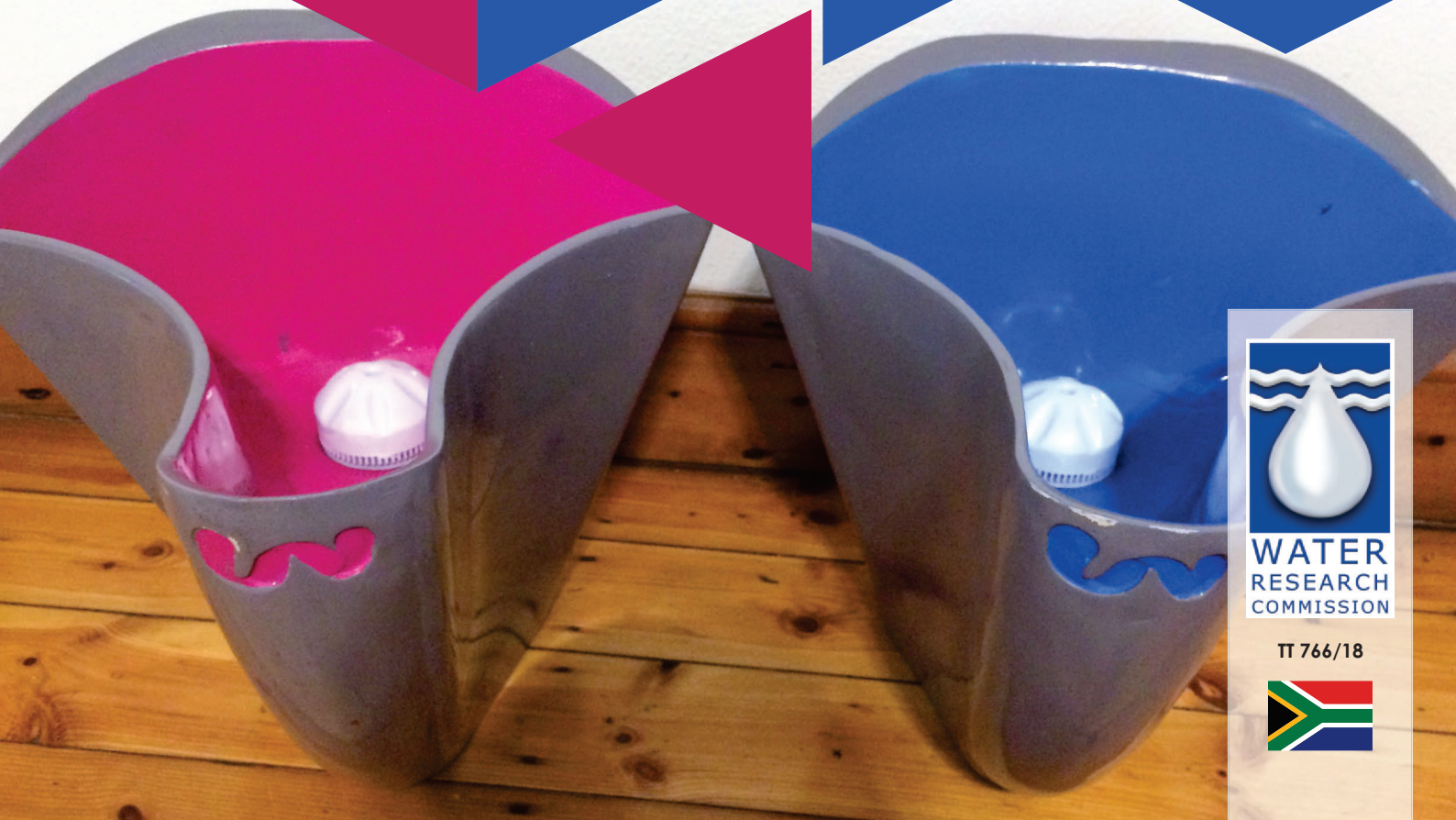
TESTING THE ACCEPTABILITY OF URINALS AMONG GIRLS AND WOMEN IN SOUTH AFRICA

Jeanette Neethling



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Testing the Acceptability of Urinals among Girls and Women in South Africa

Report to the
Water Research Commission

by

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Executive Summary

Urinals are sometimes used to reduce the number of toilets required at a school, which typically reduces the cost per child served. Urinals can also reduce queues for school toilets and the need for small learners to use pit toilets that are not suitable for them. Urinals for girls and women have been used with success in some countries and are easy for young children to use, are cheaper and faster to build than toilets and reduce unpleasant smells (Adams et al., 2009). For younger children, using urinals for urinating may be easier, cleaner and safer than using pedestals, where they may have to use their hands to lift themselves onto a soiled toilet seat. For older children, defecating may happen only rarely at school and the primary need for a toilet may be for urination. Where school facilities are inadequate it may be possible to add urinals more cheaply and quickly as an interim measure while resources are collected for improving toilets. Urinals for girls can sometimes be left unenclosed in the case of young girls who do not require privacy from each other. For older girls, urinal stalls with a water source can provide a means for cleaning and washing during menstruation. Provision of urinals for girls would have to take into account the need for bins for disposal of wiping materials.

Though there appear to be many potential benefits of urinals for women and girls, there has been limited work to test the acceptability and practicality of using urinals for women and girls. Poor situations in school and public toilets do not keep girls and women from using them, and thus improved options are likely to be used. This study focused on the options for public female urinals and their application in schools and other public spaces in South Africa. Through literature review, initial acceptability study, and a field trial with a female urinal in a number of schools, this study demonstrated the potential for acceptance of the introduction of urinals for girls and women in school and public toilets in South Africa. During the field trial, seventy-six percent of girls who used the urinals said that their experience was either good or excellent, and 98 percent said that they would use urinals if they were available at their school. These field trials also demonstrated that as long as urinals are kept clean; adequate education is provided; and privacy is provided, adoption and acceptance of the technology in schools is highly likely.

Due to the extensive benefits that can be realised and the acceptance demonstrated in this study, it is recommended that the Department of Education add female urinals as an option in their toolkit to address shortages in school sanitation and pursue refined designs for both trough and wall-mounted urinals. In a context where many schools have too few toilets compared to the number of learners, urinals for boys and girls could solve this problem more cheaply and effectively than new toilet blocks.

Not only should female urinals be seen as a way to increase the number of toilet seats in a school, but they should be considered as a way to improve girls' experience with using the toilet at schools. This study highlighted that girls would prefer to use urinals if they were available at school, mostly due to their cleanliness and improved hygiene. Providing girls with an alternative to sitting on a dirty seat over a deep pit of sludge should be given priority. If urinals are provided for girls, girls will be forced much less frequently to use pit or full-flush toilets, which at schools, often put their health and safety at risk.

On a larger scale, further work in the implementation of female urinals in schools and elsewhere can contribute to a number of the United Nation's Sustainable Development Goals (SDG). Implementation of adequate female urinals will contribute to SDG 6, Target 2, to "achieve access to adequate and equitable sanitation and hygiene for all." Female urinals in schools will contribute to SDG 3, good health and well-being, by providing a more hygienic and less odorous experience in toilets for girls. Female urinals in schools can contribute to SDG 5, gender inequality, particularly where schools have pit toilets. While boys avoid using dangerous and unhygienic pit toilets by urinating in urinals or outside, girls are presently forced to use the toilets at all times. Female urinals have potential to contribute to SDG 2, zero hunger, by providing women's urine, in addition to men's, for recovery of nutrients for use in fertiliser. It is simple to harvest urine from men, since they use urinals for urination. However, unless urine diversion is used in toilets, women's urine is mixed with faeces and lost in the pit or down the sewer. Implementing urinals for women allows for simple harvesting of urine from the other half of the population.

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1 Introduction

Urinals are sometimes used to reduce the number of toilets required at a school, which typically reduces the cost per child served. Urinals can also reduce queues for school toilets and the need for small learners to use pit toilets that are not suitable for them. Urinals for girls and women have been used with success in some countries and are easy for young children to use, are cheaper and faster to build than toilets and reduce unpleasant smells (Adams et al., 2009). For younger children, using urinals for urinating may be easier, cleaner and safer than using pedestals, where they may have to use their hands to lift themselves onto a soiled toilet seat. For older children, defecating may happen only rarely at school and the primary need for a toilet may be for urination. Where school facilities are inadequate it may be possible to add urinals more cheaply and quickly as an interim measure while resources are collected for improving toilets. Urinals for girls can sometimes be left unenclosed in the case of young girls who do not require privacy from each other. For older girls, urinal stalls with a water source can provide a means for cleaning and washing during menstruation. Provision of urinals for girls would have to take into account the need for bins for disposal of wiping materials.

Previous WRC research (WRC-2381) assessed the state of sanitation in rural schools and identified a number of issues that may be addressed by installing urinals for boys *and* girls. The advantages that could be realised through urinals, as identified in that research, are as follows:

- **Safety:** If the school has pit toilets with some risk to learners of falling into the pit, the availability of urinals limits their exposure to this risk to just those occasions when they need to defecate.

- **Reduces burden on toilets:** If toilets are reserved for defecation, the demand for them decreases dramatically. This can ease the situation at schools where the number of toilets is inadequate, and reduce the number of toilets needed in the design of new toilet blocks. Where school facilities are inadequate it may be possible to add urinals more cheaply and quickly as an interim measure while resources are collected for improving toilets.

- **Reduces exposure to disease:** Using a urinal rather than a toilet eliminates contact with key disease transmission points in the toilets, including the toilet seat and flush handle, and possibly with the door handle as well. Small children using toilets that are too big for them may have to use their hands to lift themselves onto a soiled toilet seat, which represents an unacceptable level of potential exposure to disease.

- **Overcomes difference in user size:** A trough urinal can serve users of any size, overcoming difficulties for young learners who have to climb onto toilet seats if they are too high for them.

- **Reduces odour:** The unpleasant smell of pit latrines is partially caused by the mixing of urine and faeces, which produces ammonia. Separate disposal of urine eliminates it from the pit, reducing the offensive smell. In addition, urine around toilets is often a big contributor to the unpleasantness of public toilets. By eliminating urine from the toilets, the environment will be cleaner, drier and less smelly.

- **Can be located close to the classrooms:** While many schools prefer to locate pit toilets some distance from the administration block and classrooms to prevent the unpleasant smell of the toilets from reaching these buildings, this is at the cost of safety and convenience. A small block of urinals, however, can be located closer to the classrooms or playground, making it easier for staff to monitor their use and reducing the amount of time learners spend during break or class using the toilet.

- **Reduces toilet use time**: A urinal is quicker to use than a toilet, reducing waiting times and congestion in the toilets.

- **Aids in sludge management:** As a result of eliminating urine to a large extent from the pit, sludge will be drier, making it easier to handle during manual emptying.

- **Possible use of urine in agriculture:** Urine is an excellent fertiliser and on its own does not contain the pathogens that may be present in faeces. If the school has established vegetable gardens, urine from urinals can be collected in a tank and used for this purpose. Urine should be diluted to 1 part urine: 10 parts water and poured onto the soil, avoiding the leaves of plants. Nutrient recovery technologies for separating beneficial nitrogen and phosphorus from urine are also in development and widely used in some contexts.

- **Reduces water usage for flush toilets:** Where flush toilets are in use, excessive water is often wasted to flush urine. By eliminating these wasted flushes through the use of waterless urinals, water will be conserved.

Though there appear to be many potential benefits of urinals for women and girls, there has been limited work to test the acceptability and practicality of using urinals for women and girls. In the published literature, the following applications for female urinals have been identified: 1) hand-held urinary devices with suggested use in outdoor settings or in public toilets; 2) the same hand-held urinary devices used in assisting patients in the medical field; and 3) various urinal designs meant for public spaces in order to reduce wait time in public toilets and afford women certain hygienic benefits. This study focuses on the options for public female urinals and their application in schools and other public spaces in South Africa.

2 Project Overview

The aims of this project were as follows:

1. To investigate the experience of organisations which have implemented female urinals in schools or public toilets and understand the variables and issues influencing their success or failure
2. To establish a criteria for technology design and identify female urinal designs most suitable for school toilets and test the technical performance of these
3. To identify key maintenance and management issues to support female urinal technologies, develop management strategies, and test and refine these
4. To assess the perceived acceptability of female urinals among school girls and document responses, attitudes, and feedback through facilitated focus groups in schools
5. To test the interest, acceptance, and commitment of schools to the use of urine for growing vegetables
6. To provide a recommendation regarding the acceptability of female urinals in rural schools and accompanying guidance on selecting a design and providing appropriate management support
7. To disseminate findings to participants, DoH, DoE, DPW, DWS, WSAs and the relevant development and academic communities.

The original project plan included a literature review and field testing and monitoring of two urinal designs in two schools in the Pietermaritzburg area. The literature review would investigate previous projects with female urinals in schools and other public places and determine the major considerations in implementing female urinals. Field testing would include installation of urinals, focus groups and regular surveys with learners, and interviews with principals, cleaners, and staff members. Through the field trials, the project team would identify the key management and maintenance issues associated with female urinals as well as the attitudes and preferences of users.

A review of the available literature found no data regarding the willingness of women and girls in South Africa to use urinals. The need for urinals for women has not yet been properly assessed, and this was determined to be a gap in the existing research. As a result, the project team slightly modified the approach to the project, in order to collect a wider range of responses and provide an initial assessment of the feasibility of implementing female urinals in South Africa. The final project plan included the following activities:

1. Literature review
2. Initial acceptability study with girls at school and women in taxi ranks about the need for and willingness to try female urinals
3. Urinal field testing study, using a portable female urinal set up at 5 different schools and collecting data from users

The results of the above activities are described below, in addition to implementation guidelines for female urinals in schools.

3 Literature Review

To provide a starting point for further research, an initial literature review was carried out. This investigated existing urinal designs and any past projects that had been carried out using female urinals. Urinals for women have been tested and demonstrated in various contexts (outside of South Africa) but, while user feedback is generally positive it is too soon to be able to say conclusively whether they should be widely replicated. In the South African context in particular, urinals in public settings have not been tested.

3.1 Urinal Design

Urinals come in three basic designs: hand-held urinals for women; trough urinals; and wall-mounted individual urinals. Hand-held urinals are not discussed in this report, but trough urinals and wall-mounted versions are discussed below, as two options for school and public toilets. The use of both designs for men has been widespread for some time.

3.1.1 Trough Urinals

A simple trough urinal design is shown in Figure 1. Urine runs into a 110 mm floor-level channel which is separated from the screeded concrete floor by a raised foot kerb. When used by males, they simply stand at the edge of the channel and urinate normally. Females using this configuration would squat and direct their urine to the gutter. The urinal channel leads to a drain pipe that empties into a soak pit or into the pit of a VIP toilet. The walls of the urinal compartment should be plastered and steel floated up to approximately 1.2 m above the floor and painted with a washable epoxy or acrylic paint (or if funds permit a stainless steel urinal can be fitted). A robust screen or grid is needed to prevent debris from blocking the channel outlet. Dividers can be placed between the urinals spaces with at least 600 mm allocated for each person. As urinals in toilet blocks can be smelly, some schools have constructed them separately from the toilets, unroofed, allowing them to be dried by the sun or rinsed by rain. (Deverill & Still, 1998)

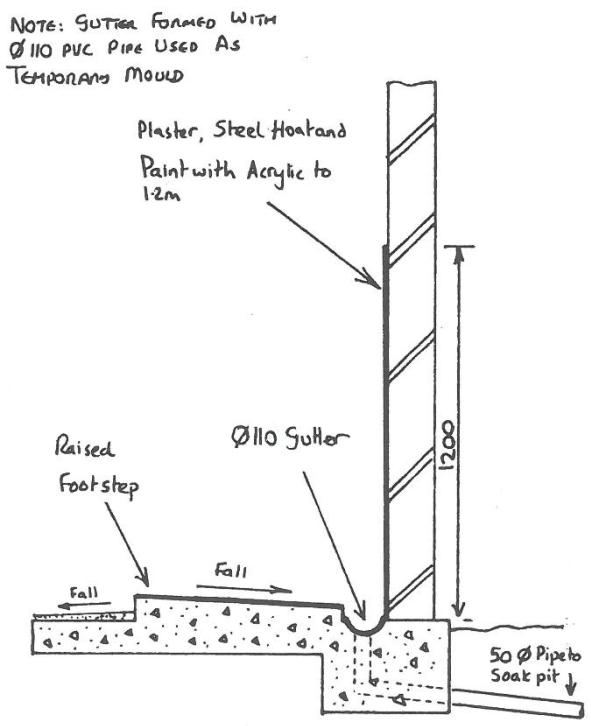

Figure 1: Urinal design (Deverill & Still, 1998)

The most detailed design of female urinals located to date is the "School Toilet/Urinal Design and Drawing" booklet developed by UNICEF for Nepal, which provides detailed design for trough urinals in schools. The booklet contains designs for schools of varying numbers of students and suggests spacing, pipe slopes, and a layout for disposal. This booklet is attached as Appendix A, and one plan drawing from the booklet is shown in Figure 2.

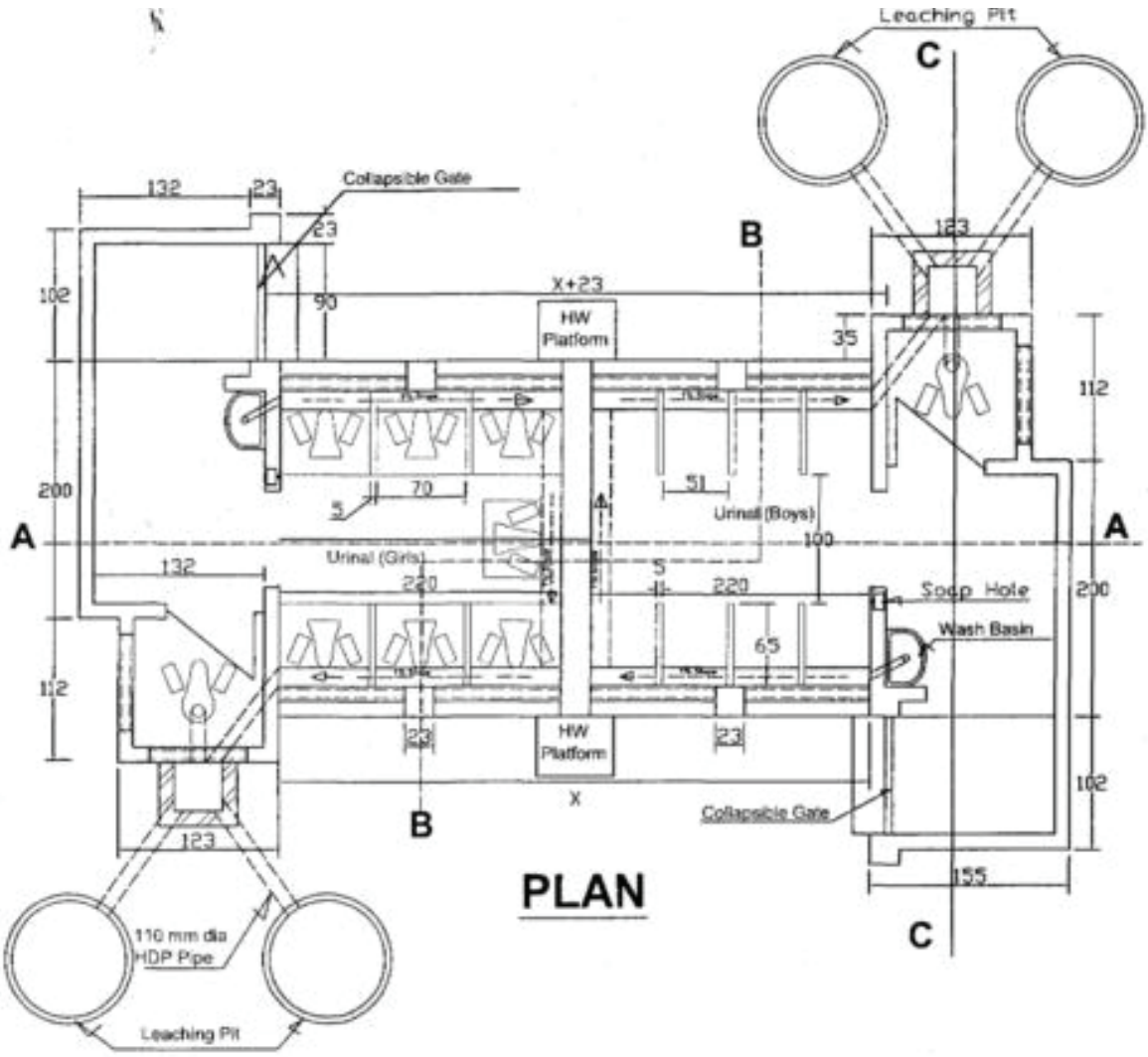

Figure 2: Drawing in plan of female and male urinals for a school (UNICEF, 2006)

3.1.1.1 Case study: Trough urinals for boys in a South African school

Trough urinals for boys are very common in South African schools. As with all school toilets, these must be designed with maintenance in mind. This includes selecting materials and finishes that will repel, rather than absorb urine; avoiding crevices and cracks that can be difficult to clean; and providing an adequate slope in the trough so that urine flows freely and does not puddle. Photos in Figure 3, Figure 4, and Figure 5 show an existing urinal for boys at Phayiphini High School before and after some simple adjustments were made. While the design of a trough urinal for girls would be slightly different (such as including space for squatting, rather than standing, to urinate), the same design-for-maintenance principles can be applied.

Figure 3: Phayiphini Urinal 1 – The design of this urinal uses tiles to protect the wall. However, water-resistant material, such as epoxy, has not been applied to the drain and surrounding area, which has led to excesses of urine soaking into the concrete, creating unpleasant odours. In addition, the drain is shallow and not properly sloped, leading to insufficient drainage.

Figure 4: Phayiphini Urinal 2 – This urinal in another block of boys' toilets at the school is slightly better than Urinal 1, in that the tile work extends to the floor around the urinal and that a gutter has been used to create a drain that is more water-resistant, providing better drainage. However, the area in front of the urinal is again not painted with water-resistant epoxy, leading to the same odour issues as in Urinal 1. As can be seen in the photo, cracks and edges in the urinal also make it difficult to clean.

Figure 5: To improve the situation in Urinal 1, the urinal was made deeper and the drain formed using a gutter. The concrete frame was then painted with water-resistant paint, to ensure that any urine missing the drain would not soak into the concrete and to make cleaning the urinal much

easier. These improvements made the urinal more manageable, and these design elements should be incorporated from the beginning.

3.1.2 Wall-Mounted Urinals

The typical design for public male urinals consists of ceramic or plastic wall-mounted urinals, as shown in Figure 6. Similar designs have been developed for women, which have a narrow edge, allowing women to stand or squat and straddle the wall-mounted urinal. Slightly squatting over a wall-mounted urinal is not that different to the way that many women are already accustomed to squat over public toilet seats for hygiene reasons. One example of wall-mounted design for female urinals is shown in Figure 7, and more are shown in the next section. These versions are typically made out of plastic in low-cost applications and can be used with or without water. The flushing version uses water to flush the urine away and to seal the drain so that the urine smell does not cause problems. The waterless option will have a different type of trap consisting of either a solid or liquid barrier for smells.

Figure 6: Typical wall-mounted ceramic urinal at Laduma High School (left) and plastic urinals at Shayabantu High School (right)

Figure 7: Example of a female wall mounted urinal with space to straddle and squat or stand ("Female Urinal Tested in Europe," 2012)

As can be seen in from Figure 6 and Figure 7, the designs of male and female wall mounted urinals are not that different. The female design is longer and narrower, with a deeper basin.

3.2 Previous projects and studies

This section describes designs and lessons learnt from a variety of projects involving female urinals in different contexts.

3.2.1 The Sanistand (United States)

The first mass-produced female urinal was the Sanistand fixture, which was manufactured by American Standard in the United States between 1950 and 1973. This urinal, shown in Figure 8, was made out of ceramic and available in a variety of colours. According to an advertisement by American Standard, shown in Figure 9, the company received feedback from 5 029 users at department stores, bus terminals, railroad stations, hotels, restaurants, theatres, and service stations. The questionnaires showed a 90 percent acceptance rate of the Sanistand; however, the urinals were discontinued in 1973.

Figure 8: Photograph of a Sanistand from between 1964 and 1967 installed in a university dorm (http://rebrn.com/re/iff-im-staying-in-a-dormitory-in-the-us-built-in-the-s-and-there-626706/)

Figure 9: An advertisement for the Sanistand from American-Standard (http://cheesegod.com/wp-content/uploads/2013/03/sanistadAd.jpg)

Figure 10: A notice about how to use the Sanistand (http://farm1.static.flickr.com/156/415931702_1d2ac00771_b.jpg)

3.2.2 The She-Inal (United States)

The next attempt in the United States to create a female urinal was the She-Inal, a design patented in 1991 by Kathie K. Jones (US Patent 4,985,940), who started the company called Urinette (Jones, 1991). The design utilised a flexible hose with a funnel on top, which would allow women to hold the funnel and stand to urinate, directing the urine to a bowl. These urinals used about the same amount of space as male urinals. The urinal units were sold at a cost of 556 USD each, exceeding the average cost of standard toilets (275 to 300 USD) and male urinals (340 USD) at the time (Gunts & Haar, 1991). There was some interest in the She-inal for use at a stadium in Baltimore, but following testing, women were greatly opposed to the design and thus, it was not adopted (Vick, 1997). About 700 She-inals were manufactured before Urinette sold the manufacturing rights (Pohlen, 2003). It is likely that the use of a shared funnel was one of the major deterrents for women, as this afforded them very little hygiene.

Figure 11: A She-inal installed in a Dairy Queen restaurant in Port Charlotte, Florida (Pohlen, 2003)

3.2.3 Female urinals in Europe

In Europe, the Pollee, a female urinal designed by the Danish Design Bureau accommodates four users at once and, being a portable system, has been used at public events such as concerts (Etherington, 2011). These urinals, shown in Figure 12, received positive feedback from the women who used them, as they greatly reduced wait times at a Roskilde Festival, where women previously had to wait in long queues or simply chose to urinate on the fence (Etherington, 2011). One designer, Christian Pagh, said, "The Roskilde project was all about testing our idea: a simple, open-air pee solution for girls. Quite frankly: the girls' response at the festival was overwhelming. We have talked to hundreds of girls and although we received ideas for improvement, the overall message was: We use it and we love it!" (Etherington, 2011) Women straddle the trough with their backs to the drains, as shown in Figure 13, and dispose of toilet paper in the bin shown in Figure 14. Though the ones pictured here do not provide privacy, other options were tested that included dividing walls while still using the space efficiently.

Figure 12: Pollee female urinal tested at a public music festival (Etherington, 2011)

Figure 13: Demonstration of use of the Pollee female urinal with women squatting over the trough (Etherington, 2011)

Figure 14: Pollee urinals with bin for toilet paper provided (Etherington, 2011)

The female urinal shown in Figure 15 was designed by Uridan, a Danish company, and has been tested in public toilets in Germany and India ("Female Urinal Tested in Europe," 2012). Users reported that they found it more hygienic but it took time to get used to disposing of toilet paper in a bin ("Female Urinal Tested in Europe," 2012).

Figure 15: Female urinal developed by Uridan and used in Germany and India ("Female Urinal Tested in Europe," 2012)

3.2.4 Mirembe Infant Primary School, Uganda

In 2008, a collaborative team in Uganda installed and assessed girls' urinals at an infant primary school. Mirembe Infant Primary School did not receive government aid and had over 800 children at the time. The head teacher noticed that pupils sometimes spent 10-15 minutes queueing for the toilets. In addition, urination facilities were shared by boys and girls, and the head teacher suspected that this was affecting class attendance. The project was initiated by the principal of the school, who contacted Community Integrated Development Initiatives (CIDI) and requested that they construct new latrines with girls' washrooms and urinals. CIDI constructed 2 washrooms and 2 girls' urinals, established a Health and Sanitation Club and assessed the intervention. The Health and Sanitation Club, which included learners from the school, was pivotal to the management and cleanliness of the urinals and toilets. (Achiro et al., 2009)

The urinal design consisted of marked spaces for feet, so that learners would squat over a sloping (45° angle) channel which leads to a main drainage channel. This slope allowed for easy flow and drainage of urine and limited splashing. The urinal was also built without a roof, allowing direct sunlight to dry the urinal and rain to wash urine down the drain to reduce stagnation. These urinals are shown in Figure 16. (Achiro et al., 2009)

Figure 16: Girls' urinal at a school in Uganda (Achiro et al., 2009)

From focus groups with the Health and Sanitation Club members, the main advantages of urinals included: decreased congestion, privacy, easy cleaning and maintenance, and convenience when located near a washroom for use during menstruation. One teacher also indicated the benefits of shorter queues after the urinals were installed. Staff at four neighbouring schools expressed an interest in having urinals for girls based on their success at Mirembe. (Achiro et al., 2009)

Though this project took place in 2008, there has been no additional information published on the long-term success of this urinal intervention and the urinals have not been monitored by the implementing agent (Rose Mwambazi, personal communication, 24 April 2017).

3.2.5 UNICEF Strategic Sanitation and Hygiene Promotion Pilot, Malawi

In 2004, the Government of Malawi and UNICEF implemented a pilot project in 100 schools across two districts, which included gender and child-friendly facilities, hygiene education, and outreach activities to communities. One aspect of the programme was construction of urinals for both boys and girls. In the schools where urinals were constructed, the teachers and pupils requested that more be installed. Girls appreciated the urinal design that incorporated foot rests and urine pans leading to a common urine channel and drainage pipe. This design is friendlier for girls to use when squatting, but splashing and pooling of urine were identified as problems with the design. The biggest construction issue identified in this pilot was drainage, as the slope and smoothness of the urine channels was often insufficient, leading to standing urine and smelly conditions. (DeGabriele, Keast & Msukwa, 2004)

In addition to the design described above, one design in this study was meant to use run-off from an external hand-washing tank to flush urine from the channel. However, this design was not tested in the study, as the hand-washing tank was not properly designed. The other adjustment to urinal design was to include walls dividing younger girls from older girls for increased privacy. (DeGabriele et al., 2004)

Overall, girls' urinals were viable and accepted in Malawi primary schools. The pilot study suggests that urinals should be constructed prior to construction of new latrines, relieving pressure on the latrines. In this pilot study, which included a wide range of interventions specifically geared towards girls, urinals were identified as the most important girl-friendly feature, reducing pressure on latrines and allowing most or all girls access to facilities during all break periods. (DeGabriele et al., 2004)

Figure 17: A girls' urinal in Malawi, which does not provide adequate privacy (Freeman, Erhard, Fehr & Ogden, 2011)

3.2.6 A study on urinal usage at schools, Kenya

Freeman et al. (2012) assessed the provision and usage of urinals at schools in Kenya and the potential for urinal construction to improve sanitation access in schools. Forty-five schools were surveyed, with a median of 782 pupils per school surveyed. Sixty-seven percent of schools had at least 1 urinal for boys, and 19% had one urinal for girls. One key finding of this study was that the majority of pupils in schools use the sanitation facilities for urination, rather than defecation, during the school day. Of the girls surveyed, 57% *only* urinate at school; 32% defecate at least once a day; and 11% do not use the facilities at all. (Freeman et al., 2012)

The study found that girls in schools without urinals were 50 percent less likely to use the school toilets, compared with those in schools with urinals. However, 82% of girls at schools with urinals who reported urinating during break time did not actually use the urinals, but rather used the latrines or the bush. The main reasons for being uncomfortable with the urinals included lack of privacy, long ques, and uncleanliness. These two pieces of data appear to contradict one another: girls at schools without urinals were much less likely to use the school toilets, but a large majority of girls at schools *with* urinals did not use the urinals provided. In other words, girls were not encouraged to use the urinals that were provided. Overall, more pupils in schools with urinals used the sanitation facilities, suggesting that these facilities might be better maintained and less congested than those in schools without urinals. By direct observation of toilet usage, this study developed a guideline for urinals and latrines at schools: 12 girls per urinal and 33 girls per latrine. (Freeman et al., 2012)

3.2.7 SWASH+ Program in Nyanza Province, Kenya

SWASH+ was a five-year applied research program with the goal of identifying, developing and testing innovative approaches to school water, sanitation, and hygiene interventions in Nyanza Province, Kenya. One innovative aspect of the research was an assessment of acceptance of girls' urinals constructed by the Kenya Water for Health Organization (KWAHO) at three of the schools. Acceptance was determined through structured interviews with learners and staff members as well as unannounced visits to the schools. (MacMahon, 2009)

Each school had urinals contained in stalls with doors for privacy. Figure 18 shows one of the urinal stalls with tile floors that were reportedly easy to clean. During interviews, most of the girls praised the urinals for incorporation of mirrors, tile floors, handwashing stations, and the shape of the urinal. The raised foot blocks prevented urine from splashing on the girls' feet. Some girls suggested that the addition of running water in the urinals would improve their experience, particularly during menstruation. Additionally, blood smears and faeces were reported in some urinals, which is mostly a behaviour-change issue. This must be considered especially in situations where learners are fearful of the pit latrines and may resort to using urinals for defecation. Pads were also reported to block some urinals, indicating that bins must be provided for pads and toilet paper and adequate training must be carried out. All head teachers and a number of students mentioned the benefit of less time spent queuing to relieve oneself. (MacMahon, 2009)

Figure 18: Urinal with tile floors, installed at Atono Primary, Kenya; the use of tile for the floors makes cleaning simpler

Overall, the urinals were used twice a day on average by each user, demonstrating high acceptance and usage. Though some small learners were afraid of the urinals at first, the overall emotional response to the urinals was good in this pilot. Learners generally felt comfortable and much safer compared with the alternative of using the bush. One student mentioned that the smell was improved compared to the pit latrine. Overall, interviewed learners ranked girls' urinals as their preferred place of urination, typically followed by household latrines, school latrines, and open defecation. (MacMahon, 2009)

Though this study demonstrated high acceptance, it also demonstrated the need for proper education and a cleaning regime to ensure success of the facilities. This suggests that schools are a good place to test the technology, since there is greater potential for monitoring and education than in an alternative public place, such as at taxi ranks.

3.2.8 Peepoople in Kibera, Kenya

Peepoople is a single-use, self-sanitising, biodegradable toilet that is meant to protect the environment and turn human waste into a resource. Peepoople has been used in schools in Kibera, Kenya since 2010 to serve a number of schools that have too few or no toilets at all. The school program provides Peepoo toilets to more than 100 schools and over 18 000 children, with collection points for the Peepoo bags are provided around Kibera. ("Peepoo bags at schools in low-income areas in Kenya," 2013)

Children collect a Peepoo device and go into one of the private stalls that have been constructed. The Peepoo bags are meant only for faeces and a little bit of urine, but not solely for urine. To accommodate urination, each stall has been equipped with a urinal, which leads directly to a soak pit, as collection and transport of urine is too expensive. Figure 19 shows the female urinals at this school, which were found clean and in working order during one reported visit ("Peepoo bags at schools in

low-income areas in Kenya," 2013). There has been very little reported about these urinals, as the main focus is on the Peepoople solution, but this experience does provide a simple design option for female urinals.

Figure 19: Girls' urinal in Kibera, Kenya as part of the Peepoople schools program ("Peepoo bags at schools in low-income areas in Kenya," 2013)

3.2.9 Female urinals in India

In India, the Ministry of Urban Development and Human Resources Development in its National School Sanitation Manual (no date) recommends 1 urinal for every 20 users, both girls and boys. Figure 20 shows a design for urinals for boys and girls, with raised footsteps provided for girls to prevent splashing, recommended by the Government of India ("School and Anganwadi toilet design -Norms and Options," 2004). The use of squatting, trough urinals in India is very appropriate, given that girls are used to squatting both for defecation and urination.

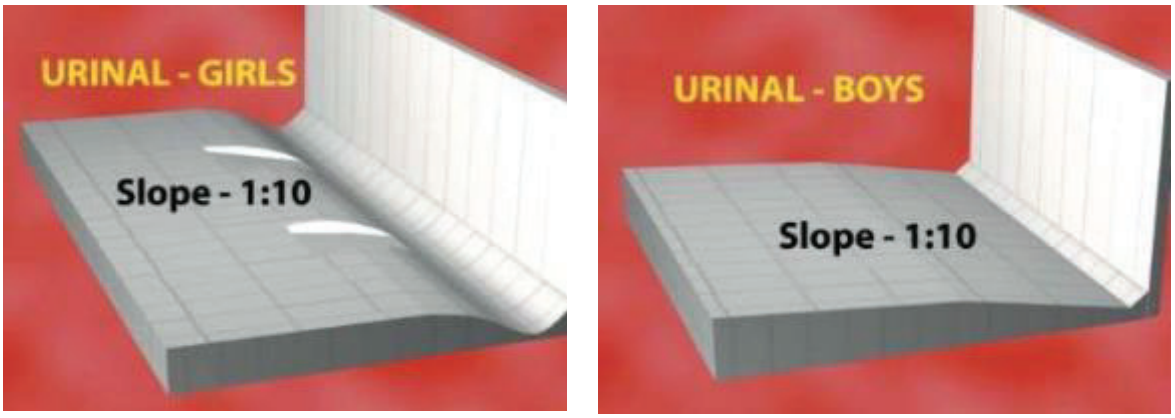

Figure 20: Designs for girls' and boys' urinals recommended by the Government of India

A non-profit organisation, *Wherever the Need*, has built an impressive urinal and ecological sanitation facility for girls at Valadore Girls' School in Tamil Nadu, India, which has 1 500 pupils ("Valadore Girls' School, Tamil Nadu," 2011). The facility, shown in Figure 21, Figure 22, and Figure 23, is designed as suggested by the Government of India ("School and Anganwadi toilet design -Norms and Options,"

2004). The design features numerous urination spaces, with ecological toilets included for defecation. Each urination space has partitions, giving learners more privacy during use. Urinals are used by squatting, and urine is drained away via a tiled channel. The design of the facility demonstrates a high regard for aesthetics, using attractive paint colours. Though attempts were made to contact the designers of the project, the research team was unsuccessful to gather any feedback on the success of these urinals.

Figure 21: The completed sanitation facility at Valadore Girls' School, providing approximately 90 spaces for urination and 5 ecological toilets for defecation

Figure 22: Walls mark the urination spaces and provide privacy to users

Figure 23: The squatting urinal design, including a ceramic squat pan with raised foot spaces to reduce splashing, and a tiled channel for discharge of urine

3.2.10 Female urinals in South Africa

In South Africa, the concept of a urinal for women has entered the sports arena with portable models such as the GoGirl and SheWee urinal funnels. The GoGirl markets itself as "the way to stand up to crowded, disgusting, distant or non-existent bathrooms." ("GoGirl," n.d.)

3.2.10.1 LiquidGold

LiquidGold is a start-up company originally from Johannesburg and based in the Netherlands, with the goal of changing the perception of urine from a waste stream to a resource. Through waterless urinal retrofits, the company is able to save businesses large amounts of water. At the same time, by collecting urine and treating it to produce a bio-friendly fertiliser, LiquidGold seeks to address issues of environmental health and food security. The company uses a simple treatment system to produce a phosphorus-rich (struvite) and a nitrogen-rich fertiliser (nitrified urine). LiquidGold's founder, Orion Herman, estimates that 163 litres of urine can produce 1 kg of struvite fertiliser (magnesium ammonium phosphate). LiquidGold has developed a non-return valve called the Ecoflow valve (Figure 24) which serves to prevent urine odours from travelling up the drainage pipe. This, therefore, eliminates the need for flushing water, providing LiquidGold with undiluted urine with which to produce fertiliser. Thus, LiquidGold's main focus has since been on retrofitting existing urinals in businesses with the Ecoflow valve and setting up reactors to produce fertiliser. The typical business model uses a service level agreement for 2-3 years, in which the property owners pay R120 per urinal each month for LiquidGold to carry out necessary cleaning and maintenance of the urinals. (O. Herman, personal communication, 8 September 2017)

Figure 24: LiquidGold Ecoflow valve for reducing odours in waterless urinals

The Department of Education advised LiquidGold that their product was too male-oriented and should be adapted to be used by both genders. They worked with female students at Vaal University of Technology (VUT) to develop a "gender-neutral toilet", for urine only. This allows LiquidGold to harvest urine from males and females as well as to address the need for a hygienic and safe alternative for girls and women. This urinal design is shown in Figure 25, and works the same as other wall-mounted urinals. (O. Herman, personal communication, 8 September 2017)

Figure 25: LiquidGold Weestand design, with Ecoflow valve installed

LiquidGold has also developed a containerised solution (the E-container), which provides these gender-neutral toilets for both boys and girls at schools (7 urinals for each gender). The details of this design are provided in Annexure B. One unit has been installed at Osizweni Primary School in Mpumalanga Province, where there are nearly 2 500 learners actively using the system. Throughout the year since installation, there have been only two instances of learners defecating in the urinals. While in-depth data is not publicly available yet, Herman reports that 2800 primary school learners are using the toilets, 65 percent of whom are girls, and the overall acceptance rate is 80 percent thus far. The company has run 3 training sessions with the users. Presently, 1500 litres of urine are produced each month, which allows LiquidGold to make 17 kg of fertiliser, which is enough for two sports fields. (O. Herman, personal communication, 18 December 2017)

In 2017 the E-containers cost R175 000 for a six metre long container and R350 000 for a twelve metre long containers inclusive of delivery, installation, and an educational programme. This price also includes treatment of the urine and reuse of the fertiliser in the environment. This equates to approximately R25 000 per seat. (O. Herman, personal communication, 18 December 2017)

3.3 Operational issues with urinals

3.3.1 Odours

Urine contains large amounts of urea, an organic form of nitrogen, which is quickly transformed to ammonia/um (NH_3/NH_4^+) after leaving the human body. Ammonia is the gaseous form, which causes the intense odours associated with urine. It is important to note that the introduction of water to urine speeds up the conversion process from urea to ammonia and thus can cause worse odours at the user interface, particularly when drainage is insufficient.

The best way to reduce odours in urinals is through effective urinal design incorporating ventilation, smooth, non-adsorbent construction materials, and sufficiently sloping urine channels to ensure that

urine does not pool. Some urinals are even built without roofs to aid in ventilation, though this presents a problem for users when it is raining.

The EcoSmellStop (ESS) valve manufactured by Addicom (www.addicom.net/) in South Africa allows the urine to flow through silicon curtains/flaps that stick together when wet but don't stick so tight that the urine couldn't get through. It has been used to upgrade standard urinals to waterless urinals. This is similar to the design of the Ecoflow valve by LiquidGold, described above.

The NGO *Women in Europe for a Common Future* (WECF) retro-fitted conventional flush urinals for a waterless operation by sealing them with a condom with a small hole cut into the tip, fitted over the outflow piping. This simple setup allows urine to drain by gravity into the discharge piping, but prevents odours from travelling up from the urine collection vessel. However, practitioners working in warm climates have reported that these condoms fail to work because they stick together within a short time, especially when the toilet is not used for a day. (Rieck, von Müench & Hoffman, 2013)

Charcoal can be used for odour control at the user interface through adsorption of urine odours. Charcoal contained in a mesh bag and placed directly in the urine-diverting section of the user interface has been applied in the Philippines, and shown to be an effective means of odour reduction (Gensch et al., 2010). The adsorptive capacity of the charcoal will be gradually exhausted, requiring the charcoal to be replaced periodically.

3.3.2 Scaling from the production of precipitates

The conversion of urea to ammonia/um and the increasing pH lead to the formation of phosphorus precipitates. These precipitates can cause scaling, which creates unsightly conditions in urinals, as shown in Figure 26. The precipitates can also clog urine collection and reuse systems, particularly when piping is of a small diameter. This can be avoided by increasing pipe diameters and reducing the potential for urine hydrolysis prior to the storage or infiltration system. It is impossible to completely control the hydrolysis of urine in piping systems as it has been demonstrated that most of the enzyme forming bacteria grow in piping systems (Udert et al., 2003). Dilution of urine with flush water or handwashing water can also enhance the formation of precipitated solids, which makes dilution disadvantageous in urine collection systems (Rieck et al., 2013).

Figure 26: Unsightly impact of scaling from urine and improper cleaning regime observed in Vezokuhle Primary School (left) and Imbubu Primary School (right)

3.3.3 Misuse issues

As described in the projects above, a number of issues may arise due to misuse of the urinal. The main issues involve putting things in a urinal that are not meant to be there (i.e. anything besides urine). Since girls are accustomed to sitting or squatting when defecating and urinating, there is a chance that girls may defecate in a urinal. This will cause unpleasant odours and create difficulties with cleaning. In addition, girls using toilet paper to wipe or disposing of pads may put them into the urinal instead of the bin, particularly in contexts where pit toilets are common, due to the practice of disposing of solid waste in toilets. These user issues can be addressed through effective education and messaging in the urinal units, coupled with regular follow up education.

3.4 Urine disposal and treatment

Urine can either be disposed or reused in agriculture, due to its high nutrient content. If it is to be disposed of, urine is directed to soak pits or infiltration trenches and then leached into the soil slowly. Due to its high nutrient content, urine cannot be disposed of into surface water, as it will cause eutrophication (the depletion of dissolved oxygen, with serious effects on aquatic biota, due to over stimulation of plant life). For treatment and reuse, urine is collected in storage containers and either applied with some dilution directly to fields or sent through other novel nutrient recovery processes, as described by (Udert et al., 2015). The main beneficial nutrients in urine include nitrogen, phosphorus, and potassium.

Reuse of urine in agriculture is often met with rejection due to cultural taboos around human waste. A number of studies have considered the acceptability of urine reuse in the South African context. One study, conducted in eThekwini with local farmers found that even though there are some other cultural uses of human urine, farmers had a negative perception about use of urine in agriculture (Benoit, 2012). Another study, which looked at households across Eastern Cape, Limpopo, and KwaZulu-Natal provinces, found that while some people were aware of the agricultural benefit of human faeces and willing to try it, most families were unaware of any benefits that could be realised from human urine (Duncker, Matsegebe & Moilwa, 2007). Another study in Limpopo with university students and staff found the same lack of knowledge of the potential for urine reuse (Mugivhisa, 2015). These three studies highlight that urine reuse for agriculture in South Africa will require extensive education and promotion before it is accepted by users.

4 Initial acceptability study

Given the limited experience with female urinals in South Africa, an acceptability survey was necessary to assess whether women and girls in South Africa would even consider using a urinal. With a new technology, user-centred design is a more effective approach than simply designing from within a closed room. This involves speaking to potential users of the product to get their input on how the product should be designed.

4.1 Methods

A few methods were used to collect and analyse data for this survey, and this project was used to test a tool called Open Data Kit (ODK). ODK was developed for collecting large amounts of data in the field, which is then stored on a server, where it can be quickly observed and exported for analysis. (Hartung et al., 2010) By using current mobile and web-based technology, this tool can increase the rate at which data is collected and reduce the need for manual entry of data, which comes with the risk of incorrect data entry.

4.1.1 Survey design

Two surveys were prepared: one for learners in schools and one for women of any age in a public place. The surveys were initially prepared in English and then translated into Zulu. The surveys included questions regarding public or school toilet usage, knowledge about female urinals and willingness to use them, key concerns and opportunities with urinals, and preferences around design and use of urinals. The questions asked in the survey are listed in Table 1 and the English and Zulu surveys can be found in Annexure C.

The paper surveys were adapted to mobile application surveys using XLS form, a tool developed as part of the Open Data Kit (ODK) suite. The survey is entered into Excel and then converted to .xml format through the online ODK application. The XML file can be used with web and mobile application data collection. The Open Data Kit mobile application is called ODK Collect, and Figure 27 shows screen shots from the urinal survey. (Hartung et al., 2010)

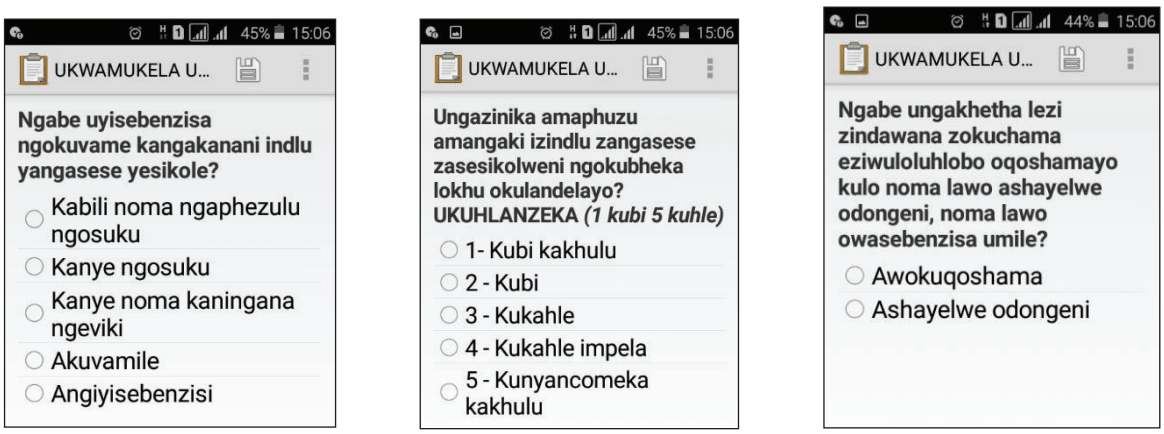

Figure 27: Screen shots from female urinals survey in ODK Collect

Table 1: Survey questions on female urinal acceptance

How often do you use the school/public toilet?
Do you ever sit down on the school/public toilet seat?
Out of the times you do use the school toilets how often do you go #1?
Out of the times you do use the school toilets how often do you go #2?
How frequently do you wait in line when using the school/public toilet?
How would you rate the school/public toilets in terms of cleanliness, wait time, safety, and privacy (1-5)?
Have you ever seen a urinal before? (after this question, pictures of a male urinal are shown)
Have you ever heard of a female urinal?
If a female urinal were provided, would you use it? (after this question, a description of how and why it works is shared and pictures are shown)
After hearing about urinals and seeing photos, would you be willing to use one?
Do you have any concerns about female urinals? What?
Do you think there would be any benefits to female urinals? What?
What you prefer squat or wall-mounted, standing urinals?
Would you be willing to throw your used toilet paper in a bin?

4.1.2 Data collection

Three female researchers collected data at schools and taxi ranks in the Pietermaritzburg area. At the schools, the researchers read the questions out loud and provided explanation where it was needed, while the learners filled out the paper surveys. Surveys were completed just after school, and this method allowed for a large amount of data to be collected in a short amount of time, though this method was difficult for younger learners. All learners who participated in the survey were awarded with a sweet, and it is expected that many of the younger learners may have filled in the survey so they could get the candy, without thoughtfully considering the questions. However, by collecting a large sample set, some conclusions can be drawn from the learner surveys.

Data was also collected from adult women by going to various taxi ranks around Pietermaritzburg. Participants were chosen at random by observing women who were waiting for their taxis and had time to do the survey. Since taxi ranks are either extremely busy or slow, depending on the time of day, it was often difficult to locate participants. Researchers collected a few surveys on paper and the rest were collected using ODK Collect.

4.1.3 Data capture and analysis

Data collected with ODK Collect required no additional capture before exporting to MS Excel. Surveys that were completed on paper were entered into the same ODK Aggregate server using the ODK Collect application. This proved to be simpler and quicker than entering the survey data directly into MS Excel and the use of controlled answers on ODK Collect reduced the risk of human error and typos during data entry. Data was analysed on a basic statistical level using MS Excel.

4.2 Results

4.2.1 Girls at Schools

4.2.1.1 Respondents

In all, 8 schools were visited with a total of 625 participants, and a detailed breakdown is shown in Table 2. The ages of participants ranged from primary school through high school, and the breakdown of participants' grades is shown in Figure 28.

Table 2: School participants in female urinal surveys

School	No. Participants
Bhezkiziwe Primary School	96
Imbubu Primary School	73
Laduma Secondary School	52
Mabane Primary School	56
Msimude Secondary School	70
Phayiphini Secondary School	60
Shayabantu Secondary School	64
Vezokuhle Primary School	140
School not specified	14

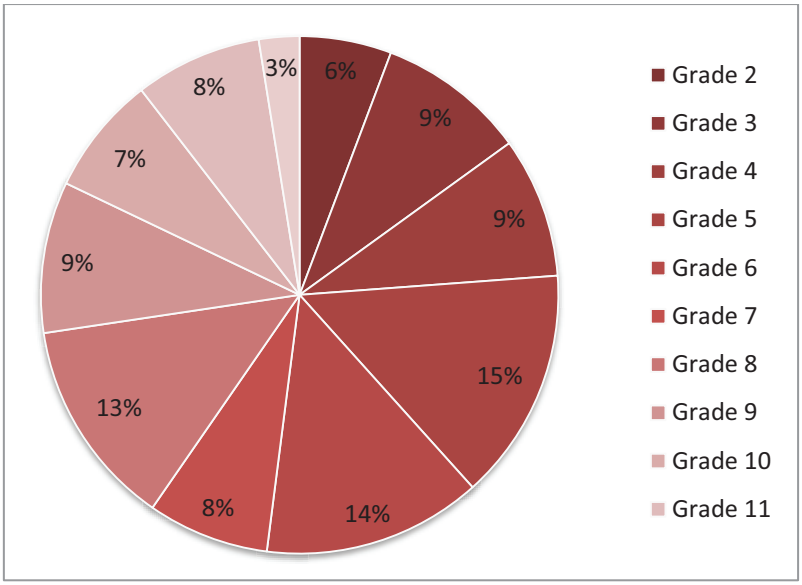

Figure 28: Grades of participants in school female urinal surveys

4.2.1.2 Toilet usage and status

Overall, school toilet usage was relatively high, with 74 percent of participants reporting that they use the school toilets at least once per day. The fact that the toilets are used regularly suggests that the toilets are *at least* in a good enough state that learners are not forced to wait until they get home to use the facilities. When asked to rate their school toilets in terms of cleanliness, safety, wait time, and privacy, responses also appear quite positive. However, each quality received at least 30 percent "bad" or "very bad" responses, as shown in Figure 29.

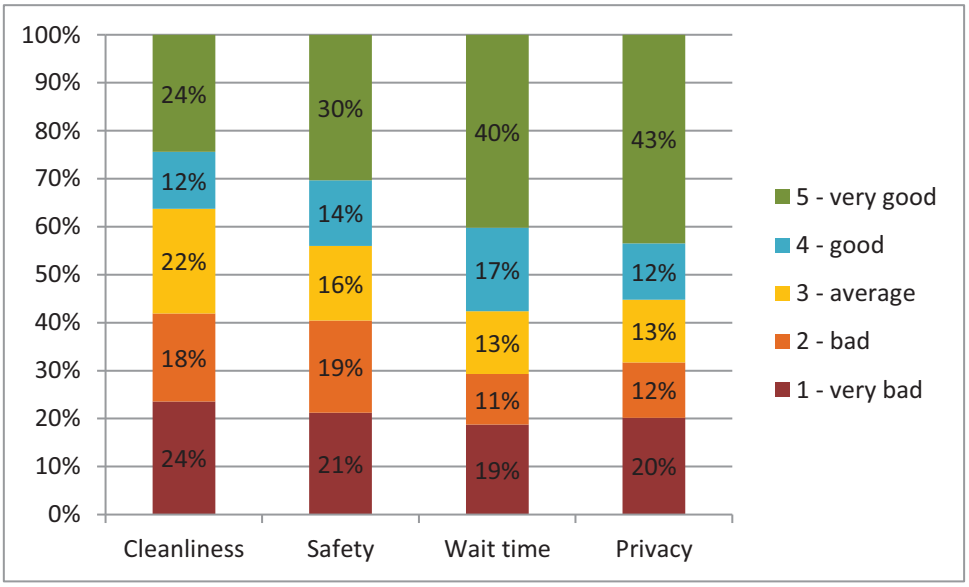

Figure 29: How would you rate your school toilets in terms of the following qualities?

Wait time and privacy appear to be the areas of least concern in the girls' toilets. Twelve percent of participants said they *always* have to wait to use the school toilets while 31 percent said they *never* have to wait.

Cleanliness and safety are the main concerns for girls in school toilets. This is partially reflected in the fact that only 44 percent of participants reported *usually* or *always* sitting down on the toilet seats. The concern for personal hygiene and cleanliness in the toilets leads 36 percent of participants to report *never* sitting down on the toilet seats. Whereas boys only sit on a toilet seat when they defecate, girls use the same pedestal for urination and defecation, though many have hygienic concerns with the toilet seats. Fifty-five percent of participants said that they usually or always urinate when they use the school toilets. Furthermore, 28 percent said they *never* defecate at school. The majority of uses of school toilets are for urination, as was described by Freeman et al. (2012), which means that a urinal could eliminate a large number of instances where girl learners are forced to sit on or use a dirty pedestal.

4.2.1.3 Knowledge of and willingness to try urinals

Only 31 percent of participants reported having seen a urinal before and 34 percent had heard of female urinals. However, despite limited knowledge and experience with the technology, 61 percent initially said they would be willing to use female urinals and a further 31 percent said they would *maybe* be willing to use them. Following the initial question, researchers gave a description of female urinals and showed pictures. When asked the question again, 65 percent said they would be willing to use the female urinal, and 25 percent said they would *maybe* be willing, reflecting very little change compared with the situation prior to the explanation.

4.2.1.4 Preferences with female urinals

Overall, 43 percent of participants said they have concerns with female urinals and 63 percent that they see benefits. However, it appears that many learners did not fully understand the first part of the question regarding concerns. When they were asked what concerns they had, a number of learners gave responses which would be positive attributes of urinals. However, the responses can give guidance on which aspects to prioritise during design of urinals. Considering the most common negative aspects of urinals, 21 learners mentioned worries about squatting; 19 were concerned about how to actually use them; and 18 thought they would be dirty and/or unhygienic. Other concerns included a lack of privacy (7); the fact that you can only urinate (3); and fear that there will be pests and animals (3). One learner explicitly stated “If maybe you are there to urinate but end up having poo come out by mistake,” which could be an issue for girls who are used to being able to freely urinate and defecate in one pedestal.

The major benefits mentioned included: the urinals being clean (38); less wait time in the toilets (32); less chance of disease being spread (25); the attractiveness of the urinals (22); and not having to sit on a seat/being able to squat or stand (10). It appears that some learners believe that STIs can be transmitted from a toilet seat, which is why they think the urinals will be better. While the STI concern is unfounded, the fact that learners will not have to touch a toilet seat does protect them from other diseases caused by faecal contamination. Though several learners were nervous about having to squat to pee, others recognised the benefits of squatting as opposed to sitting on a dirty seat. The key factor in this issue is behaviour change and training. Eight learners mentioned the improved safety of the urinals, with two specifically saying that they will not fall in, as opposed to a pit toilet, with which some people are concerned about falling into the pit.

The preferred urinal configuration is the wall-mounted, standing version, which was voted for by 57 percent of participants. This configuration is challenging to implement due to manufacturing needs and the limited availability of these products in South Africa, whereas a trough version can easily be built with standard concrete and building materials. Despite a preference for wall-mounted urinals, 43 percent said they would prefer a trough version, i.e. the relative difference in preference between the two designs is not great.

Forty-seven percent of participants said they would not be willing to put their toilet paper into a bin. This is cause for concern, as it is a key behaviour to the success of the urinals. This statistic emphasises the imperative to train users of the urinals properly so that blockage does not occur.

4.2.2 Adult Women at Taxi Ranks

4.2.2.1 Respondent data

Researchers visited four taxi ranks in the Pietermaritzburg city centre to survey women who were waiting for taxis. Overall, 93 responses were gathered, and the participants represented a range of ages and rural/urban residents, as shown in Figure 30.

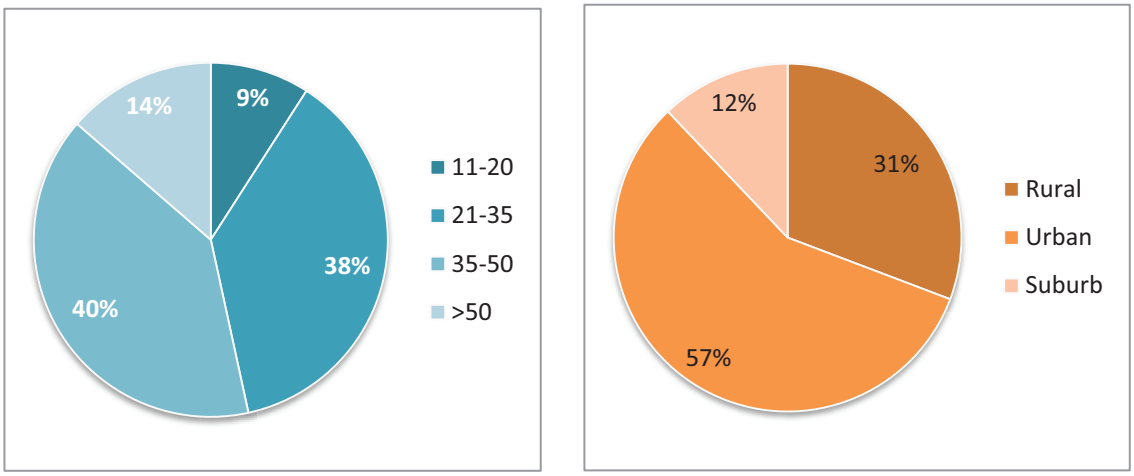

Figure 30: Age breakdown (left) and household location (right) for taxi rank survey participants

4.2.2.2 Toilet usage and status

The public toilets are used very frequently, with 79 percent of women saying that they use the toilets at least once per day. This is not surprising, as women who use taxis for transport spend substantial amounts of time in transit and waiting for taxis. When asked to rate the public toilets, over 50 percent of women gave them a *bad* or *very bad* rating for all four criteria, including cleanliness, safety, wait time, and privacy, as shown in Figure 31. To further assess women's experience in the public taxi rank toilets, 30 percent said they *never* sit down on the toilet seats; and 44 percent said they *always* or *usually* have to wait to use the toilets, with a further 45 percent saying they *sometimes* have to wait. This data demonstrates that though conditions in the toilets are not favourable, the women are still forced to use them out of necessity and that any improvements would be welcomed.

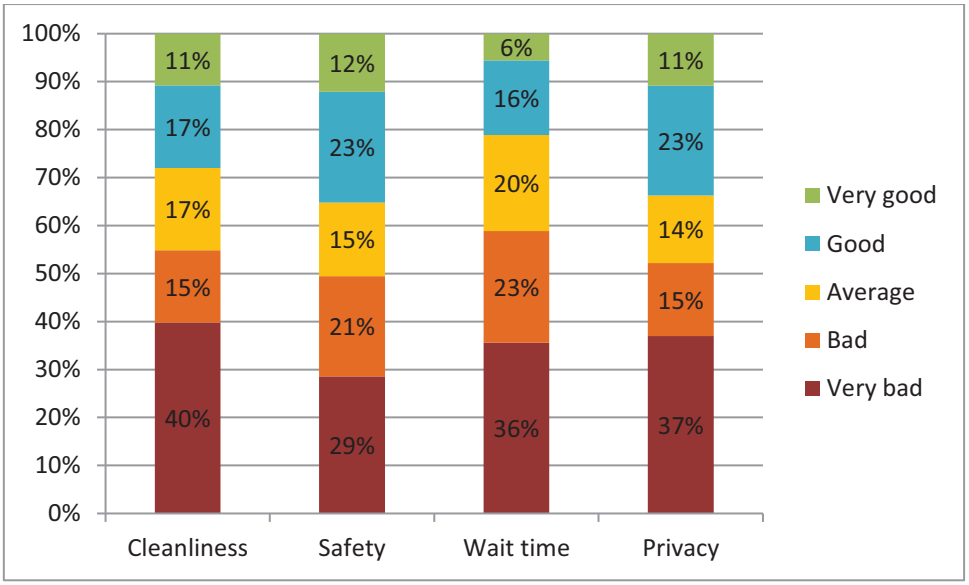

Figure 31: How would you rate the public toilets in terms of the following criteria?

As shown by Figure 32, most women (84%) *usually* or *always* urinate in public toilets. This suggests that urinals may be able to solve a large part of the problem of waiting to use public toilets as well as worries about cleanliness and hygiene, which lead many women to avoid sitting down on toilet seats if possible.

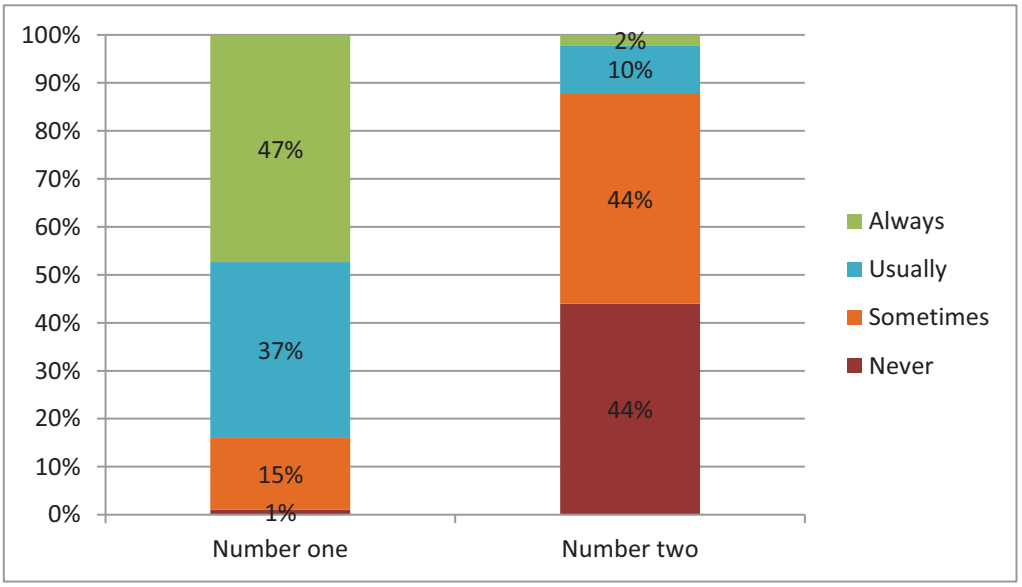

Figure 32: How often do women urinate (#1) and defecate (#2) in public toilets?

4.2.2.3 Knowledge of and willingness to try urinals

Very few women have knowledge about urinals, with only 13 percent saying they have seen urinals before and 6 percent saying they have heard about female urinals. However, as with the learners, willingness to try using one was widespread, with 89% initially saying they would use it and 93% saying they would use it after hearing the description and seeing photos.

4.2.2.4 Preferences with female urinals

Overall, 49 percent of respondents said that they have concerns with female urinals. The most common concerns were with having to squat to use them (6) and the risk of urine splashing them while using them (7). Four respondents said that the urinals would be dirty, and some women mentioned the need for education, so that women don't make it messy for each other. Furthermore, 3 respondents specifically mentioned concerns about old women using the urinals, which is likely due to their lack of physical strength and flexibility to use the squatting urinals.

Sixty-one percent of respondents said that the urinals would bring some benefits. The most common benefits were reducing the spread of disease (30) and reducing waiting time (29). Five women specifically mentioned the benefit of not having to sit on a dirty seat. Nine respondents mentioned that the urinals would be clean and another 9 mentioned improved safety.

In terms of urinal configuration, 61 percent of women prefer the wall-mounted, standing version rather than the trough version. Examining the data closer, preference seems to be differentiated by age. While 74 percent of women over 35 said that they would prefer the wall-mounted, standing version, 54 percent of women under 35 said they would prefer the trough version. Older women likely prefer the standing version due to the physical strength it takes to squat and worries about physically being able to handle it.

Ninety-seven percent of participants said that they would be willing to put their used toilet paper in a bin.

4.3 Discussion

The data reflects the overarching theme that unfavourable conditions in public and school toilets will not keep most women from performing one of their most basic needs, that is, to urinate. Despite poor conditions in the toilets, 74 percent of learners and 79 percent of women use the school or public toilets daily. Furthermore, public and school toilets are mostly used for urination, which suggests that it is unnecessary to have only pit toilets or full flush toilets as an option. Urinals have the potential to address issues in toilets, particularly hygiene and waiting time. By removing the need for women to sit down on toilet seats, a potential disease transmission pathway is also removed. This is especially true in situations where cleaning and management protocols are sparse and the toilet seats are not regularly disinfected. By installing urinals, the number of times women sit on a dirty seat is limited to only those times when they defecate. Urination takes less time than defecation, and less space is generally required for urinals when compared with full toilet stalls. Due to these differences, more women can be accommodated in a small amount of time and space when using urinals. This will reduce waiting time, which is a problem in public toilets but also in schools where there are often not enough toilet seats for the number of pupils. Both benefits were widely recognised by the participants in this survey.

The favoured design configuration of respondents is a wall-mounted standing version, similar to a male urinal. However, the trough version was not far behind in terms of user preferences. Given the developments by LiquidGold in South Africa in wall-mounted urinals, both versions would be possible to implement in the South African context. Both design configurations will require education, so that

women use it properly by putting only urine down them. While adult women were mostly willing to throw their toilet paper in a bin, many school children were not. This would be a key component of user education during the implementation of female urinals.

5 Urinal field testing study

The original proposal for WRC project 2735 included installing two different types of urinals at two schools and monitoring their use and success over a 3-month period. However, given the difficulty with management of school toilets, it was determined that should a 3-month trial be initiated, interviews would likely reflect various management issues rather than technology-specific issues. Given that this study seeks to provide an initial gauge of acceptance of female urinals, it was decided that more controlled trials of urinals with a more widespread data base would be ideal.

5.1 Mobile urinal design

Initial work was done to design a mobile urinal which could be moved between different schools and locations to get a large pool of feedback on the technology. Given the work currently being done by LiquidGold with the Weestands described above, it was determined that it would be advantageous to partner with the company in testing the acceptability of these urinals.

The urinals used in testing are shown in Figure 33-Figure 38. Materials used include:

- Weestands with Ecoflow valves from Liquid Gold;
- Associated 50 mm-diameter PVC piping and necessary fittings;
- Toilet huts from Atlas Plastics;
- 200 litre storage tank from Ecotanks; and
- Wooden pallets to raise the huts to create the necessary fall from the urinals to the tank.

The Weestand units were mounted 120 mm off the floor of the toilet unit. Given the height from the bottom of the Weestand to the upper edge of 350 mm, this led to a total height from the ground to the edge of the urinal bowl of 470 mm. This height was too high for very small learners.

Figure 33: Two rectangular huts for the Weestands, sitting on pallets to provide necessary height for drainage of urine

Figure 34: Toilet huts decorated with necessary messaging to ensure that the users used the urinals correctly

Figure 35: Weestand installed in the toilet hut; both toilet huts were equipped with a bin for toilet paper

Figure 36: All materials fit on the back of this bakkie, simplifying daily transport and installation

Figure 37: 200-litre storage tank was placed below the outlet from the urinal units, to enable gravity flow of urine into the tank and storage

Figure 38: In some cases, a small hole had to be dug to ensure that the tank was below the outlet of the units

5.2 Testing methodology

Over a two-week period, the urinals were set up at 5 different schools and one community Park Run. Two researchers interviewed each user after they used the urinal. The researchers also assisted users who had questions about how to use the urinals; provided toilet paper to the users; and recruited new users.

5.2.1 Survey design

Two surveys were prepared: one for learners in schools and one for women of any age at the Park Run. The surveys were initially prepared in English and subsequently translated into Zulu. The survey included questions about the users' experience in the urinals, what they liked or didn't like, and what they would change about it. The questions asked in the survey are listed in Table 3.

Table 3: Survey questions for users after using the test urinals

Questions	Options
Overall, how would you rate your experience using the urinal (1 is bad, 5 is good)?	1 to 5
What did you like most about it?	It was clean; it was easy to use; it was pretty; I didn't have to touch the seat; nothing; other
What did you dislike most about it?	It was dirty; it was hard to use; having to put my toilet paper in a bin; it was weird; I didn't understand how to use it; nothing; other
Did you face the wall or the door while using it?	Wall; door
If this was always available at your school, would you use it?	Yes; no
Do you like this better than your school toilets? Why or why not?	Yes; no
What would you change about it?	Open answer
What is most important to you when using the urinal?	Cleanliness; wait time; privacy; safety; other

The paper surveys were adapted to mobile application surveys using XLS form, a tool developed under the Open Data Kit (ODK) suite. The survey is entered into MS Excel and then converted to .xml format through the online ODK application. The XML file can be used with web and mobile application data collection. The same Open Data Kit mobile application used in the initial surveys, ODK Collect, was used for data collection. (Hartung et al., 2010)

5.2.2 Data collection

Two female researchers collected the data at the schools. The researchers waited near the urinals and asked users the survey questions in Zulu after using the urinal. All learners who participated in the survey were awarded with a sweet. In general, at the primary schools, the researchers tried to recruit mostly older learners, as young learners were often too short to use the urinals and were difficult to survey.

The same method was used during the Park Run, but participation was extremely low. It is unclear why it was so low, but due to the very limited number of responses, the results from the Park Run are not provided here.

5.2.3 Data capture and analysis

Each day after data collection, the researchers uploaded the surveys to the ODK Aggregate server, where no additional data capture was required before exporting to MS Excel. Data was analysed on a basic statistical level using MS Excel.

5.3 Results

5.3.1 Respondents

In all, 5 schools were visited with a total of 236 participants, and a detailed breakdown is shown in Table 4. The ages of participants ranged from primary school through high school, and the breakdown of participants' grades is shown in Figure 28. Seventy percent of participants were primary school learners, though most of them were from Grade 3 or older. The fact that the data is skewed towards primary school learners is owing to the fact that high schools had begun exams by the time the trials took place, which meant that not all learners were at the schools at all times. This made it difficult to get a large amount of users at the high schools included in the study.

Table 4: Female urinal users and survey participants at schools

School	No. Participants
Bhezkiziwe Primary School	25
Imbubu Primary School	58
Laduma Secondary School	25
Shayabantu Secondary School	45
Vezokuhle Primary School	83

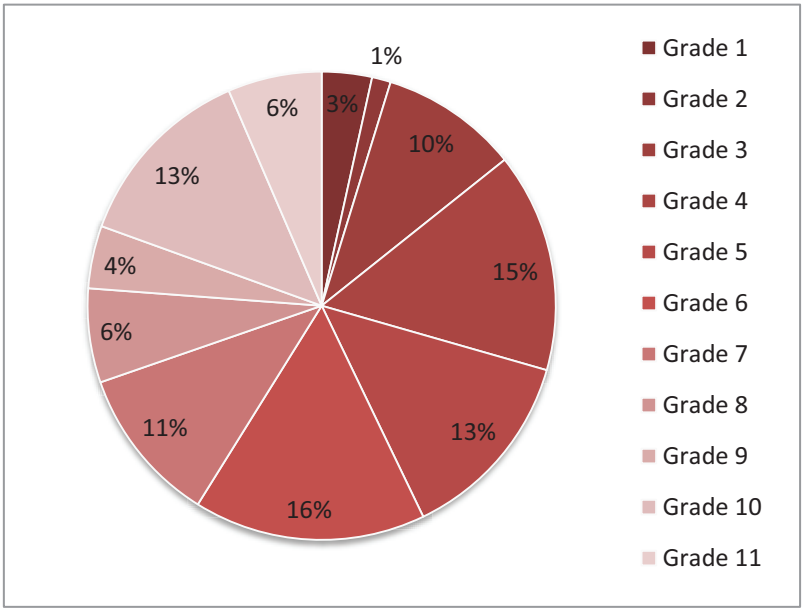

Figure 39: Grades of participants who used the urinal and participated in the survey

5.3.2 Experience with using the urinal

Users were asked to rate their experience from 1 to 5, where 1 means *very bad* and 5 means *excellent*. As shown in Figure 40, only one out of the 236 participants described the experience as "bad", while 79 percent had a *pretty good* or *excellent* experience.

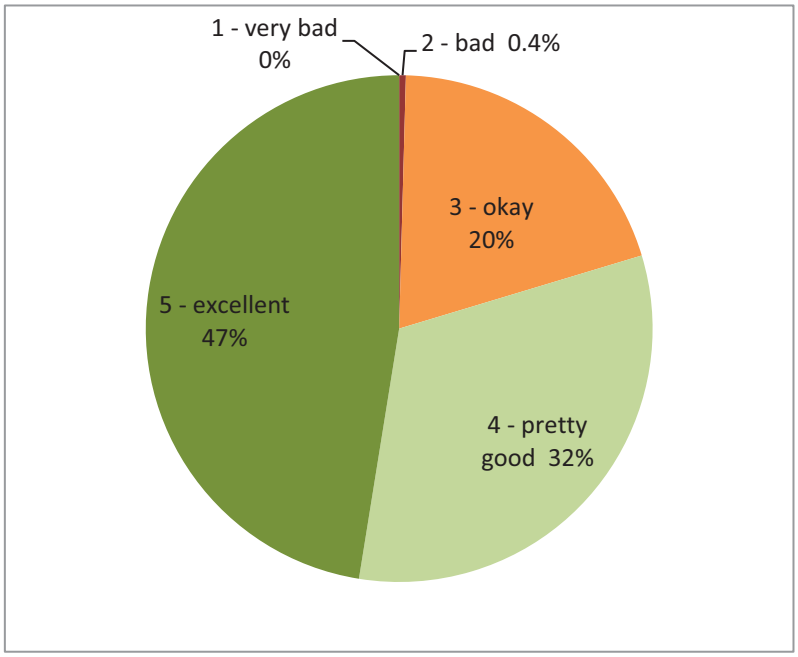

Figure 40: Results of users' experience while using the female urinal

Users were then asked what they liked and didn't like about the urinals, which provides some insight into the most important factors to consider in design. By far, the aspect that girls enjoyed most about the urinals was that they were clean. It is important to note, however, that cleanliness of the urinals is really a management issue. The other factors that girls said they liked about the urinals can be intentionally designed for, such as creating a product that is aesthetically appealing and user-friendly. The results of girls' positive impressions of the urinals are shown in Figure 41.

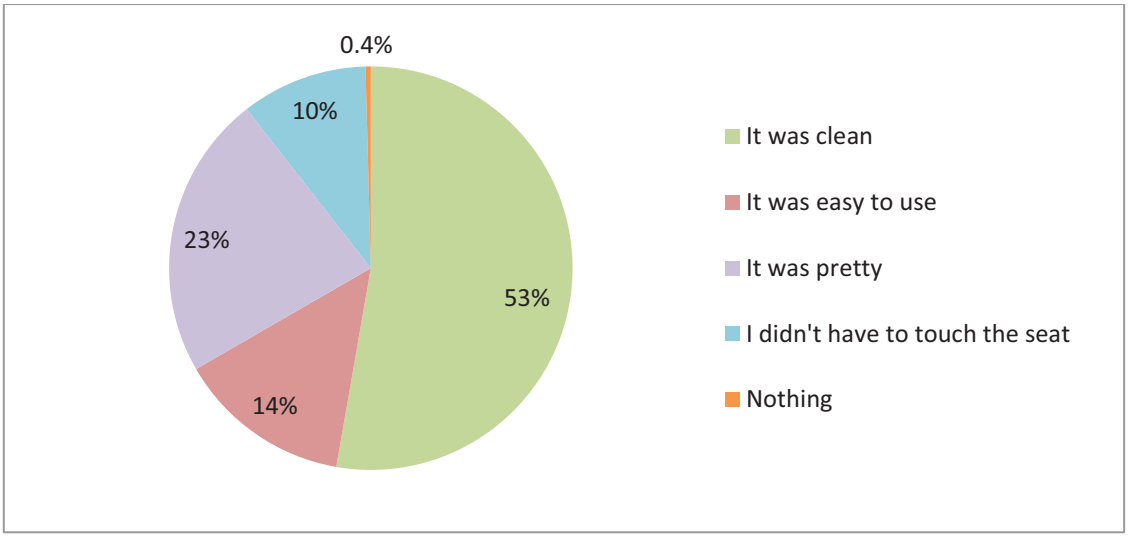

Figure 41: Responses to the question, "What did you like most about the urinal?"

Figure 42 presents the results from the question of what users didn't like about using the urinal. Overall, the majority of issues involved it being weird to use and the need to put their toilet paper in a bin, rather than into the toilet. Both of these are behaviour change issues, which can be addressed through education and formation of new habits. Furthermore, the majority of responses under "other" were about the fact that they had to squat over the seat (9) or the fact that the urinal doesn't flush (5). The issue with the urinal not flushing is interesting, since all of the participating schools have pit toilets, not flush toilets. However, due to the Ecoflow valve, flow leaving the urinal is quite slow, causing the urine to talk a moment to drain from the urinal. It is most likely that users who gave this response did not like this aspect of the design.

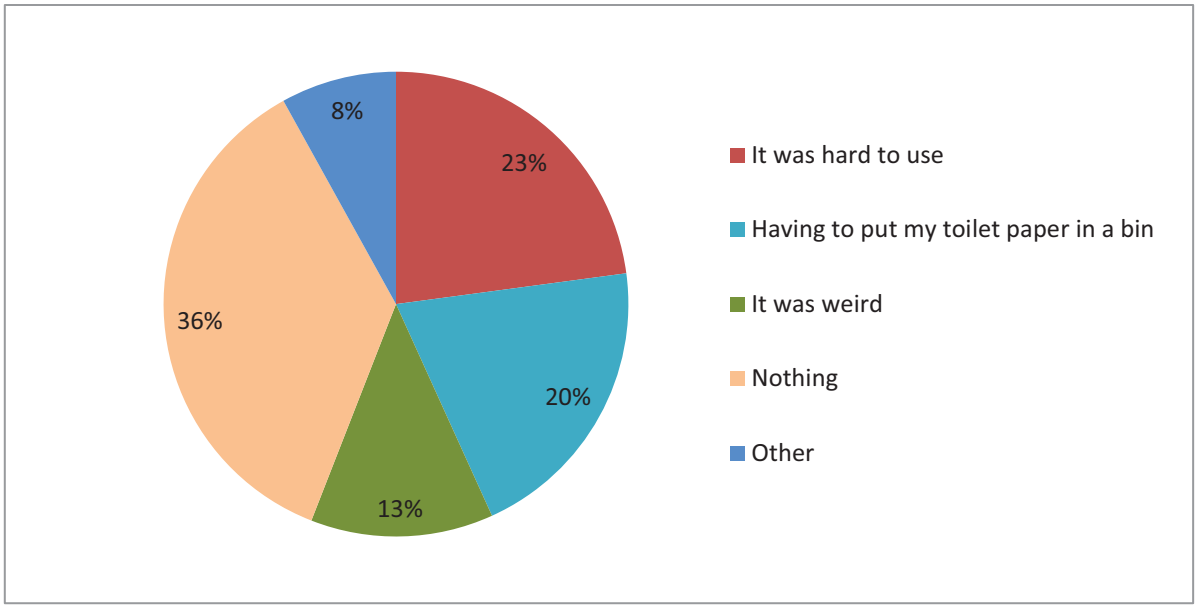

Figure 42: Responses to the question, "What didn't you like about the urinal?"

5.3.3 Willingness to use the urinal if available at school

Only 3 users out of 236 said that they would not use the urinal if it was available at their school. This wide acceptance of the urinals is echoed in the fact that 227/236 users said that the urinal was better

than their school toilets. The major reason learners gave for the urinal being better than their school toilets was that it is clean (135 out of 227 responses). It is again important to note that long term cleanliness will be determined by the effectiveness of management of the urinals. Thirty-four learners said that it is better than their school toilets because it is attractive. The other aspects that girls liked compared to their school toilets were: not having to sit (13), that the urinals don't smell (11), privacy (11), simply the fact that it is different (10), and the fact that it is comfortable to use (7).

Of the 9 learners who did not prefer the urinals to their school's existing toilets, 3 said this was due to the fact that the urinals are new and that they are not used to it. In addition, 2 said they prefer to sit on their school toilets, and 2 did not like the fact that they cannot use it for defecation. This is given the fact that girls are used to being able to defecate and urinate in the same toilet, and this would likely be the greatest risk if urinals were implemented in a school that already had pit or flush toilets.

5.3.4 Key design considerations

While all of the earlier questions provide some insight into key considerations when designing a female urinal, users were also explicitly asked a number of questions to assess what is most important to them. Firstly, users were asked what they would change about the urinal. Nearly half (117/236) said they wouldn't change anything, and the remaining responses are summarised in Figure 43. Interestingly, the main aspect that girls wanted to change was the ability to sit down on the seat. However, the purpose of urinals being implemented would partly be to reduce a girl's need to sit on a toilet seat, which can be unhygienic. The second-most desired change is to be able to flush. While this is an important user attitude to be aware of, it is likely not feasible in many contexts. For instance, in all schools visited during this study, water supply is very unreliable, and there are days when there is no water available. If urinals requiring water for flushing were installed, this could lead to malodorous and unpleasant conditions in the urinals. The use of a waterless and odour-free mechanism makes urinals more resilient to water challenges very common in South African schools. A number of learners would want water to flush the urinal specifically for dealing with toilet paper. The need to throw toilet paper in a bin can be addressed through behaviour change activities and can also be addressed in a more attractive way than was used in these temporary structures, by simply providing bins which would be very vulnerable to breakage in a long-term situation. Some learners' desire to be able to defecate in the urinal is, as described above, due to the fact that there are many instances when girls may go to the toilet to urinate but end up defecating as well. In addition, as shown in the previous acceptability study, the number of learners who defecate at school is quite a lot higher than expected, with 72 percent of learners indicating that they at least *sometimes* defecate at school. Finally, the hygiene-related issues expressed by learners included wanting a tap or hand sanitiser in the unit or a holder for the toilet paper. These are factors of how the trials were carried out but should all be considered in a more permanent installation.

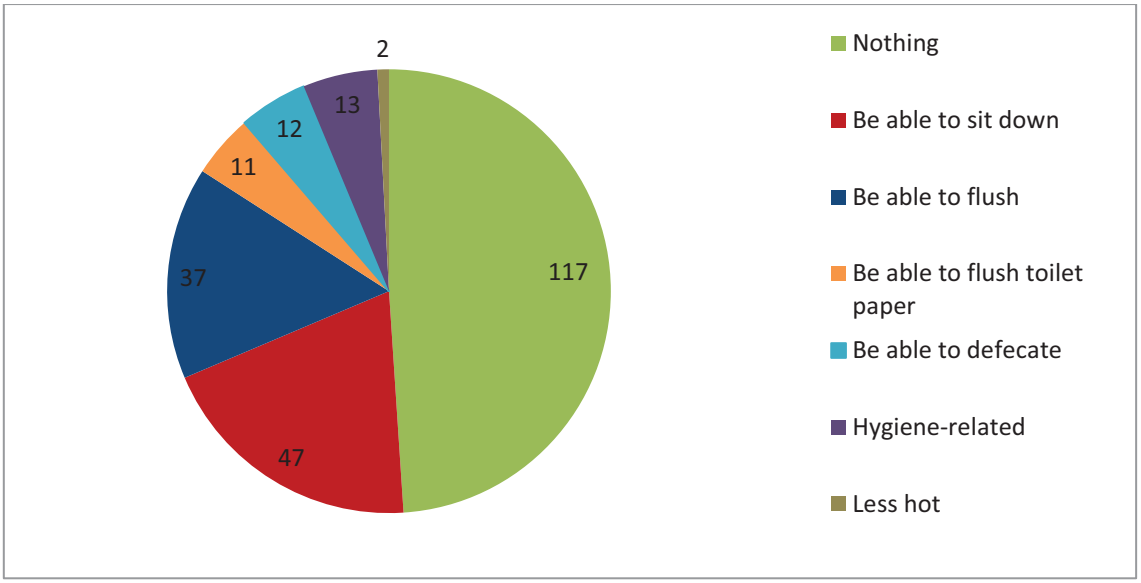

Figure 43: Responses to the question, "What would you change about the urinals?"

Learners were finally asked to indicate what aspect is most important to them when using the urinal. The results from this question are shown in Figure 44, and privacy (40%), safety (30%), and cleanliness (26%) were all deemed relatively important. This data emphasises the need to utilise partitions in implementing urinals, as girls in South Africa see their privacy as very important. This sentiment was shared both by primary school and high school learners. Furthermore, these results point to the benefits that can be realised by improving safety for girls at schools by limiting their need to use pit toilets. To enhance girls' safety in urinals, other design elements would include adequate lighting and urinals being placed close to the classrooms, if possible, to reduce risk of intruders and rape. Cleanliness can only be ensured through adequate management and a regular cleaning schedule for the urinals. This may prove to be a barrier to success, given that many schools are unable to effectively manage their existing school toilets. Thus, an addition of new urinals may not be properly managed. Interestingly, only 3 percent (6/236) of learners said that wait time was most important to them.

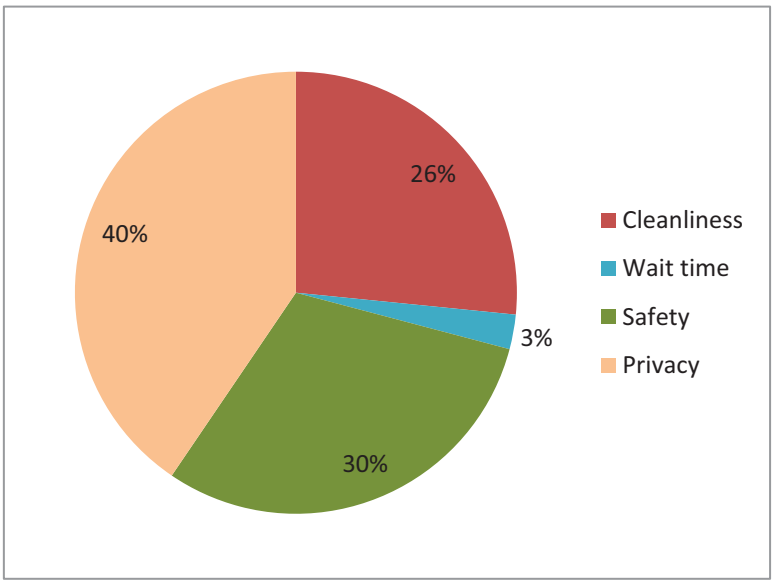

Figure 44: Responses to the question, "What matters most to you when using a urinal?"

5.4 Discussion

The results described above suggest that urinals for girls have definite potential to improve girls' experience with sanitation at school. The majority of learners had a positive experience with using the urinal and would use it again if it were available at school. The key aspects to consider in implementing this technology include: a user-friendly and aesthetically pleasing design; user training and education; and effective cleaning and management. The Weestand design used in this study was generally easy to use, aside from the users who would prefer to sit down. The height of the urinal off the floor must be adjusted to accommodate the learners who will be using it. In this study, the top of the urinal was 470 mm above ground level, which suited most learners, but the very small learners struggled. If the urinal was mounted on the floor rather than the wall, the urinal height would only be 350 mm. In an interview with Orion Herman of LiquidGold, he indicated that it is actually quite important to design the urinal so that it is uncomfortable to sit down, as this will limit the likelihood of someone sitting down and defecating, as girls in South Africa are accustomed to sitting when defecating. This is the reason for the Weestand's very thin edge. Other effective user-friendly and aesthetic-related aspects include attractive paint colours, as has been observed by LiquidGold, and adequate light in the urinal building. Privacy is an important consideration for urinals for girls. Although some of the projects in different contexts described above did not use partitions for girls' urinals, girls interviewed in this context indicated that privacy is very important. Adequate privacy will protect girls' dignity and also encourage learners to use the new technology without fear of being judged while learning how to use it.

In terms of education and training, the key points to stress include that only pee should go into the urinal (no poo, toilet paper, or rubbish) and that users should squat, not sit. These points can be reiterated with effective messaging at the urinal itself to remind users, as was used in this trial. Orion Herman has indicated in the school trial that they have done 3 training sessions for the users and that the girls become more comfortable using the technology the more training they receive.

Finally, effective management and regular cleaning will be vital to realising the true benefits of female urinals, as is true with all new school toilets. Given the participants' great value for cleanliness of the urinals, it appears that should newly installed urinals become dirty and smelly, user satisfaction will be greatly decreased. Thus, in implementing this new technology, it is crucial for a school to consider precisely how it will be managed and regularly cleaned *before* embarking on design and planning.

6 Implementing female urinals in South African schools

Female urinals could serve a need in public and school toilets in South Africa. Despite no previous exposure to the technology, girls and women in the initial survey were generally willing to test the idea and could see its potential benefits. Girls who used the urinals during field trials were in general positive about the technology itself. Further development of female urinals for the South African context should be user-centred, by creating prototypes, receiving feedback, and adjusting the design. Given that there is potential for this technology to improve conditions and an initial positive reaction to it, research and testing should be taken further. This is especially true since sanitation not only affects women's basic physical needs but also emotional needs. Improving conditions in public and school toilets will enhance women's ability to thrive in school, work, and other societal settings.

6.1 Trough urinals

Trough urinals would be easily implemented in South Africa and would use the same construction materials and concept as currently used in most school settings. With some slight changes to design, these urinals would be very similar to the trough design common to many boys' urinals in schools. The urinal blocks could be constructed out of concrete as the foundation, concrete blocks or bricks for the walls and partition, and zinc sheets for roofing. Stalls should be equipped with full-length wooden doors, and the toilet block should have handwashing facilities. The urinals would be formed using a 110 mm gutter as formwork for the drain, sloped at least 2.5% towards the outlet, and ideally the floor would be sloped at least 10% towards the drain where the users squat. This will limit splashback, as was demonstrated in Mirembe Primary School in Uganda (Achiro et al., 2009). The drain, sloped area for urination, and the urinal wall, approximately 1.2 metres above the drain, should be painted with epoxy or water-resistant paint or tiled, to keep urine from soaking into the surface. An example drawing is provided in Annexure D, which provides 3 urination stalls and one basin. The water discharged from the basin could be released to the urine drain, providing flushing for the drain. However, should urine reuse be deemed advantageous, water from the handwashing basin could be directed to a soakaway. The attached rough cost estimate for this design in Annexure E indicates a cost of R51 500 for this 3-seat urinal block. This equates to a cost of R17 200 per seat for a trough urinal with handwashing facilities. This cost estimate assumes that all handwashing water and urine are sent to a soakaway.

6.2 Wall-mounted urinals

During the course of this project, the project team developed a simple conceptual drawing of a wall-mounted urinal, which could be installed in a star-shape, similar to the design done by Pollee, shown above. The simple drawing is shown in Annexure F, but development of these units would require detailed drawings, followed by a 3D-printed model which could then be translated into an injection-moulded plastic or fibreglass version.

The only available wall-mounted female urinal in South Africa at the present time is the Weestand by LiquidGold. These units are currently 3D printed, but there are plans to generate injection-moulded plastic versions, which will reduce costs and weight. LiquidGold has developed and piloted a container top-structure for their Weestand at a school in Mpumalanga province, which resembles the shipping

container community ablution blocks common in eThekwini Municipality. The E-container can be supplied in 6- or 12-metre versions, using used ISO standard steel containers. The 12-metre version provides 7 male urinals and 7 female urinals, including partitions and doors for the female urinals. More information about the design of these units can be found in Annexure B. According to Orion Herman of LiquidGold, the 12-metre unit costs R350 000, including delivery, installation, and an educational programme for the learners. This translates to cost of R25 000 per seat for the urinal hardware and structure, as well as the treatment system to produce fertiliser. The treatment system provided by LiquidGold will produce a fertiliser, which can be used to irrigate a garden at the school, thus providing added value.

The system currently installed at the school in Mpumalanga serves approximately 2 500 primary school learners. With 14 seats available, this does not meet the required user to toilet ratio (recommended at approximately 1 urinal per 40 users for boys), but the old toilet block is still in use. Data from the pilot project is not yet publicly available, but according to Herman, the system has an acceptance rate of 80 percent thus far (O. Herman, personal communication, 18 December 2017).

The developers are also gradually improving their efficiency in the treatment and nutrient recovery system. At present, they are producing struvite ($MgPO_4$), but they also have capability to produce concentrated liquid nitrogen, which will begin this year. According to Herman, production of fertiliser is 1 kilogram of fertiliser for every 88 litres of urine (O. Herman, personal communication, 3 January 2018). At a urine production rate of 1500 litres each month, this translates to 17 kilograms of fertiliser produced at the school each month. This suggests that the phosphorus concentration in the fresh urine is at least 649 mg P/ℓ, which is on the high end of phosphorus data in literature (e.g. 370-740 mg P/ℓ (Tilley, Atwater & Mavinic, 2008; Udert, Larsen, Biebow & Gujer, 2003)).

6.3 Cost comparison

Though the wall-mounted urinals provided by LiquidGold exceed the estimated cost of trough urinals per seat, both urinal options are much lower than the estimated amount budgeted per seat for new VIP toilets in schools. A summary of estimated cost per seat for urinals assessed in this study and VIP toilets installed by the Department of Education are provided in Figure 45. The costs for VIP toilets come from two documents from the Limpopo Department of Education: (1) a service-level agreement between Limpopo DoE and Mvula Trust for infrastructure delivery, including 86 toilet construction projects (Mashaba, 2014); and (2) a 2016 Norms and Standards report by Limpopo DoE (Mutheiwana, 2016). Both price estimates have been adjusted for inflation to the end of 2017. Due to procurement costs associated with projects by the Department of Education, it is likely that the unit cost for the two urinal designs would likely be higher in a real-case scenario. However, they are not likely to exceed the presently budgeted amount for new VIP toilets.

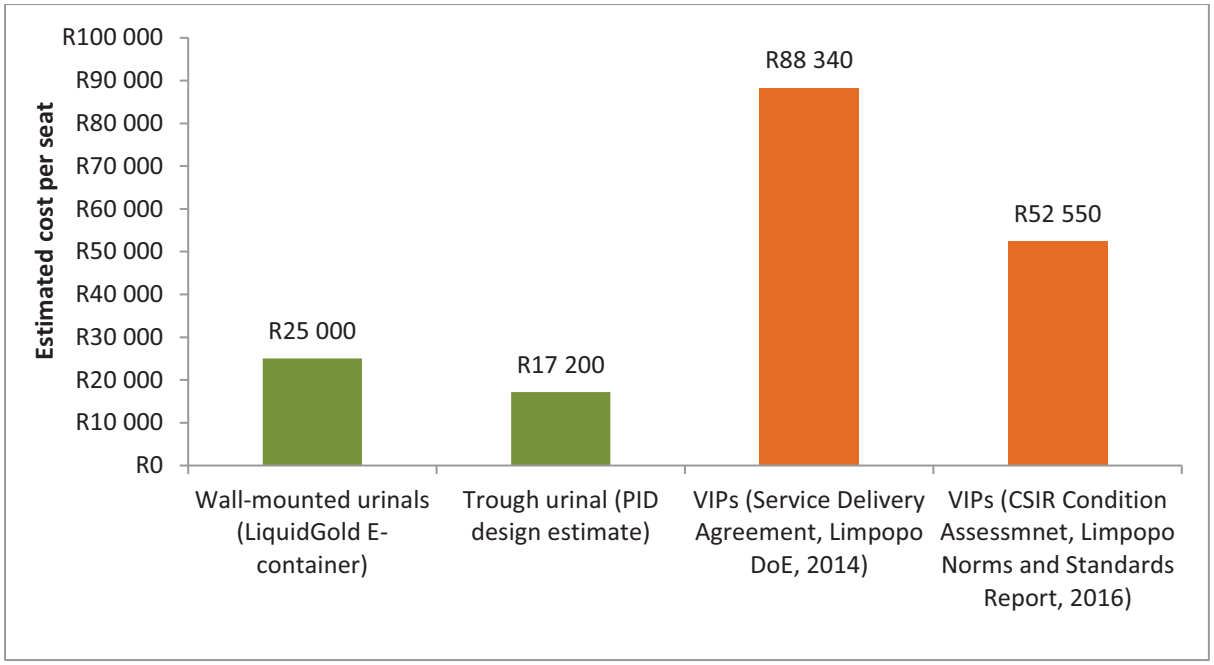

Figure 45: Estimated costs per seat for urinals and VIP toilets, from various sources

Based on the above cost estimates, it is clear that the more cost-effective approach to upgrading school toilets is by installing the necessary number of urinals, both for boys and for girls. Based on the typical approach to sanitation in schools, consider a school of 1000 learners (505% boys and 50% girls) and a required user-to-toilet ratio of 1:25, as per the World Health Education guidelines. This translates to 40 total seats required. Based on the above estimates, the cost for implementing 40 new VIP seats to meet the needs of the school will be between R2 100 000 and R3 500 000. On the other hand, if urinals are built instead, based on an assumption that 75 percent of toilet uses at school are for urination, the overall cost decreases. This will translate to approximately 30 urinal seats and 10 VIP seats, leading to an overall cost between R1 275 000 and R1 600 000 to meet the school's needs.

In reality, most schools have existing VIP toilets, but often not enough to meet the needs of the learners. Installing urinals to meet the remaining needs can be accomplished at a much lower cost than installing additional VIP toilet blocks. These urinals come with the added benefits described above, including the opportunity to install them closer to the classrooms or centralised circulation area, enhancing monitoring and creating a safer environment, particularly for girls.

7 Guidelines for implementing urinals for girls in schools

Urinals should be implemented in schools in a way that protects the health, safety, and dignity of girls more than the present sanitation solution does. If urinals do not effectively do this, they are not solving the problem. Some specific guidelines for installation of urinals are as follows:

1. All female urinals, whether wall-mounted or squatting, should be provided with partitions and doors to protect girls' privacy.
2. Implementation of urinals cannot fully replace latrine usage, given the fact that learners also need a safe place to defecate as well as the needs of disabled learners. Disabled learners will also likely be unable to use urinals due to the need to squat rather than sit.
3. Urine can be safely disposed of using a simple soak pit. In most cases, a pit 6 m long x 1.25 m deep x 0.5 m wide will suffice for 500 learners (Deverill & Still, 1998), but this will be determined based on the site's soil permeability and whether or not handwashing water is also included. A soak pit should be lined with geofabric or other equivalent geofabric to prevent clogging and should be filled with rubble, large stones or used tyres. As a minimum, the top of the soak pit should be 300 mm below ground level, to reduce risk of human contact with the urine.
4. Urine reuse in agriculture is possible, either directly by diluting the urine and using manual or drip irrigation, or through treatment and recovery of nitrogen and phosphorus fertiliser.
5. Urinal units should provide adequate light, either through the use of windows, air gaps between the roof and the walls, or by turning concrete blocks near the top of the wall on their side so that light enters through the holes.
6. As long as urine is properly contained and disposed of, odours associated with urinal units will be minimal. This will enable urinals to be installed closer to classrooms, allowing for adequate monitoring to protect learner safety and improve learner behaviour. The majority of schools have VIP toilets which are located very far from classrooms, and this leads to bad behaviour as well as serious safety threats to learners.
7. Extensive messaging should be installed in the urinal units. Messaging should highlight that urine *only* should go down the urinal and that toilet paper and other rubbish should go in the bin. Examples of messaging are provided in Annexure G. Posters or notices must be designed and installed in a way that will protect them from the rough environment of school toilets (i.e. so that learners cannot remove the messaging easily).
8. Urinals should not be implemented without a detailed plan for management of the urinals. A management programme for urinals would include regular (i.e. daily) cleaning of the urinals; emptying of bins; education for users; monitoring of users; provision of toilet paper; and addressing accidents as needed. The main risk is learners defecating in the urinals, which must be addressed using chemicals with disinfecting abilities.
9. Further to the previous point, urinals should be designed with maintenance in mind. Designs should ensure that a liquid-resistant material is used on surfaces that will come into contact with urine. This will reduce the need for heavy scrubbing of floors and the risk of unpleasant odours. In addition, parts which are easily clogged and difficult to clean should be avoided in general.
10. Waterless urinals are ideal, particularly where water is scarce and unreliable. The waterless option will require some kind of odour trap. This could include a valve, like the Ecoflow valve

from LiquidGold or the EcoSmellStop from Addicom, both manufactured in South Africa, or some kind of filter.

8 Conclusions and Recommendations

This study demonstrates the potential for acceptance of the introduction of urinals for girls and women in school and public toilets in South Africa. Though the concept is relatively new and unknown, it is clear that there are existing problems which female urinals can effectively solve. Poor situations in school and public toilets do not keep girls and women from using them, and thus improved options are likely to be used. Field trials with a wall-mounted urinal demonstrated that as long as urinals are kept clean; adequate education is provided; and privacy is provided, adoption and acceptance of the technology in schools is likely.

Due to the extensive benefits that can be realised and the acceptance demonstrated in this study, it is recommended that the Department of Education add female urinals as an option in their toolkit to address shortages in school sanitation and pursue refined designs for both trough and wall-mounted urinals. Previous WRC research (WRC-2381) demonstrated that most schools have an inadequate number of toilets. Average toilet-to-user ratios at schools assessed in the study were 1 toilet per 36 girls and 1 toilet per 37 boys, which is somewhat higher than the World Health Organization recommendation of 1:25. The average presented here accounts for all toilets on the school grounds and does not factor in the num ber of unusable toilets at a school. Thus, in reality, the ratio of *usable* toilets to number of learners is likely higher in most schools. The need for more toilets in schools could be more cheaply and effectively addressed by implementing female and male urinals in schools.

Not only should female urinals be seen as a way to increase the number of toilet seats in a school, but they should be considered as a way to improve girls' experience with using the toilet at schools. This study highlighted that girls would prefer to use urinals if they were available at school, due mostly to their cleanliness and better hygiene. Providing girls with an alternative to sitting on a dirty seat over a deep pit of sludge should be given priority. If urinals are provided for girls, girls will be forced much less frequently to use pit or full-flush toilets, which at schools, often put their health and safety at risk.

Pilot projects using both trough and wall-mounted urinals for girls should be initiated in schools in different parts of South Africa. These pilot projects should be accompanied by extensive education and monitoring and evaluation to solidify the feasibility of female urinals in South African schools and provide evidence for their further implementation. These projects will also provide the necessary user feedback to refine the design of female urinals and generate a technology that enhances girls' experiences in school toilets. Longer-term pilot demonstrations of the technology will also contribute to management, cleaning, and maintenance guidelines for female urinals in schools. These pilot projects can also partner with nutrient-recovery entrepreneurs, providing more insight into the potential for urine reuse in agriculture in the South African school context.

LiquidGold has plans to expand their installations in schools in the near future, provided the Department of Education is supportive. While the cost per seat appears to be evidence enough for the implementation of female urinals, proven success in the field will be required to realise their widespread adoption. Schools are potentially an ideal setting to test female urinals, as children more easily adapt to new technologies. Should schools prove to be a successful market for female urinals, this technology could be expanded to serve the needs of public toilets in malls and taxi ranks, among other locations.

On a larger scale, further work in the implementation of female urinals in schools and elsewhere can contribute to a number of the United Nation's Sustainable Development Goals (SDG). Implementation of adequate female urinals will contribute to SDG 6, Target 2, to "achieve access to adequate and equitable sanitation and hygiene for all." Female urinals in schools will contribute to SDG 3, good health and well-being, by providing a more hygienic and less odorous experience in toilets for girls. Female urinals in schools can contribute to SDG 5, gender inequality, particularly where schools have pit toilets. While boys avoid using dangerous and unhygienic pit toilets by urinating in urinals or outside, girls are presently forced to use the toilets at all times. Female urinals have potential to contribute to SDG 2, zero hunger, by providing women's urine, in addition to men's, for recovery of nutrients for use in fertiliser. It is simple to harvest urine from men, since they use urinals for urination. However, unless urine diversion is used in toilets, women's urine is mixed with faeces and lost in the pit or down the sewer. Implementing urinals for women allows for simple harvesting of urine from the other half of the population.

The implementation of female urinals in schools must be motivated by the need for increased health, safety, and dignity for learners. If their installation does not accomplish these improvements, there is truly no point in pursuing this new technology. As is demonstrated by many failed sanitation projects, any proven technology can fail to protect health, safety, and dignity of users if it is not designed, implemented, and managed properly. This is also true for female urinals, but if they are designed, implemented, and managed properly, the benefits could be numerous compared to the current options for girls and women in public and school toilets in South Africa.

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Annexures on the associated USB

ANNEXURE A: UNICEF school toilet/Urinal design and drawing

ANNEXURE B: LiquidGold E-container brochure

ANNEXURE C: Initial acceptability study surveys

ANNEXURE D: Preliminary drawing of three-seat squatting urinal

ANNEXURE E: Preliminary cost estimate of 3-seat squatting urinal

ANNEXURE F: Preliminary drawing of wall-mounted female urinal

ANNEXURE G: Messaging used during female urinal field trial


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