to engage with Arlindos Fibreglass to make a few minor modifications to the design to enable plumbing of the pour flush toilet into the Sustainability Institute (SI) building to avoid the need of breaking out the floor slab. This was achieved by raising the outlet pipe slightly to allow the P-trap to be connected above ground and terminate with the centre of the outlet pipe at 180 mm above ground to allow direct replacement of the existing toilets. This is discussed in more detail as part of the SI trial. Apart from the toilets at the SI, the pour flush toilet design was identical to that used in the KZN study undertaken by Partners in Development.

3.1.2 P-Trap

In the implementation plan it was identified that PVC fittings, a Cape Town based manufacturer of PVC bends would manufacture the P-trap to the required dimensions to save the cost of connecting injection moulded components. However the P-Trap design requires good accuracy to ensure the necessary water seal is provided. The required dimensions proved difficult to reproduce consistently by bending the PVC pipe, particularly achieve the require bend angle. It was also not possible to achieve a double bend in a single piece of pipe. Consequently the same injection moulded fittings were used at the three community pilot sites.

Figure 3.1: Modified P Trap

We also considered an alternative P-trap design for the SI to reduce the length of the fitting by using 75 mm drainage fittings with a tighter radius bend. Despite being larger diameter, this P-Trap required a similar volume of water for the seal (approx. 700 ml)

compared with the original design. Note however that the outlet angle of the modified pedestal was not 45 degrees and as such and additional bend had to be included in the P-Trap.

3.2 POUR FLUSH INSTALLATIONS

3.2.1 Introduction

A significant amount effort was involved in liaising with the community, partner organisations and municipal officials, to allow for the necessary process of explaining the technology and receiving community endorsement in a context where sanitation provision is a particularly sensitive issue. Although this research did not intend to investigate the institutional framework for trialling and scaling a new sanitation technology, interesting lessons have been learnt in this regard which will be presented in the full research report.

3.2.2 Delivery Programme

The unforeseen time required for engaging with stakeholders, plus delays in the manufacture of the pedestals, meant that installation of the first pour flush toilets only commenced in March 2013.

It was envisaged in the proposal that the pour flush toilets could be installed inside existing structures to save time and cost of the installation and to demonstrate the use of the technology inside people's homes. However, new superstructures were built at two of the sites and significant renovations at the third which further impacted on the delivery programme, as outline below.

Table 3.1: Delivery Programme

Date Pilot Site	11/3	18/3	25/3	1/4	8/4	15/4	22/4	29/4	6/5	13/5	20/5	27/5	3/6	10/6
Klein Begin														
Biodigester														
Creche Toilet														
Communal Toilets														
Klipheuwel														
Septic Tank														
Pipework														
Structures														
Enkanini														
Biodigester														
Pipework														
Structures														
Sustainability Institute														
Meters														
Meters														N/A

3.2.3 Klein Begin Community, Grabouw, Theewaterskloof

A total of four toilets were installed at Klein Begin as indicated in Figure 3.2

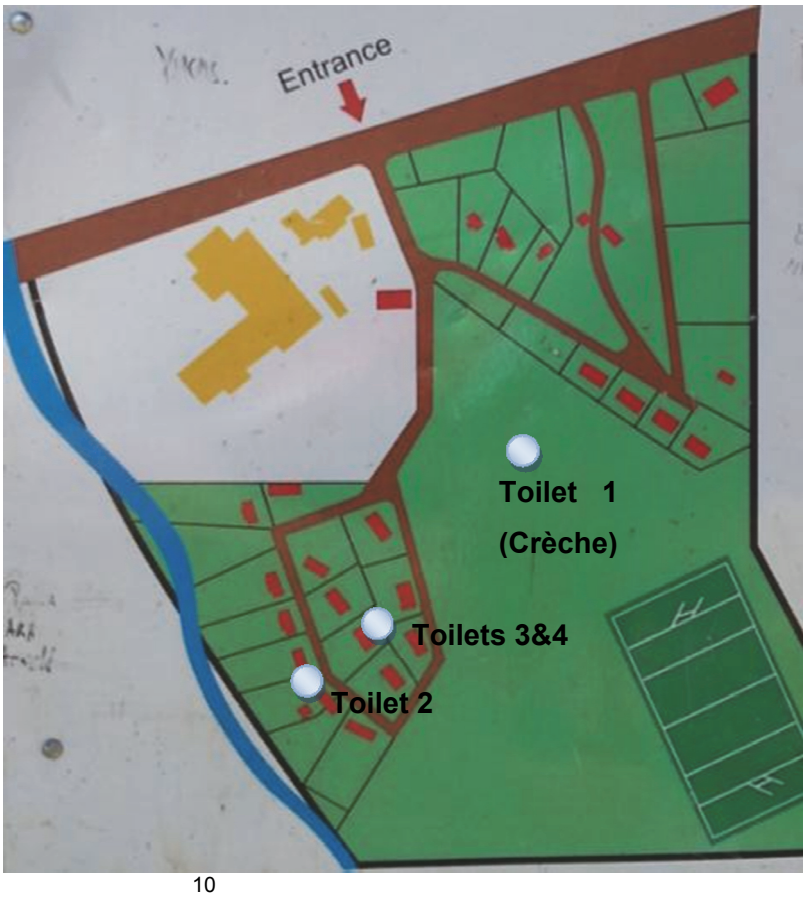


Figure 3.2: Location of Klein Begin pour Flush Toilets

A biodigester was installed by Sustainable Engineering Solutions as part of a separate project; we did however construct the soakaway to enable effective infiltration of the supernatant. The design of the French drain followed guidance from the UK's BRE365 soakaway specification which is more stringent about maintaining a good aerated zone than South African specifications. This aerated zone enables growth of aerobic bacteria which are effective at breaking down pathogens. The French drain must be laid flat along the contour with the invert of the pipe no deeper than 700 mm below ground. The conveyance pipe should only be slotted on the underside and should be encased in a good layer of stone. A Geotextile was used to avoid migration of fines into the French drain.

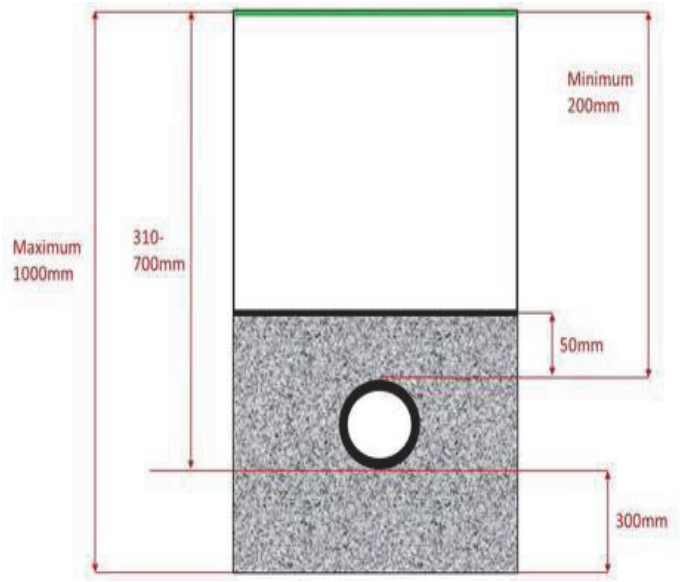


Figure 3.3: Typical French Drain Dimensions

Three additional toilets were installed inside the existing communal facility, replacing broken infrastructure. Initial work was undertaken to install one further toilet but the septic tank into which it will discharge is full. We are awaiting the community to arrange for the septic tank to be emptied before this 5th toilet is installed.

Figure 3.4: Constructing French Drain

Figure 3.5: Crèche Toilet

Figure 3.6: Toilet 3 Installation

Installed in existing dilapidated structure, (note septic tank was located directly below toilet so toilet had to be set forward to accommodate long P-trap).

Figure 3.7: Toilets 3 and 4 complete

3.2.4 Klipheuwel Informal Settlement, City of Cape Town

The original proposal was to retrofit the existing precast concrete toilets. However, the small size of these structures (internal width of 830 mm and depth of 870 mm) meant it would have been difficult to install the pour flush toilet complete with a hand wash basin and greywater bucket. It was therefore decided with encouragement from the community leader, Eric, to construct toilets to provide new sanitation facilities for un-serviced households.

The sewage will initially be discharge to a septic tank which will later be modified to enable effective harvesting of waste for the BSF research. A suitable poision for the boidigester was agreed with the community near the bottom of the site, from where 5 households were identified who could be serviced from the septic tank. The topography at Klipheuwel is quite flat such that the drainage needed to be carefully routed to ensure that a minimum gradient of 1 in 50 could be maintained for all sewer pipework.

Figure 3.8: Map of Pilot Site at Klipheuwel

Figure 3.9: Typical Pipework

Inspection chambers have purposely been avoided to improve affordability, and avoid unauthorised discharge of waste into the sewer. Research at other high density sites has indicated that a common cause of sewer blockage is the discharge of food scraps and waste into the sewer via inspection chambers. Furthermore, inspection chambers are hydraulically inefficient in surcharge conditions due to the turbulance experienced on exit and entry of the sewer pipe. Rodding eyes are provided at all bends to enable clearing of blockage should this be required.

All pipework, the septic tank and floor slabs were completed by our builders (Terrence and James). It was decided to construct the superstructure from timber and zinc as they were materials which would be familiar to locals for construction purposes. The materials and artisans were sourced from the community to promote future replicability. The demonstration

structure was constructed with the local artisans who were then provided with tools and basic support to complete the task. Unforunately (as may have been expected) the quality of materials and workmanship was not to the standard that one would hope, but this has not distracted from the appreciation and success of the project.

Figure 3.10: Demonstration Toilet

Individual toilets were provided in the yard of and individual house; those benefitting from Municipal toilets are serviced in a similar way. Each of the recipients were asked where they would like their toilet to be installed with conideration of connection into the sewer.

Figure 3.11: Magrieta with her new toilet

Figure 3.12: Finishing touches

Approximately 56 m of drainage piping was laid with rodding eyes at the top of each section that leads to the septic tank. The drainage pipes feed in to a 2 200 litre septic tank; the supernatant discharges to a French Drain to a similar specification as was used at Klein Begin.

Based on the capacity of the septic tank and the low flush volumes associated with the pour flush toilet, it is envisaged that the network can be extended to serve additional houses (up to around 100 households). There are also plans to modify the inlet of the septic tank to assist the harvesting of faecal waste for Biocycle's BSF project and to extend the french drain to irrigate a tree plantation and thereby minimise infiltration of supernantant.

Table 3.2: Klipheuwel Toilet Cost Summary

Description	Unit	Qty	Unit Cost	Amount
Toilet Structure	per Toilet	5	R 2 750.00	R 13 750.00
Toilet Plumbing	per Toilet	5	R 1 200.00	R 6 000.00
Communal Sewer	per m	52	R 70.00	R 3 920.00
Septic Tank	per unit	1	R 6 500.00	R 6 500.00
Soakaway	Sum	1	R 2 500.00	R 2 500.00
Total				R 32 670.00
Cost Per Toilet				**R 6 534.00**

An additional 5 toilets may be connected to the biodigester to utilise spare capacity, reducing the cost per toilet to approximately R 5,800.

3.2.5 Enkanini Informal Settlement, Stellenbosch

This pilot site has been realised through close collaboration with Lauren Tavener-Smith and Lorraine Amollo, both PhD Students at the University of Stellenbosch, together with their co-researchers who are residents of Enkanini. The research undertaken by Lauren and Lorraine has added significant value to this pilot and should lead to some very useful findings related to the institutional arrangements required for effective sanitation interventions. This includes the willingness to pay for the maintenance of a shared toilet close to the user's home.

The toilets are connected via a network of approximately 50 m of condominial sewer and discharge into a biodigester at the Sustainability Institutes 'resource centre'. As discussed in the Klipheuwel pilot, the sewer design has purposefully avoided inspection chambers to avoid unwanted disposal of waste into the sewer which could cause blockage. The outlet of the biodigester is fitted with an irrigation meter to measure flow; this discharges via a 30 m

pipeline to the municipal sewer. The biodigester is the prefabricated Agama BiogasPro unit (http://www.biogaspro.com) which can handle 1080 litres of effluent per day. We anticipate that 40-50 households (via 10 toilets) could be serviced by this biodigester. This will be confirmed once the research team have collected sufficient data from the flow meter.

Figure 3.13: Map of Section E, Enkanini

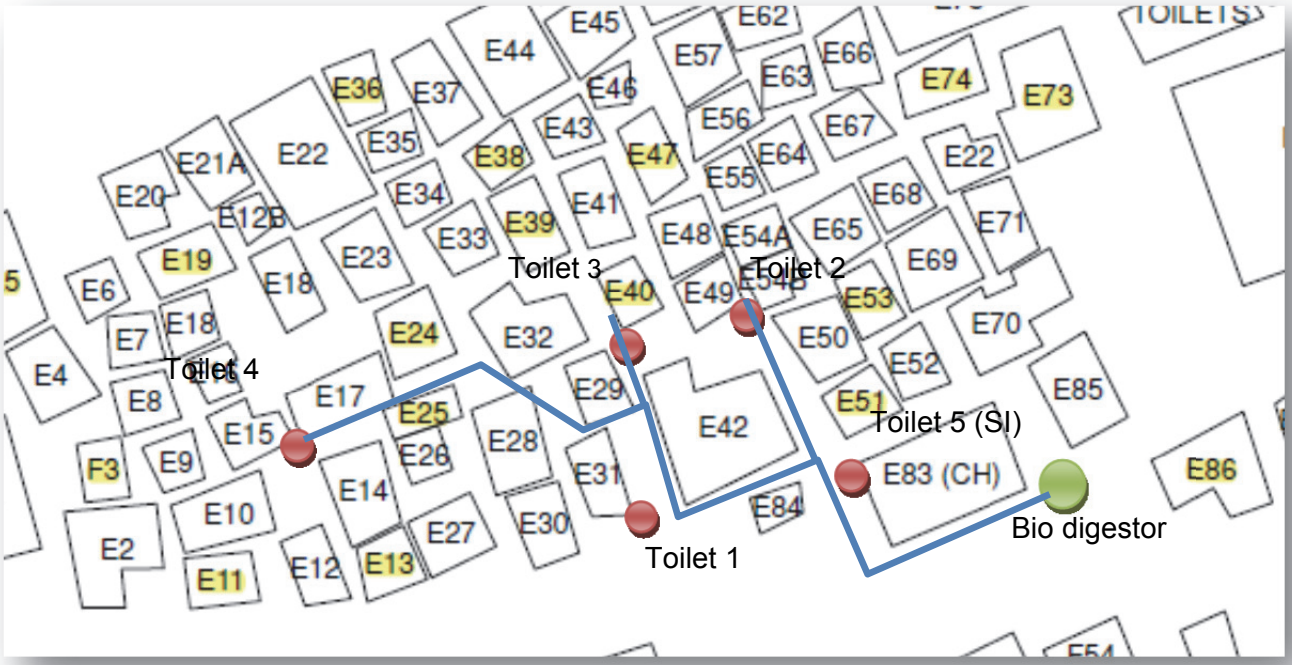


Figure 3.14: Yondela (Co-researcher, discussing possible toilet positions with future users

The start of this project was delayed due to a severe fire in the study area. Shack fires are an annual occurrence at Enkanini and mean that infrastructure must be resilient to fires. In consultation with the community, it was agreed to construct the toilets from precast concrete panels. This despite the size of the precast units being slightly less than was hoped for (1.1 x 1.1 m). The precast panel were purchased from Concretex who modified the base slab to accommodate the 45 degree outlet pipe. A modular concrete system was required to enable the toilets to be carried through tight spaces. The panels were laid on two courses of sandbags filled with a dry sand cement mix.

Figure 3.15: Biodigester installation

A good foundation is essential at Enkanini where surface erosion is a high risk due to the steep topography and low permeability soil. Because the toilets have outward opening doors, they are just large enough to install a handwash basin and bucket inside.

Figure 3.16: Placing the roof slab

Figure 3.17: External view of toilet

Figure 3.18: Toilet 1 complete with basin

Table 3.3: Enkanini Toilet Cost Summary

Description	Unit	Qty	Unit Cost	Amount
Toilet Structure	per Toilet	5	R 3 000.00	R 15 000.00
Toilet Plumbing	per Toilet	5	R 1 200.00	R 6 000.00
Communal Sewer	per m	75	R 70.00	R 5 250.00
Biodigester	per unit	1	R 20 900.00	R 20 900.00
50 mm Sewer Connection	per m	40	R 50.00	R 2 000.00
Total				R 49 150.00
Cost Per Toilet				**R 9 830.00**
Cost per HH				**R 1 966.00**

An additional 5 toilets may be connected to the biodigester to utilise spare capacity, reducing the cost per toilet to approximately R 7,400 and the cost per HH to less than R1,500 subject to the length of sewer

3.2.6 The Sustainability Institute

The intention was to install pour flush toilets to replace all existing toilets at the Sustainability Institute. However, due to the small size of the cubicles and the technical challenges associated with retrofitting the pour flush units to existing drainage, meant that it was not

possible to install the pour flush toilets. We did however undertake a monitoring programme to evaluate the impact of water consumption on toilet selection. This was achieved as follows:

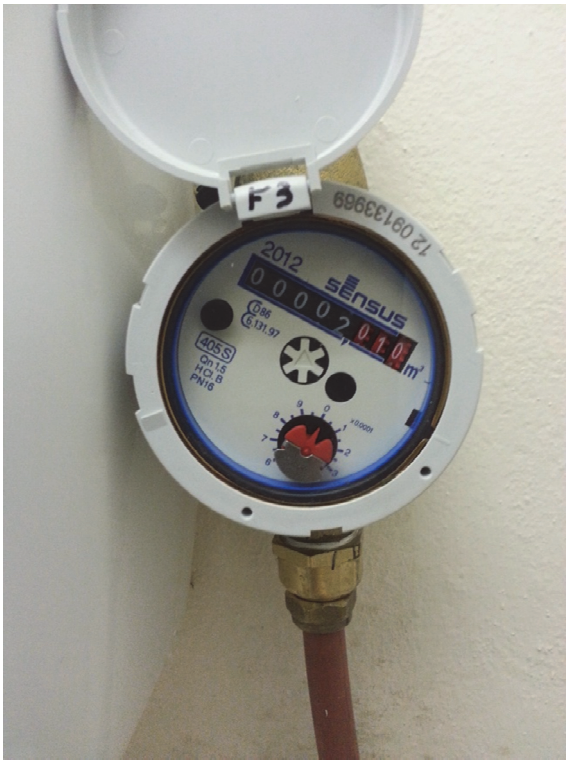
i. *Install meters to measure the volume per flush of each toilet and user preference for a particular cubicle*

ii. *Place signage on each of the cubicle doors to alert the user to the volume of water used by the different toilets and then monitor whether there is a shift in preference based on the volume of water used.*

iii. *Install the pour flush toilets and repeat ii)*

The above process is necessary to analyse the impact of known water consumption on usage patterns and to hypothesise the demand for a low volume toilet design. We intend to install a more compact toilet once this has been developed through the WRC Micro-Flush project.

Figure 3.19:& 3.20: Meter Installation



4 MONITORING & EVALUATION

4.1 Introduction

Monitoring was primarily undertaken via user interviews, un-announced site visits and frequent telephonic communications with the people responsible for operating the scheme within the given community. Regular meter reading was also undertaken at the Sustainability Institute.

4.2 Klein Begin

During preliminary discussions with the community we were led to understand that households would share the pour flush toilets that were installed within the existing toilet blocks. However it seems that despite the toilets not functioning for several months, even years, that there is an underlying agreement that a specific cubicle is for the exclusive use of a designated household. As such, the 'communal' toilet is only being used by three households.

The toilets at Klein Begin were not being well maintained with evidence of smearing and lack of use of the handwash basins. However, despite this apparent neglect, the toilets continue to work without blockage even when adjacent 'conventional' flush toilets have become blocked.

4.3 Klipheuwel

The system is operated by Biocycle who have recently established a BSF plant within the community. To date, they have not had to attend to any blockages and all toilets have been clear during site inspections. The toilets seem to be well looked after and there is a great sense of pride from the households which have benefitted from the toilets. Users report to using one or two jugs (1 to 2 litres) of water to flush. Not all users seem to be using the handwash basins.

The community have requested that the pour flush toilets be used to replace the existing AfriSan toilets.

4.4 Enkanini

The system is operated by Simphiwe who is appointed as the 'Hub Operator' to maintain the biodigester, pour flush toilets and associated drainage. Simphiwe is paid through homeowner contributions of R25 per household per month. Households have shown a willingness to contribute for an 'improved' level of service compared with the communal full flush toilets, approximately 100 m from the pilot site. Part of the revenue is set aside for spares and to contribute to seed funding for future phases. The detail of this institutional

model will be documented in Lauren Tavener-Smith's PhD thesis, but it has been interesting to observe the communities willingness to pay for a toilet shared between five self-selected households.

The toilets have been kept extremely clean throughout the monitoring period with the groups electing to have a daily cleaning rota. The hand basin discharging to the bucket has worked well as a means to collect greywater while simultaneously enforcing good hygiene practice. Most users report using two jugs (2 litres) to flush the toilets; the first is used to clear the pan and the second to clean.

During the three months since installation, there has only been a single blockage caused by the attempted flushing of an un-ripped newspaper used for anal cleansing (evidence suggests that the municipalities communal toilets block almost daily). This presented the opportunity to train the operator to unblock the toilet, the full process of which was complete in less than a minute. Whilst most users are opting to use toilet paper, there is some evidence of newspaper being used without problems.

If this pilot is successful it is hoped that we will be able to demonstrate a net reduction in wastewater flow and that the Municipality will allow permanent discharge into the municipal sewer. Plans are already underway to add an additional 5 toilets to the existing digester. The Informal Settlement Management Department of Stellenbosch Municipality has expressed significant interest in the pour flush technology, and have requested more details for possible incorporation into their standard specifications.

4.5 Sustainability Institute

The current toilets which are all the same design have flush volumes ranging from 4.2 to 6.8 litres. The measured flush volumes were clearly identified on the toilet doors and the impact of this new knowledge on user preference was monitored.

Figure 4.1: Sample Poster

Table 4.1: User preference expressed as percentage of users

Toilet	Flush Volume	31/5/13	7/6/13	7/6/13	18/6/13	24/6/13	8/7/13	13/7/13	7/8/13
F1	6.8	9%	9%	14%	8%	7%	10%	1%	21%
F2	5.4	4%	8%	14%	4%	8%	7%	16%	5%
F3	4.3	14%	8%	15%	8%	6%	7%	14%	19%
F4	4.6	14%	16%	13%	14%	18%	20%	29%	15%
F5	7.5	25%	27%	15%	42%	33%	29%	19%	25%
F6	4.7	16%	11%	15%	9%	10%	10%	10%	6%
F7	5.1	18%	21%	14%	16%	18%	17%	11%	10%
M1	5.4	36%	29%	30%	45%	48%	37%	40%	37%
M2	5.1	20%	8%	8%	14%	11%	18%	17%	21%
M3	6.4	44%	63%	62%	41%	41%	45%	42%	42%

Water Use signage installed

M1 and F7 were located adjacent to the window which seems to influence selection; however there was an apparent move away from men's toilet with the highest water demand, although no obvious trend was observed in the ladies toilets, perhaps due to the presence of sanitary bins in a limited number of the toilets.

It is proposed to install the Micro Flush toilet at the Sustainability Institute once the prototype is complete (to be developed by Maluti GSM as part of a separate WRC project). The impact of user preference will be monitored against the baseline data.

Based on the average consumption rates it is estimated that conversion of all 10 toilets to 1 litre flush will save nearly 140 m^3 of water per year.

5 CONCLUSIONS

The feedback during the installation process has been extremely positive with all sites being receptive to the technology and observations to date confirming that the pour flush design is working well without blockage.

The following points are the keys highlights and conclusions of the pour flush trials to date:

- *Successful installation of the pour flush toilets at 3 different sites.*
- *In the case of Enkanini a willingness to contribute to the maintenance of the facility.*
- *Communal pour flush toilets at Klein Begin working and being kept clean, despite failure of previous flush toilets due to lack of household servicing.*
- *2 litres is commonly used to flush and clean the toilet.*
- *Magrieta's finishing touches to her toilet in Klipheuwel.*
- *Stellenbosch Municipality considering incorporating Pour Flush into their standard specifications for informal settlements.*
- *The pour flush design works well with a simplified sewerage network.*
- *The low volume flush of the pour flush toilet is complimentary to anaerobic treatment systems where hydraulic retention time is a key factor.*
- *Multi Stakeholder Collaboration (Municipalities, Communities, Sustainability Institute, Students, Biocycle, Lighthouse Foundation, Sustainable Engineering Solutions).*
- *Pour flush case studies discussed at the SI's Ecological Design Module.*
- *The cost of a pour flush installation may be less than the typical costs of a VIP latrine and significantly less than full waterborne sewerage.*

6 RECOMMENDATIONS

The following recommendations would benefit from further research:

For all retrofit applications it would be useful to raise the outlet of the pour flush toilet to match the international sanitary ware standard whereby the centre of the 110 mm outlet is 190 mm above floor level (approx. 170 mm for the 65 mm pour flush outlet). This could be achieved by raising the floor of the toilet and creating a new step or raising the pan of the pour flush toilet.

The design of the P-Trap should be reviewed and optimised with the following considerations:

- *Potential blockage risk from cans and drinks bottles due to the deep narrow outlet.*
- *Total length of P-Trap could be reduced by increasing the pipe diameter slightly and reducing the radius of the bend.*

The South African Bureau of Standards (SABS) should be engaged to modify current standards and building regulations to accommodate the pour flush pedestal design.

The impact of reduced hydraulic load of pour flush toilet on the performance of biodigesters and appropriate loading rates with other organic materials.

Maluti GSM will continue to engage with the respective communities and municipalities to seek opportunities to extend the pilot to a wider user base.

7 REFERENCES

Still, D and Louton, B. (2012) Piloting and Testing the Pour Flush Latrine Technology for its Applicability in South Africa. WRC Research Report K5/1887/1/12, p.1-100.

APPENDICES:

Appendix A: Pour Flush User Poster

YENZA I THOBHI LAKHO ELIGUNGXULEKAYO LISEBENZA KAKUHLE

Hlamba izandla zakho xa ugqiba kusebenzisa(i Toilet)kubangela sikusele ukwanda kwezifo.

Galela I litha okanye zibembini zamanzi ethobhini ukuze ugungxule.

Sebenzisa i Brashi ukecoceni iThobhi.

i Toilet paper isebenza ngcono kune Phepha ndaba,(newspaper)

Sebenzisa i phepha ndaba elincinane kwaye ugxuzule phambi kokub usebenzise kwakhona.

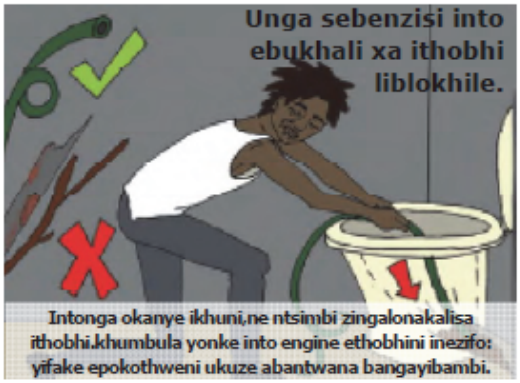
Unga faki inkunkuma okanye ikhemikhali ezinobungozi ethobhini, zingbangela umonakalo.

Ithobhi alisokuze lissebenze kakuhle ukuba ugxuzulela, amalaphu,nezikhuseli (condoms) amanaphukeni,ne pads,ezixomezeleli zenwele (hair extension) ,iplastiki, umadubula,okanye nyiphi na itlobo ye oyili.

Unga sebenzisi manzi ubuhlamba ngawo izitya, ekugungxuleni, amanye amanzi alungile.

Amanzi wezitya aneoyili kalunganga anga blokisa iThobhi.

Unga sebenzisi into ebukhali xa ithobhi liblokhile.



Intonga okanye ikhuni,ne ntsimbi zingalonakalisa ithobhi.khumbula yonke into engine ethobhini inezifo: yifake epokothweni ukuze abantwana bangayibambi.

MALUTI GSM Consulting Engineers
Jonny Harris: 021 881 3082

Appendix B: Planned Artwork for Enkanini Toilets

Pour flush toilets, Enkanini: Signage and Painting. July 2013
submitted by: Susan Immelman (Masters in Visual Arts, Stellenbosch University, Gwendolyn Meyer (PGDiP, Sustainability Institute)

message

Flushes on 1 litre of water compared to 6 litres plus for conventional toilets

Flushes on greywater

Does not require mains water connection

Can help to reduce sewer flooding

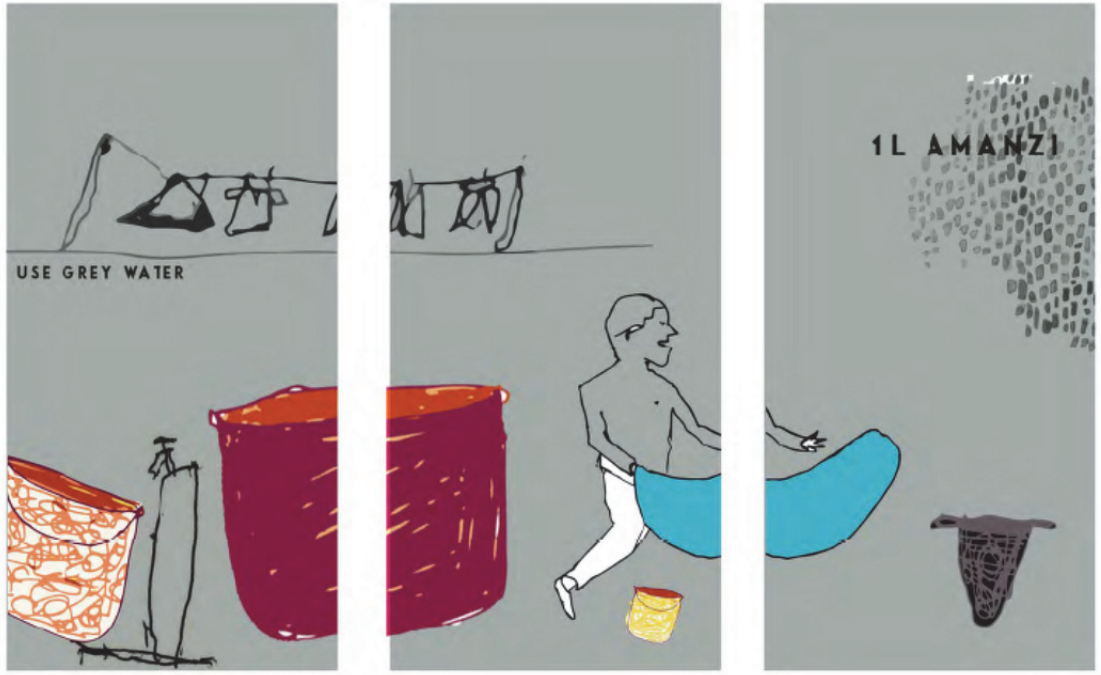
(Johnny Harris, Maluti Water- email correspondence via Lorraine, June 24th)

"I don't particularly like this poster as it is too busy. I think it also says more than it needs to for the households, i.e. some of the info is only relevant to Simpiwe."
(ibid)

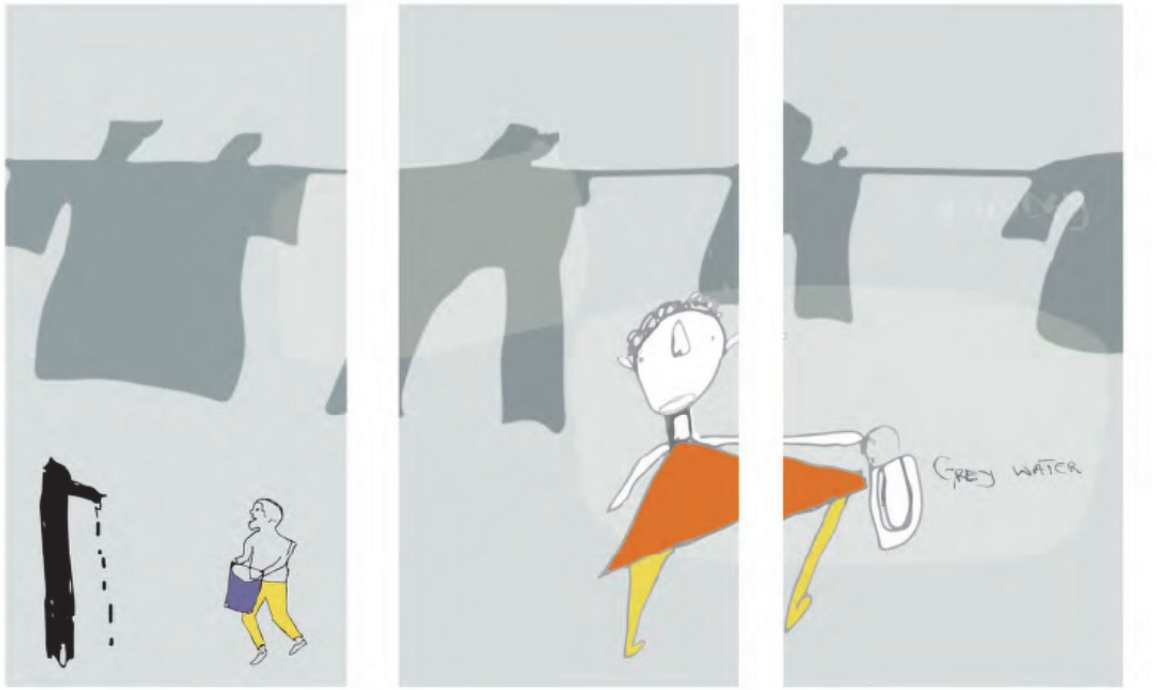
concept 1 | street view

Stylized from co-producer's drawings. Although it portrays one bucket, there is a missing component and that is, the link to water re- use may not be clear.

Also consider some sort of visual identifier (logo) forproject.


USE GREY WATER
1L AMANZI

concept 1 | variations



concept 1 | variations

concept 2 | street view

Connect toilet system to saving water or the idea of conserving resources by using symbolic imagery and words.

This as a secondary stratergy (after the right to sanitation) to educate, and recruit users.

Appropriate words in Xhosa.

Appendix C: Enkanini Questionnaires

		TOILET CHOICES			PRICES (per household)			
		Toilet sharing	Distance	Cleaning	Service charges: all toilets	Capital charges: individual toilets	Service charge	Capital
Option 1	Public toilet	1 toilet for 35 households	At toilet block	Yes	OMRR + cleaning	N/A	R0 (free)	R0 (free)
Option 2	Shared toilet	1 toilet for 5 households	Close to your home	No	OMRR	N/A	R50 per month	R0 (free)
Option 3	Shared toilet	1 toilet for 5 households	Close to your home	Yes	OMRR + cleaning	N/A	R80 per month	R0 (free)
Option 4	Individual toilet	1 toilet for 1 household	In your home	No	OMRR	Once off	R50 per month	R1500 once off
Option 5	Individual toilet	1 toilet for 1 household	Outside your home	No	OMRR	Once off	R50 per month	R3500 once off
Option 6	Individual toilet	1 toilet for 1 household	In your home	No	OMRR	2 year monthly installments	R50 per month	R65 per month
Option 7	Individual toilet	1 toilet for 1 household	Outside your home	No	OMRR	2 year monthly installments	R50 per month	R150 per month

OPTION 2: Shared toilet

1 toilet for 5 households

Close to your home

NO cleaning

Full coverage for operations, maintenance, repair and replacement costs

Service charge = R50 per household per month

Capital charge = R0 (free)

OPTION 3: Shared toilet

1 toilet for 5 households

Close to your home

With cleaning

Full coverage for operations, maintenance, repair and replacement costs

Service charge = R80 per household per month

Capital charge = R0 (free)

OPTION 4: Individual toilet

1 toilet for 1 household

Inside your home

NO cleaning

Full coverage for operations, maintenance, repair and replacement costs

Service charge = R50 per household per month

Capital charge = R1500 **once off**

OPTION 5: Individual toilet

1 toilet for 1 household

Outside your home

NO cleaning

Full coverage for operations, maintenance, repair and replacement costs

Service charge = R50 per household per month

Capital charge = R1500 **once off**

OPTION 6: Individual toilet

1 toilet for 1 household

Inside your home

NO cleaning

Full coverage for operations, maintenance, repair and replacement costs

Service charge = R50 per household per month

Capital charge = R65 **per month for 2 years**

OPTION 7: Individual toilet

1 toilet for 1 household

Outside your home

NO cleaning

Full coverage for operations, maintenance, repair and replacement costs

Service charge = R50 per household per month

Capital charge = R150 **per month for 2 years**

ENKANINI HOUSEHOLD SURVEY: Sanitation Focus	**July 2013**
This questionnaire is to be administered to an adult (person 18 years and older) member of a household living in Enkanini who can give information about other members in the household. *Instructions to Interviewers in italics*	

Interviewer details	
Interviewer Name	
Date of Interview	

Section	
A	Household Questionnaire Cover
B	Physical Conditions
C	Household Roster
D	Economic Activities, Earnings and Grants
E	Household Income and Spending
F	Household Savings, Remittances and Credit
G	Trust and Cooperation
H	Water and Sanitation
I	Water and Sanitation Willingness to Pay

SECTION A: HOUSEHOLD QUESTIONNAIRE COVER

A1	Respondent Name	
A2	Shack Number	
A3	Respondent Phone Number	

SECTION B: PHYSICAL CHARACTERISTICS

B1	What is the **main** material used for the walls, roof and floors of your house? *(Interviewer: Tick ONE material for each)*			
		B1.1. Walls	B1.2 Roof	B1.2 Floors
	Corrugated Iron/ Zinc			
	Wood			
	Bricks			
	Cement blocks/ concrete			
	Mixture of mud and cement			
	Wattle and daub			
	Clay soil			
	Tiles over clay soil			
	Carpet over clay soil			
	Tiles over brick/ concrete			
	Carpet over brick/ concrete			

B2	How many rooms does your house have?
	_____ rooms

SECTION C: HOUSEHOLD ROSTER

	C1	C2	C3	C4	C5	C6
PCode	Who are the members of this household? *Interviewer: Please enter names of individual household members*	What is [...]'s relationship to the household head? *Interviewer: See code sheet [C2-Relationship Codes]*	Is […] a male or a female?	What is [..]'s age?	How many years of schooling does [...] have? *Interviewer: See code sheet [C5 Education Codes]*	How long has […] been living in Enkanini?
		Relationship CODE	Male / Female	Years	Education CODE	Years
01						
02						
03						
04						
05						
06						
07						
08						
09						

C7	Is […] a member of any of the following groups? *(Interviewer: Tick ALL that apply for each person)*					
PCode	Church	Savings Group	Burial Society	Community Committee	Street Committee	Political organisation
01						
02						
03						
04						
05						
06						
07						
08						
09						

	C8. Did anyone in this house receive income from **government grants** last month?	C9. Which government support grant did [...] receive? *Interviewer: See code sheet for Grant Codes*
PCode	Yes/ No	Grant CODE
01		
02		
03		
04		
05		
06		
07		
08		
09		

SECTION D: Economic Activities, Earnings, Grants and Household Income
This section should only be asked for household members 16 years and older (except D1- ask for all)

	D1	D2	D3	D4	D5
	Which category best describes [...]? *Please record for all household members* *Interviewer: See code sheet for question Economic Status codes*	What kind of work does [...] usually do in this job? In other words, what is your occupation or job title? *Interviewer: Record at least two words, eg car sales person, office cleaner, vegetable farmer, primary school teacher, etc.*	How much did [...] **earn last month**? *Interviewer: income after deductions for tax, pension etc if employed. If self employed then income less business expenses?*	Please would you look at the show card and point out the most accurate earnings category for **last month's** take home pay? *Interviewer: Show the income categories on the show card and record the appropriate code for the respondent's monthly earnings*	How many hours did [...] work for money in the **last week**?
PCode	Economic Status CODE	Description	Rands	Income Category CODE	Hours
01			R		
02			R		
03			R		
04			R		
05			R		
06			R		
07			R		

SECTION E: HOUSEHOLD INCOME and SPENDING

E1	What was the **total amount of income from all sources**, earnings and grants etc that this **household** received **last month**?			
			Refuse	Don't know
E1.1	Amount in Rands **per month**	R		
E1.2	Income Category *Interviewer: Show the card for Household Income [Code Sheet D15]*	Income CODE		

E2	How much money did this household **spend** in the **last 30 days**?	
		Amount in Rands
E2.1	Rent	R
E2.2	Transport	R
E2.3	Food and drink include take-away *(Interviewer: exclude toiletries and other non-food and drink groceries)*	R
E2.5	Paraffin, electricity, gas, candles etc	R
E2.6	Membership fees *(Interviewer: Prompt re. including monthly payments to church)*	R
E2.8	Clothes and shoes (cash and lay-bye payments	R
E2.9	Toiletries (soap, shampoo, hair products, creams etc)	R
E2.10	Cigarettes, alcohol)	
E2.11	Airtime	R
E2.12	Household Items (furniture, bedding, materials for home maintenance etc)	R
E2.13	Medical (traditional healer/ doctor/ clinic/ medicine)	R
E2.14	School fees	R
E2.15	Other- please specify _____	R
E2.16	Other- please specify _____	R

E3	How much money did this household **spend** on all its expenses in the **last 30 days**?			
			Refuse	Don't know
E3.1	Amount in Rands **per month**	R_____		
E3.2	Income Category *Interviewer: Show the card for Household Income [Code Sheet D15]*	Income CODE		

SECTION F: HOUSEHOLD SAVING, REMITTENCES AND CREDIT

F1	How much did this household save in the last 30 days, eg in an umgalelo?	
	Amount in Rands	R_____

F2	How much money did this household send back to their rural family in the last month?			
			Refuse	Don't know
	Amount in Rands **per month**	R		

F3	Does anyone in this household use credit, ie is anyone currently paying back a loan or lay-bye?	
	Yes	
	No	

SECTION G: TRUST AND COOPERATION

G1.	Please indicate whether you **agree** or **disagree** with the following statements		
		Agree	Disagree
G1.1	People in Enkanini look out for their own families but are not much concerned with the welfare of the community.		
G1.2	Relations amongst people living in Enkanini are generally peaceful and cooperative.		
G1.3	People living in Enkanini meet to talk about issues of common concern (eg crime, grey water etc).		
G1.4	People living in Enkanini take action together to address common issues.		
G1.5	People living in Enkanini have an influence in making Enkanini a better place to live.		
G1.6	People living in Enkanini generally trust each other		
G1.7	If I had to go somewhere for a night, I would trust my neighbours to look after my house		
G1.8	People in Enkanini can commit to common community goals		
G1.9	We can be united in the community vision that we present to outsiders		
G1.10	Working together we can improve the quality of life in the community		
G1.11	Our community can cooperate to resolve shared problems		
G1.12	It is possible to influence the municipality if we act together		

G2	Do differences between people cause divisions amongst people in Enkanini? *Interviewer: Please tick ALL that apply*		
		Yes	No
G2.1	Differences between men and women		
G2.2	Differences in long time and short time residents		
G2.3	Differences in religious beliefs		
G2.4	Differences in political party affiliation		
G2.5	Differences in race/ language/ ethnic background		

G3. In the following scenarios who would people turn to for support? *Interviewer: please tick ALL that apply*		
	G3.1. If your neighbour suffered a NON-economic loss (eg death of their mother) who can they turn to for non- financial support?	G3.2. If someone suffered an economic loss (eg loses their job) who can they turn to for financial assistance?
Family		
Neighbours		
Friends		
Church		
Community leader		
Business leader		
Political leader		
Employer		
Other Please specify:		

G4. If your neighbour faced the following choice, which one would he/ she prefer? *Interviewer: Please tick ONE*	
Own a piece of land that is 10m2 for their own family to use alone	
Own a piece of land that is 25m2 that they share with one other family	

SECTION H: WATER AND SANITATION

H1	From where do you collect your water? (*Interviewer: Tick ONE)*	
	A tap at your house	
	A tap at your neighbour's house	
	Communal tap at toilet block	
	Other (please specify) _____	

H2. What containers/ buckets do you use to collect water in?		
	H2.1 What size containers do you use to collect water? About how many litres does each carry?	H2.2 How many times per day do you fill each of your water containers?
	Volume (litres)	Times filled per day
Container 1		
Container 2		
Container 3		

H3. How many litres of water do you think your household brings to the house every day?					
0 – 20 litres	21 – 40 litres	41 – 60 litres	61 – 80 litres	81 – 100 litres	More than 100 litres

H4	How many litres of water do you think your household uses per day for the following? *(Interviewer: Only record water that you bring from the tap to your house.)*	
		Volume (litres)
H4.1	Drinking	
H4.2	Cooking	
H4.3	Bathing (yourself)	
H4.4	Cleaning (your dishes and home)	
H4.5	Laundry that you do at your house *(Not laundry that you do at the public taps)*	
H4.6	Watering garden	
H4.7	Other (please specify) _____	

H5. Where does your household dispose of used water? *(Interviewer: Tick ONE disposal point for each type of used water)*			
	H5.1 Cooking water	H5.2 Cleaning water	H5.3 Bathing water
Roadside			
Bush			
Channel			
Toilet			
Garden			

H6. When you are in Enkanini, where do people in your household go to the toilet if you have to urinate/ number 1?		
	H6.1 During the day (*tick ONE*)	H6.2 At night (*tick ONE*)
Bush toilet/ open defecation		
Public toilet		
Own toilet at home		
Neighbour's toilet		
Bucket at home		
Other (please specify)		

H7. When you are in Enkanini, where do people in your household go to the toilet if you have to defecate/ number 2?		
	H7.1 During the day (*tick ONE)*	H7.2 At night (*tick ONE)*
Bush toilet/ open defecation		
Public toilet		
Own toilet at home		
Neighbour's toilet		
Bucket at home		
Other (please specify)		

H8. Where does your household throw the contents of your toilet bucket? *(Interviewer: Tick ONE)*					
Roadside	Bush	Drainage channel	Toilet	Garden	Manhole/ sewer

H9. Do you ever have to wait in a queue to use the toilet?	
Yes	
No	

H10	What are the main problems with current toilets in Enkanini? *(Interviewer: RANK from (1) most problematic to (6) least problematic)*	
H10.1	Too far to walk	
H10.2	Dangerous to use at night	
H10.3	Congestion/ too busy	
H10.4	Unclean	
H10.5	No privacy	
H10.6	Toilet blockages	
H10.7	Other (please specify)	

H11. Has anyone is your household experienced diarhhoea in the past month?	
Yes	
No	

H12. Would you like a toilet closer to your house?	
Yes	
No	

H13. Why has your household not installed a toilet at your home? *(Interviewer: Tick ONE)*	
Too expensive	
Public toilets are adequate	
Do not know how to and do not know anyone to install for me	
We do not have space	
It could bring trouble from the municipality	
I don't know how long I am going to be in Enkanini so I do not want to invest	
I don't have security of tenure so I do not want to invest/ threat of being relocated	
I am too far away from the sewer	
Other reason (Please specify)	

H14. What are the main benefits that you think you would get from having either a shared or your own toilet closer to your house? *(Interviewer: RANK from (1) greatest benefit to (6) least benefit)*	
Takes less time	
Safety	
Avoid congestion	
Toilet will be cleaner	
More privacy	
My shack will increase in value	
Other (please specify)	

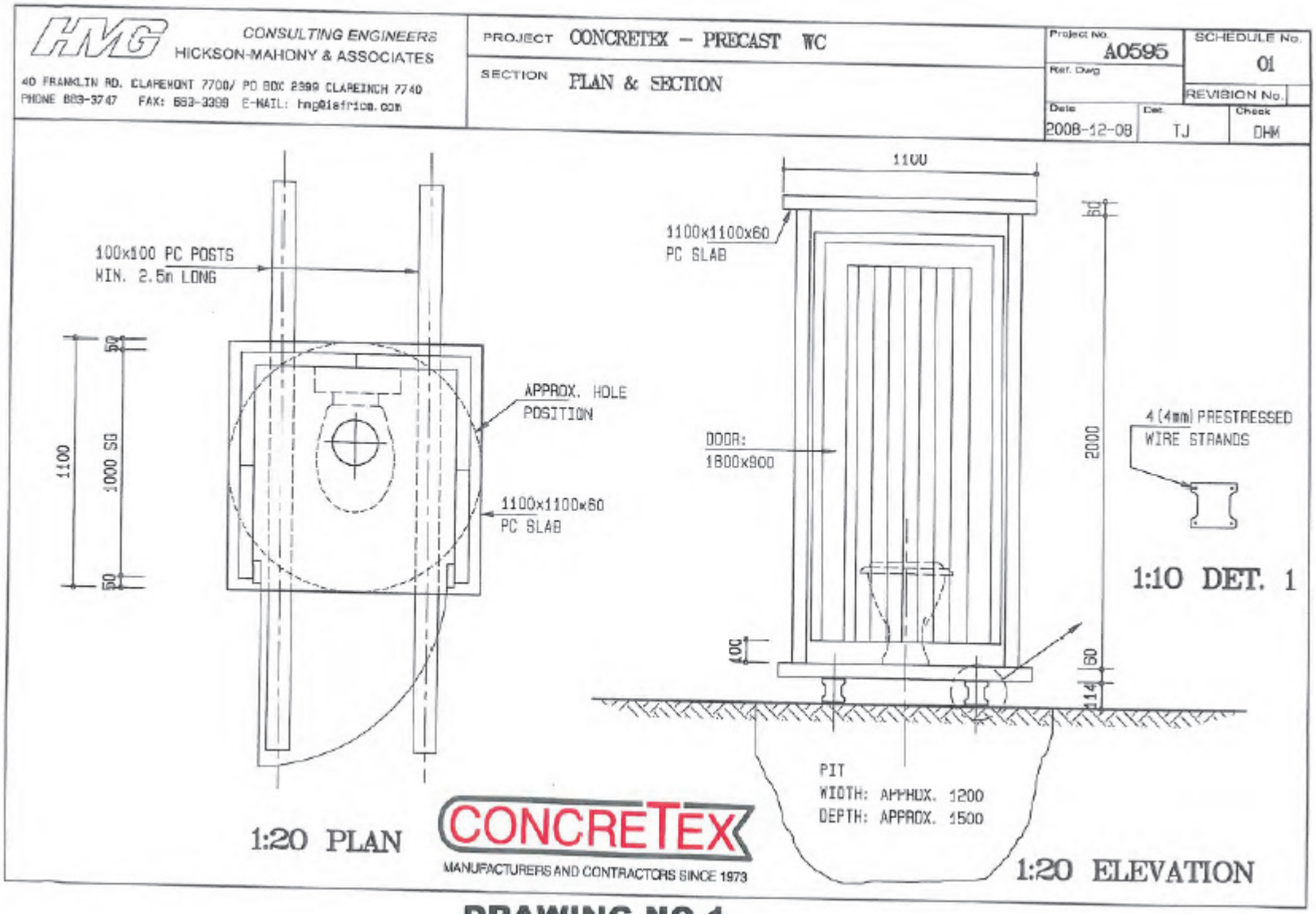
H15. How much do you think you would be able to sell your house for today?	
Amount in Rands	R

H16. How much do you think you would be able to sell your house for if it had an individual toilet on the plot?	
Amount in Rands	R

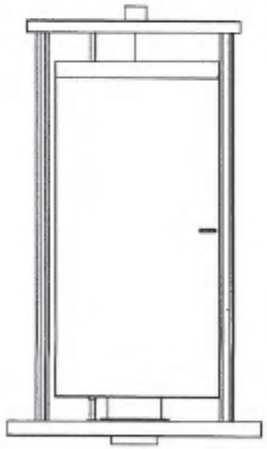
END

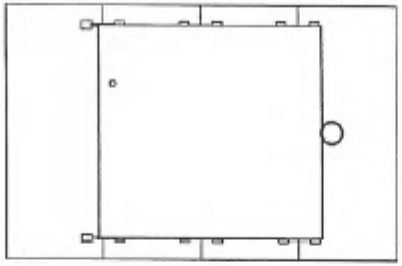
Enkosi, Thank you.

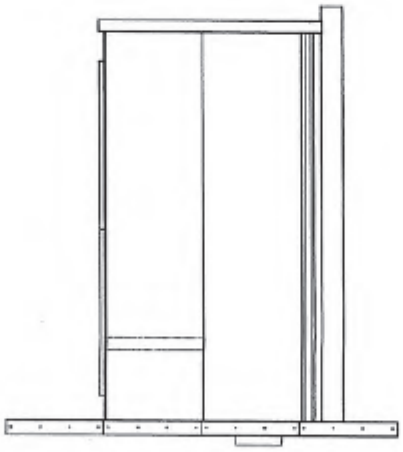
Appendix D: Prefab Toilet Design

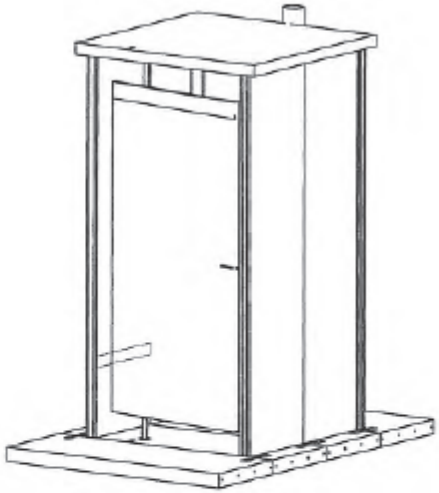

HMG
CONSULTING ENGINEERS
HICKSON-MAHONY & ASSOCIATES
40 FRANKLIN RD. CLAREMONT 7700/ PO BOX 2399 CLAREINCH 7740
PHONE 683-3747 FAX: 683-3399 E-MAIL: hmg@iafrica.com
PROJECT CONCRETEX – PRECAST WC
SECTION PLAN & SECTION
Project No. A0595
SCHEDULE No. 01
Ref. Dwg
REVISION No.
Date 2008-12-08
Det. TJ
Check DHM
100x100 PC POSTS
MIN. 2.5m LONG
APPROX. HOLE POSITION
1100x1100x60 PC SLAB
1100
1000 SQ
50
1:20 PLAN
CONCRETEX
MANUFACTURERS AND CONTRACTORS SINCE 1973
1100
1100x1100x60 PC SLAB
DOOR: 1800x900
2000
4 (4mm) PRESTRESSED WIRE STRANDS
1:10 DET. 1
400
60
114
PIT
WIDTH: APPROX. 1200
DEPTH: APPROX. 1500
1:20 ELEVATION

DRAWING NO 1









VIP Toilet

A3

PAVEPRINT CC
CK 1991/025325/23
VAT REG NO: 4870132846
TRADING AS:-

CONCRETEX

MANUFACTURERS AND CONTRACTORS SINCE 1973

SILICA ROAD
ATHLONE INDUSTRIA II
TEL: 021 691 0027 / 8 / 9
WEB SITE: www.concretex.co.za

P O BOX 24177
LANSDOWNE 7779
FAX: 021 691 0072
EMAIL: concretex@mweb.co.za

PRECAST CONCRETE REINFORCED VENTILATED IMPROVED PIT LATRINE. 1

SPECIFICATION

GENERAL DESCRIPTION:

- The system comprises of a pitliner below the ground made up of concrete panels bolted together.
- A concrete slab is placed on top of the liner walls forming the floor base for the top of the toilet structure.
- This top structure also consists of concrete panels bolted together with a concrete roof, steel door, pedestal and a vent pipe.

1. PIT LINER

1.1. Excavate ground +/- 1 100mm in depth by +/- 1 300mm in width and +/- 1700mm in length.

1.2. Use the steel template supplied, set level and place 4 x concrete pads to receive the pitline panels.

1.3. Position panels on base pads and bolt together using the 1 200mm and 1 600mm panels.

1.4 Reinforcement: Panels are reinforced using prestressed steel of the crimped variety and to be free of rust, loose scale, flux, grease or oil substances and shall in general comply with BS5896.
The required concrete compressive strength in all prefabricated prestressed elements shall be a minimum of 25mpa at 28 days determined in accordance with SABS method 863.

2. FLOOR SLAB:

The dimensions of the floor slab must be 1 300mm x 2 000mm x 75mm thick. These panels are reinforced as per 1,4.to withstand a live load of 300 kg plus the weight of the concrete top structure applied on an area 1.0m² in the centre of the slab.

3. TOP STRUCTURE:

3.1. Concrete panels 60mm thick x 500mm wide x 2 000mm in length are erected on top of the floor slab in a vertical position and are bolted together to form a cubicle measuring 1 000 x 1 000 x 2000mm

3.2. Roof slab for top structure: Lightweight concrete panel 1 100 x 1 100 x 60mm is placed on top of the structure wall panels.

3.3. Reinforcement as per 1.4 and steel mesh ref. 100

3.4. Door: Galvanised steel door suitably braced and measuring 815mm x 1 800mm high opening outwards on a steel pivotal hinge.

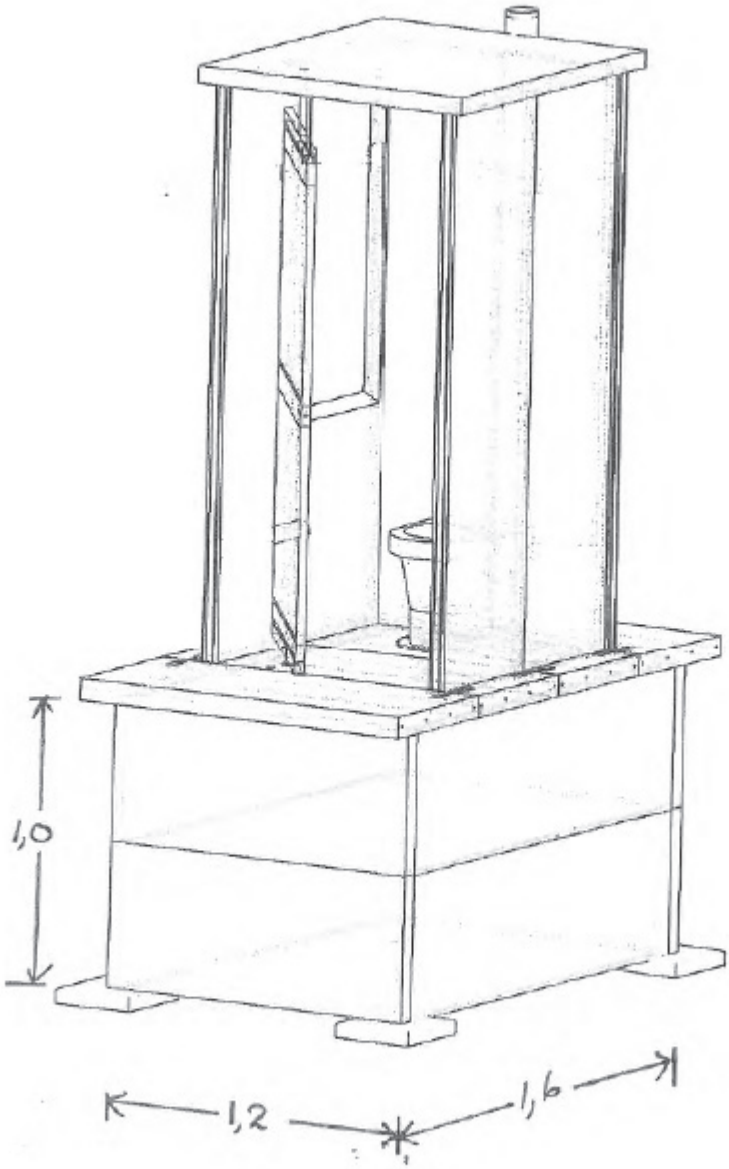
4. PLASTIC PEDESTAL:

The plastic pedestal (Atlas Plastics type VIP200) with plastic toilet seat and cover is fitted into an opening in the floor slab which leads into the pitliner.

THE VENT PIPE:

The vent pipe is 110mm in diameter x 2 400mm in length in black plastic (UV resistant) with vent cowl and fly screen.
Holder bats x 2 to be fixed to the rear wall of the top structure to hold the vent pipe in position.
The pipe is inserted into a hole in the floor slab to ventilate the pit.

DRAWING NO 2



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