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Water, Sanitation and Hygiene Technologies
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The **Water, Sanitation and Hygiene Technologies (WASHTech)** is a three-year action research initiative that aims to facilitate cost-effective investments in technologies for sustainable water, sanitation and hygiene services (WASH). Through action research and the development of a set of methodological tools and participatory approaches, WASHTech embeds the practice of multi-stakeholder learning, sharing and collaboration – instilling individual and collective ownership and responsibility for sustainable WASH services.

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Abbreviations

CFA	West African Franc
NGO	Non-governmental organisation
UDDT	Urine diverting dry toilet
UNICEF	United Nations Children's Fund
US$	United States dollars
WAD	Voluntary Action for Development
VIP	Ventilated improved pit
WASH	Water, sanitation and hygiene
WSA	Water and Sanitation for Africa

1. Introduction

This report synthesizes the information contained in the Country Technology Reviews provided by the WASHTech partners in Ghana, Uganda and Burkina Faso. The objective is to glean out, through a systematic and comparative analysis, the lessons that can be learned from the different outcomes that various WASH technologies have ultimately led to in each country, after earlier efforts to introduce them, encourage their adoption, and ultimately take them to scale. Some of these technologies have been *successful*, others have proven to be *failures*, while others are *promising* but have not yet been thoroughly tested. Still others are *new opportunities* that seem promising but have not yet even been tried. These outcomes were rarely the same in the three countries, even for a given technology, and in explaining the differences--as well as any similarities--the context, and even the particular local history of the promotion effort, must be taken into account.

This reveals the central idea behind the WASHTech project. The introduction of a large number of WASH technologies in Africa has created a kind of natural experiment, one leading to very divergent and highly interesting results. By sorting out the different local outcomes in a small set of three countries, and explaining them as thoroughly as possible based on a wide array of factors--both contextual and otherwise--it should be possible to develop a framework that will assist development practitioners in making decisions about options to be tried in the future. A compilation of those past experiences, and a systematic analysis of the observable results, is thus long overdue.

The lessons to be learned from this exercise are now fairly clear, and they do have great relevance to policy in the WASH sector. This is partly because the quality of the country reviews prepared by the three partners was generally high. Each team used slightly different methods in assessing the value or appropriateness of the various technologies, but they generally followed the procedures, and employed the analytical criteria, that were suggested in the Terms of Reference. It should be noted, however, that the Ghana and Uganda partners were exemplary in this respect, having selected their target technologies and then gone out and done interviews with stakeholders to collect the information needed to explain the different outcomes. The Burkina Faso partner, in contrast, used a focus-group discussion among fifteen invited NGO personnel. This was because technologies have only been introduced by NGOs so in fact all relevant actors attended the workshop. The workshop participants selected and categorized five focal technologies, and compiled a list of factors that seemed, to those same stakeholders, to help explain the results. This approach yielded less useful information, but fortunately there was enough overlap in the experiences reported by the three partners in their reports to allow some much-needed extrapolation.

2.0 Successful Technologies

The technologies rated as successful are, almost by definition, the easiest ones to analyze, simply because they tend to be the ones about which the most is known. A list of the ones chosen by each country partner is shown in Table 1, where a degree of overlap and agreement can be seen. Two of the partners, Uganda and Burkina Faso, rated a particular water supply technology as successful—a type of manual pump--also rating a sanitation technology that highly as well—an ecological latrine. And the characteristics of the specific ones chosen were similar in the two cases. The third successful technology is the one that, to date, has been rolled out to the biggest scale and now affects the largest number of people. Hence it will be discussed first.

Status	Water Supply	Sanitation	Hygiene
Successful	***Slow Sand Filtration System*** (Ghana) ***U2 Water Pump*** (Uganda) ***India Mark II Pump*** (Burkina Faso)	***UDDT Toilet*** (Uganda) ***Sanplat VIP Latrine*** (B-F)	

Table 1: Successful technologies

2.1 The Slow Sand Water Filtration System

The Slow Sand Water Filtration System, like the other successful technologies, was tried out and proved to be effective in Ghana over a long period of time, and this was done in more than one locale. It is designed for small-town rural water supply, where poor quality groundwater means surface water must be used, for example water collected behind a dam. The first system was installed during the late 1980's in a district in the Volta Region, where it now serves a total of 15,000 people residing in 23 user communities. The system proved to be so successful after its introduction that it others were built with capacities up to 300m^3/day, including one in the Greater Accra Region, where it now covers three districts and meets the daily water needs of 115,092 people residing in 130 communities, as well as those served by 18 local institutions. This is currently done through 223 household connections and 63 commercial ones, in the biggest small-town water supply scheme in the country.

Both of these systems were built largely with funds provided by government and by foreign donors, with those external agencies contributing 82% and 95%, respectively, of the total monetary costs in the two systems. These costs were US$52,320 and US$11 million, respectively, showing that the technology can be expanded to cover a broad range of sizes. The beneficiary communities in each system together contributed only 18% and 5%, respectively, of those monetary costs, while providing all of the necessary communal labour. These latter figures, it should be noted, indicate that the technology is probably not feasible for use in rural areas with populations below a certain critical density and size.

The slow-sand technology is a water treatment option, a filtration system that is only effective in situations where the existing supply of a community is fairly large and of sufficiently high quality, with low turbidity and a fairly low content of suspended solids. It is ideal in situations where the groundwater table sits very low, as in Northern Ghana, where the source is typically a stream flow or an existing reservoir. The technology relies on passing water through a layer of porous sand in which microorganisms actively remove biological contaminants, while the sand slowly filters out any suspended inorganic matter. The output of this basic treatment process--a process that itself must be housed in a sizable holding structure--can be pumped and stored in one or more elevated tanks, and ultimately distributed through an extensive network of pipes to the connections that serve the end-users. The system can later be expanded to meet growing demand, and in Ghana this has been done carefully so as to include an increasing number of facilities, situated so as to minimize people's travel times. The technology is also compatible with a number of other higher-tech improvements, for example large-capacity chlorinating units, which in Ghana have been added both to improve quality and to expand the service.

The slow-sand technology is a relatively low-cost appropriate design, is fairly easily maintained by local people using local materials—given suitable training—and its introduction, piloting and subsequent "roll-out" all involved a wide range of stakeholders, including, most significantly, the end-users and beneficiaries themselves. In the larger of the two systems, a private company is now in charge of routine operation and maintenance, but in the other one a central Water Board does this, along with a seven-member Caretaker Team. Both of these latter entities are made up of local people who are themselves water users. In the larger system, a Water and Sanitation Development Board—again made up of local water users--oversees the private company in its daily activity and work. Users pay for water on a volumetric basis and this covers the operation and maintenance of the system, but some of the more expensive parts are not being replaced.

In both situations, the systems can be said to be wholly owned by the user communities, and the technology would have to be considered to be a resounding success. These two favourable local outcomes, achieved through cautious piloting and high levels of stakeholder involvement, have ultimately led to the technology being installed in over 20 other areas within Ghana. Overall, the lesson to be learned is that the slow-sand technology is probably a viable option for many African countries, one worth trying in situations where surface-water use is necessary on a significant scale, and sizeable rural population centers, combine to require a substantial, and somewhat costly, water-treatment system. The costs, although considerable, are within the capacities of many donor organizations, and the benefits thus far have easily been great enough to justify such investments, although time will tell whether the same donors will replace systems when they become worn out. High-quality water is currently available to users in the two case study systems during most of the day, for a low and affordable 'price' or fee, where it can be collected within a relatively short walking distance. (Although admittedly this will not cover the subsequent replacement of the system). Consequently, the major water-borne disease vectors of guinea-worm and bilharzias have reportedly been eliminated in the two service areas. This is a substantial public-health achievement.

2.2 The U2 Water Pump

The U2 Water Pump, is a water-supply technology of much smaller scale, one designed to provide benefits that are more localized and dispersed in the way they are delivered. Introduced in Uganda in the 1990s by UNICEF, and then rolled out gradually over a period of more than twenty years, the pump is used to extract water from deep boreholes or from shallow hand-dug wells, of the sort that are widely found throughout the African countryside. Initially, pumps were imported from India and subsidized by UNICEF, which spearheaded their introduction using funding provided by the Swedish government. Shortly thereafter, a Ugandan company, Victoria Pumps Ltd began to produce a standard pump, the U2, along with the necessary spare parts, in a programme sponsored by UNICEF and the Ugandan government. Today there is competition between these domestic and foreign manufacturers. The Ugandan pumps remain more expensive, probably because the Indian pumps are produced in a bigger 'economy of scale'.

Other than a widespread need for an appropriately-designed technology, the one factor that has been most critical to the success of the U2 is a standardization policy instituted by UNICEF and the Ugandan government in 1995. This narrowed the range of hand pumps that were available in the country to two simple types: the U2 and the U3. The spare parts for both soon became widely available, and a concerted effort was made to build on the existing skills of people in the countryside so as to ensure that the necessary expertise in repair and maintenance was relatively easy to find. Previously, there had apparently been a plethora of pump designs, introduced by various donors in different development projects, none of which had spread very far in the uptake process. Note that it is the domestically-produced version, the U2, which was designated as successful by the Uganda partner in their report. This is apparently because that pump is more easily repaired, although it appears that the judgment between the two types was a close one in this regard, perhaps even a toss-up. The supply of spare parts is said to be more reliable for the Indian pump, and those imported parts also cost less money—again, probably because they are produced in a bigger economy of scale. The relative ease with which the U2 can be repaired is assumedly the reason why people in Uganda are willing, from time to time, to pay somewhat higher prices in order to keep those pumps going. It is important to note, however, that local people in Uganda have not had to purchase these pumps, and that they are not even aware of their full cost.

The capital financial costs have continued to be paid by government, NGOs and other development agencies ever since the pumps were first introduced. These agencies, both foreign and domestic, have purchased the pumps and installed them, with local governments (at the Sub-county level) paying a small but symbolically significant percentage of those monetary costs. The beneficiaries and their communities, meanwhile, have contributed only housing and meals for the masons or artisans who did the installation, as well as donating land and locally-available construction materials such as sand and bricks. They also pay for ongoing operation and maintenance. This high level of financial dependency should of course be taken into account by any countries and agencies that might consider adopting the pumps in the future, and of course the costs of drilling a borehole are in addition. It appears extremely doubtful that the pumps—as simply designed and relatively inexpensive as they are--would have been a success in Uganda without this.

The U2 pump is suitable for use in wells varying in depth from very shallow—or less than 25 meters—to moderately deep—as much as 50 meters. It can potentially provide water every day for as many as 400 people, and is not highly prone to breaking down. Just as importantly, the pump can be installed using relatively inexpensive, locally-available materials: sand, aggregate, cement, rods, pipes, and stones. It is easy to operate relative to other available types, even for children. Yet, as with most of the technologies under review here, there are other significant start-up costs, which to date have also been paid almost entirely by the donor organizations. The pump requires a trained mason for its installation and, more importantly, a trained caretaker to operate the facility, to collect any required fees (from commercial vendors and users of the facility), to protect it (locking the pump up at night and unlocking it in the morning), and generally to keep the facility going. Moreover, a Water User Committee must be set up initially to hire and pay the caretaker, and to ensure that the collected fees are properly spent, especially in paying for the repairs and the occasional spare parts. In Uganda, all of this has been provided by local people. However major repairs incase the pump needs replacement for example are covered by the District Local Government. Despite the general availability of everything that is needed, there has apparently never been a case of a more endogenous grass-roots adoption of the U2 pump.

The pumps seem to have been in nearly-continuous use for many years now in several rural districts, with an estimated 24,660 is use. The technology has clearly been a resounding success, suffering the occasional breakdowns in maintenance that are inevitable and to be expected, but generally proving to be both socially and environmentally sustainable. A sizeable framework of institutions had to be set up in order to achieve this, and from the beginning this was done with the broad participation of the primary stakeholders, the end-users, and achieved through appropriate piloting and modification, or trial-and-error. But, again, it was the donor organizations and government agencies who paid most of these capita costs, doing the initial training of artisans as well as caretakers, and providing refresher courses for these people from time to time. Yet an effective and sustainable maintenance system was ultimately created, a feat that should be possible in other similar countries.

2.3 The India mark II

The India Mark II, which was named a successful technology by the partner in Burkina Faso, is the same imported India Mark II pump referred to above. Thus this example is an almost identical technology with a highly similar history, and there is little need to say much more about it here. The Burkina Faso report does mention, however, that the parts for the pump are made in India but exported in large quantities to Africa, where they can be assembled without a license by any company in order to 'manufacture' the final product. This must explain why the parts are so widely available and cost relatively little in Uganda, and does indicate a fairly big economy of scale.

The pumps themselves are heavily subsidized in Burkina Faso by UNICEF, in order to keep them affordable to rural people, and the national government provides the boreholes, which are drilled for local people at very low cost. No overall figure for the costs is given in the report, although "capital costs" for boreholes are said to total 8,686,000 CFA (US$18,000). The report specifies a standard community contribution of 150,000 CFA (US$300) per borehole, which assumedly includes the pump. The cost to the beneficiaries is extremely low within the existing system of provision.

The India Mark II was introduced to Burkina Faso in the 1980s. The technology is currently being promoted in Burkina Faso by the government throughout the entire country, through subsidized installations, but it is not clear exactly how widely it has been introduced to date. Interestingly, no pilot phase is said to have taken place. The India Mark II pump is listed as now in use in 9983 locales, 33.4% of the total number of installed hand pumps, and far exceeds the contribution of any other pump type. Thus it would appear to have been tried out very widely, and to indeed be a great success.

The report mentions that local artisans and caretakers are invariably enlisted to contribute to the India pump installations, an involvement that obviously begins their training. It also emphasizes the relative ease with which the pump can be repaired by these personnel, who are said to be trained by the suppliers in a wide array of tasks, including dismantling, reassembly, and maintenance. The strong impression is thereby given that virtually all of the elements that were so crucial to the success of the pumps in Uganda are now in place in Burkina Faso. One major element is missing, however: the standardization policy, at a national level, which was thought to have been so crucial to the positive outcome in Uganda. The India Mark II pump has been widely tested, without the kind of competitive advantage that standardization provides, and yet the pump is rapidly winning out over a large set of competing types.

2.4 The UDDT or Urine Dry-Diversion Toilet

The UDDT or Urine Dry-Diversion Toilet, a sanitation option classified as successful by the Uganda partner, is the quintessential appropriate technology. Designed and subsequently improved by a Uganda government ministry official, with no foreign prompting or support, it was introduced in 1997, piloted in several communities, and then rolled out gradually, and more widely, over an extended period of time. The technology itself went through several modifications during this period, and today it comes in a number of specific types, which are constructed to fit specific local conditions and needs: ones for sitting, ones for squatting, others made of various materials, all available in both indoor and outdoor varieties. A major advantage is that the toilets, like pit latrines, are built entirely of relatively cheap, locally-available materials, ones commonly used in building structures of other types. The many variants of the toilet are all intended as alternatives to pit latrines which, in the often waterlogged or rocky countryside of Uganda, are difficult to dig and hard to maintain. Pit latrines also generate bad odours, a problem that the UDDT toilet does not have, provided that it is properly used and maintained. All of these are major reasons for the technology’s wide appeal, but the chief one is probably its relatively low cost.

Interestingly, the toilets have been far more successful as a private household option than as a public institutional one, mainly because of problems with overuse, misuse, and poor maintenance in hard-to-control public settings. These latter limitations will be difficult to overcome in most countries, but they do not appear to be insurmountable. In any case, the UDDT clearly has the potential to be successful as a household sanitation facility in a wide array of countries and settings. It is even likely eventually to be built indoors, once enough people become convinced of its effectiveness in preventing odours within the household.

This main positive feature of the toilet, odour control, is not fully explained in the report, but clearly it is linked with the use of ash, which has to be applied to the faeces after the toilets are used and the diversion or urine. People must of course be aware of this, and be willing to do it, and instruction on this has to be provided, either by the masons and artisans who build the toilets or by some other sponsoring organization. The same is true of the required upkeep and maintenance, particularly the supplying of the ash and the periodic emptying of the toilets. The treated and dried refuse can ultimately be used as nearly cost-free fertilizer, but the report notes that few of the users interviewed cited this benefit as having contributed to their decision to buy the toilet. Attempts to provide the necessary instruction publicly in institutional settings, by posting well-designed signs, have apparently been made, in an effort to make the public UDDT toilets more sustainable. But the report notes that most of the public toilets built to date in Uganda to date are now closed. It seems clear that people must be regular users of the technology, enjoying its benefits daily, if they are to be willing to pay the associated costs, including the very small cost of correct use. The report mentions the idea of hiring caretakers or operators for the public facilities--people who are continually present on-site at the point of use--to urge people to use them properly, but notes that this option has not yet been tried on a significant scale.

The cost of a household Ecosan unit—i.e. one to be constructed outside, the cheapest option and the only one that has been tried to date—is relatively low, but is still a substantial one for most African families: US$306 to build a unit and US$19 to empty it, a task that only has to be done every two years. The purchase and construction cost is clearly the biggest obstacle to more widespread use. The report notes that more than 300 household toilets have been built in the trial area, none of which were subsidized, while the more costly institutional toilets invariably required outside funding. The users were not consulted during the process of design and introduction, but stakeholders were widely involved in the piloting and the first public demonstrations of the toilets' use. This clearly contributed to the fairly wide uptake, in a process that did not involve extensive social marketing. The facilities are physically durable, and the vast majority of the household units that have been installed are still in use today.

In sum, the Ecosan toilet is definitely a success, at least as a household sanitation option in many parts of Uganda. It is especially suitable for areas where a high water table and waterlogged soils make the digging of latrines difficult, as nearly all of the householders interviewed in Uganda noted. However, the toilets are so highly preferable to latrines that their widespread adoption, even in areas where latrines are seen as less problematic, would appear to be feasible. The problems inherent in their use as public facilities are more substantial, but their widespread adoption at the household level would of course be a major achievement. This 'homegrown' African technology must be considered one of the most successful and promising options out of all those discussed in the three reports, one that should be promoted widely in other countries.

2.5 The Sanplat VIP Latrine

The Sanplat VIP Latrine, classed as a success in the Burkina Faso report, is apparently one of the most widely-used sanitation technologies in Africa. Introduced there and in neighbouring countries by UNICEF and WaterAid, during the early 1990's, the latrine is extremely low-cost and built entirely of locally-available materials (typically just three bags of cement). As such, it is a viable household alternative to the more expensive UDDTs, and is also widely used in public settings. Intended for the poorest households in areas where people normally defecate out in the open, it has been hugely successful both in Burkina Faso and in other countries.

Construction costs are currently only 30,000 to 40,000 CFA (US$40-60) in rural areas, and 100,000 to 130,000 CFA (US$200-260) in urban ones. Despite this, the technology was widely subsidized in Burkina Faso after its introduction, with WaterAid's progammes covering 60 to 80% of the costs, and one government programme paying 20 to 39%. Given the success of the more expensive and unsubsidized Ecosan toilet in Uganda, these subsidy programmes could perhaps be phased out today without negatively affecting the uptake. A third government-sponsored programme, which is now underway, is currently testing this idea out.

The latrines must be excavated to a depth of at least one meter; and they can only be built in areas where the water table sits at least a meter or more below ground, so as to avoid contamination. They consist of a lined masonry-and-concrete pit, a covering slab of steel-reinforced concrete--designed for comfortable use and for easy cleaning (either one-hole or two-hole versions)--and a supporting above-ground shelter for privacy. The only maintenance required is regular clearing of the ventilation pipe, and perhaps emptying the pit when it finally becomes full. The most frequently-used option in the latter case, however, is simply to move the slab and the superstructure to a new area after digging a new pit.

Being one of the simplest and least costly technologies imaginable, the Sanplat does not require a network of specialists trained in maintenance techniques. Nor does its installation involve the difficulties usually associated with instilling a sense of local ownership of the facilities. During the initial piloting and promotion, local masons were widely trained in the techniques of construction. But in this regard the 'institutional overhead' was relatively low to begin with, as many local people already had the necessary skills. The ability of local people to build the latrines is now widely in place, a setup that should prove to be sustainable. With subsidies or without them, the Sanplat latrine is obviously a success, both in Burkina Faso and in other countries, and is clearly here to stay.

3.0 Failed Technologies

The technologies considered to be failures also have a lot in common and, with the benefit of hindsight, they are easy to spot, as they tend to have a single fatal flaw that stands out above all others. The examples are listed in Table 2 below according to country. It is interesting to note that only three technologies were ultimately placed in this category, with the Ghana partner nominating two examples and Uganda only one, while the Burkina Faso team did not nominate any. This pattern perhaps reflects a reluctance to "give up on" any technology that has not been tested over a long period of time, and yielded disappointing results in many different locales. Nearly all of the technologies introduced in the three countries to date appear to have a lot going for them, and bad results sometimes seem attributable to problems of maintenance that could, theoretically, be resolved, rather than to flaws in the design. Since few options have been tried exhaustively in the "acid test" of actual practice, with all of their required components in place, the low number of options designated as failures is perhaps understandable.

Status	Water Supply	Sanitation	Hygiene
Failed	***Rope Pump*** (Uganda)	***Aqua Privy*** (Ghana) ***Enviro-Loo*** (Ghana)	

Table 2: Failed technologies

3.1 The Aqua Privy toilet

The Aqua Privy toilet, one of two technologies rated as failures by the Ghana team, is a sanitation option of very simple design. Indeed, it appears to be the simplest option available which addresses the most serious problem afflicting nearly all low-cost public sanitation facilities: odor control. The Aqua Privy is designed for institutional rather than household use--particularly for use in schools. It is built entirely of inexpensive materials that are locally available, generally being already in widespread use. The toilet also requires very little maintenance. Indeed, at first glance it is difficult to understand why the technology has been rated as a failure.

The toilets were introduced in Ghana in the 1930's, and have been in widespread use for decades. In one region of the country, 16% of the current population, or about 200,000 people, are now said to be using them. The design was piloted appropriately and then promoted in several government development projects, all assumedly funded mainly by foreign donors. Although primary stakeholders were not involved in the piloting, the technology had been scaled up progressively there, in the Ashanti region, reaching the aforementioned level of service by 2005. All of this seems to have been done in an appropriate way.

The Ghana team did an evaluation of the current state of four Aqua Privy facilities in four local communities, ones primarily used by students in local public schools. They note that the toilets have had a positive impact on the students' health, pointing out that materials for their maintenance and repair are readily available, and at low cost. The team point to an ongoing problem of inadequate odor control, but say that the communities have worked out an acceptable way of dealing with this (daily cleaning of the toilets and stalls). The students and other users reportedly consider the Aqua Privy to be preferable in this respect to two other low-cost options that have been tried out locally and are widely available in the country. All of this reveals that the technology has not really performed at intended levels, while also showing why, in many local areas, the toilets are still in use.

Overall, at a national level, the Aqua Privy is judged by the Ghana team to have been a failure, probably for two reasons. First of all, many of the existing facilities are evidently no longer in use. The problem is poor maintenance of the water seal thereby making the system to function like an ordinary vault latrine with associated occurrence of odour. This is caused by the limited water sources at installations   Secondly, and most tellingly, a government ministry that for a long time strongly promoted the toilets is no longer encouraging their installation and use.

The reasons for this are fairly clear in the report. This example provides a cautionary tale about the chances of ultimately providing effective sanitation services in public and/or institutional facilities in Ghana and other countries. The Aqua Privy is considered preferable to other similar technologies mainly because of its simple design. It has a water-tight settling tank into which waste is carried by using small amounts of water for flushing. The quantity of water needed for this is very small relative to other similar technologies, but the waste drops into the tank through a pipe whose end must remain submerged—by at least 75 mm.—within the layer of liquid below it in order to form a water seal. This is the design feature that, along with a ventilation pipe, provides the all-important control of odours, which normally makes the toilet superior to other low-cost options.

In order to maintain the seal, and keep the liquid and sludge in the tank at the appropriate level, one bucketful of water—preferably wastewater or grey water—must be poured into the tank every day, so as to counteract routine evaporation. That, of course, should be an easily manageable task for a caretaker or other designated person, whether they have been carefully trained or not. And yet it is here that maintenance of the facilities has apparently broken down, on a big enough scale to render this otherwise promising technology a failure. The tank must also be cleaned out periodically, and the ventilation pipe must be kept clear in order to avoid a buildup of noxious gasses. But a failure to provide a small daily top-up of water—or rather, an inability to do this reliably at the local level--has apparently caused this technology to fall out of favour, leading it to be abandoned after decades of strong promotion by the Ghanaian government.

3.2 The Enviro-Loo

The Enviro-Loo, is a similar, but significantly more complicated, technology that has also been widely promoted in Ghana, and led to a similar result. Intended mainly for public use, it is a waterless system consisting of toilet bowls or pedestals housed within individual cubicles that are joined together. Each of these cubicles has its own patented gas extraction unit or fan, which is positioned on the top of the structure, at the terminal end of a ventilation pipe. The design is a popular one mainly intended to control odors, which has been tried out in 39 countries, with a total of 53,000 units now said to be in use worldwide.

The design was developed initially by a private company in South Africa, and most Enviro-Loo toilets are still manufactured there today. A Ghanaian affiliate also takes part, which is supposed to supply the spare parts needed for repair, but that logistical support system has apparently broken down. The Ghana report notes that the toilet was not piloted properly nor subjected to the normal process of government ministry approval, saying that its widespread introduction within a very short period of time was the result of "political arm-twisting". By all appearances, the Enviro-Loo is a relatively low-cost technology that appears to be appropriate, with highly-promising features, all of which led to an executive decision being made at a very high level that it was the solution to Ghana's public sanitation problems.

The lack of appropriate trials, and of public consultation, apparently led to its fatal flaw being overlooked: reliance on imported components and parts. The ventilation fans eventually break and, if they are not replaced immediately, the toilets soon become unusable due to a rapid buildup of both heat and odor. This ultimately leads people to tear off the doors, apparently at night, which of course makes the toilets almost unusable during the day.

In a country where even the most minimal maintenance of public facilities can be problematic--such as providing just a bucketful of water per day--surely this kind of folly could have been foreseen and avoided. In any case, this example provides yet another cautionary tale. When the motivation is high to do so, and the money is available, it can be relatively easy to set up a supply chain to purchase, and even to maintain, an imported technology that does effectively solve a local problem. But, as is so often said in Africa, "things fall apart". Government ministries must be vigilant to ensure that this does not happen, taking great pains to see that a crucial degree of continuity is maintained in the relevant health and development bureaucracies from year to year, as governments come and go. When a technology like this falls into disuse—a fairly expensive one that has been adopted so widely and so publicly, and that initially served the population fairly well--it truly is a disaster that will have implications long into the future.

3.3 The Rope Pump

The rope pump, a failure discussed by the Uganda team, is another seemingly appropriate water-supply technology. Promoted throughout the country in recent years by WaterAid and affiliated NGOs, it must be the simplest of all available options for pumping water out of wells, and is obviously the one that costs the least. It can be built entirely out of locally-available materials—scrap metal, discarded plastics, and old tyres. Pumping waster for a family is somewhat strenuous but can be handled by older children. Consisting of a metal pulley-wheel, a rope with pistons attached, a pipe that enters the well, and a guidance device for the rope, it can lift groundwater from as far below the surface as 50 metres. The design is simple, sturdy, and especially easy to repair, as the rope is the only moving part that tends to wear out with use.

Why, then, is the pump considered a failure in Uganda? The only clear reasons given in the report are that the rope eventually deteriorates. This problem does not appear to be a sufficiently serious one, however, to justify rejecting the technology, and others had to be sought by reading between the lines of the Uganda report. The devices are very inexpensive—reportedly costing between US$200 and US$388 each—they require simple maintenance by a small local maintenance committee, and, again, they are easily repaired. One reason for less-than-desirable results seems to be that, in Uganda, the handpump is competing with the other two pump types referred to previously—the U2 and the India Mark II—against which it appears not be performing very well. But the wells themselves may be the main reason for this.

The report refers two times to a failed national programme to install the pumps on hand-dug wells that were to be built by private-sector companies. Apparently the required government permission for this contract to be awarded was never given, so that the programme ultimately fell apart. In any case, several of the stakeholders interviewed complained that the wells that were dug, where these pumps were subsequently installed, turned out to be unreliable, running dry after the rainy season. The problem is mentioned repeatedly, specifically in discussing this pump but not in discussions of the other two types. The overall impression given, both in the Uganda report and in the other two country documents, is that the other pump types, besides being somewhat easier to operate and more 'modern' in appearance, are commonly used on boreholes, which are generally deeper and have a more reliable water flow than hand-dug wells. This may be causing the rope pump to be viewed less favourably in Uganda than it otherwise would. The reasons for considering the technology a failure there may have relatively little to do with the design or the performance of the device itself.

The design, however, can definitely be improved, as we will see below, something that has not yet happened in Uganda. If it were possible for people in Uganda to learn from the experience of their counterparts in other countries where the Hand Pump has been introduced—and that, of course, is the purpose of this exercise, of the forthcoming Technology Assessment Framework, and more generally of the WASHTech project—then the technology would very likely be viewed more positively there. The failure to date might be seen as temporary, and the appropriate steps might be taken to eventually make it a local success.

4.0 Promising Technologies

The promising technologies are ones with many desirable features that have not yet been tried out thoroughly enough, or on a big enough scale, to allow them to be judged as unqualified successes. Here unsteady government support can be an issue, as can a lack of clarity in buyer/provider relationships. Only the three technologies listed below were put in this category, but two of those—the rope pump and the tippy tap--were each nominated by a pair of countries. This concurrence of opinion did not emerge for any other technologies involved in the assessment exercise; thus it has to be considered to be significant.

Status	Water Supply	Sanitation	Hygiene
Promising	***Rope pump*** (Ghana) ***Rope pump*** (Burkina Faso)	***Ecosan Latrine*** (Burkina Faso)	***Veronica bucket*** (Ghana) ***Tippy Tap*** (Uganda)

Table 3: Promising technologies

4.1 The Rope Pump

The Rope Pump is placed in this more positive category, this time by the teams in two different countries, presents an opportunity to take into account more information and to assess the technology's performance in greater detail. The pump appears to be gaining in popularity in both countries, with as many 2,000 reported as having been installed in Ghana in recent years. In both nations the pump is considered to be suitable for either institutional (i.e. public) or household (i.e. private) use. The technology has been tried out, and improved, over a longer period in both of these cases, leading to a different result, as the opinions of the stakeholders consulted for this exercise revealed. When these two relatively strong endorsements are taken into account, the technology appears likely to eventually be a success, potentially in all three countries, so that the previous negative assessment by the Uganda team should perhaps be reconsidered.

The pump has been promoted strongly in Ghana since the late 1990's, by the World Bank in conjunction with WaterAid and other local NGO's, through well-designed and sustained efforts to pilot the technology and promote its uptake. The effort in Burkina Faso was more recent, having really gotten underway in 2004, but it has led to basically the same encouraging result. Local artisans were widely trained in both cases through capacity-building programmes to construct and to repair the devices. Heads-of-household were also widely trained to act as caretakers and repairmen in situations of domestic use. Two factors seem to have been chiefly responsible for the early success of these programmes.

The first, as in many of the previous technologies discussed, was the full *subsidizing* of all of the pump purchases, at both institutional and household levels, at least in Ghana. Although the pumps cost very little—an estimated average of US$253 in Ghana—this was clearly thought to be necessary in order to get their promotion off the ground. The Burkina Faso report was not entirely clear about this matter, but in all other respects it seems to be describing a highly similar promotion programme. The second factor, as previously mentioned, were certain improvements in the design. The most important of these, in both countries, was the addition of a thin metal casing or cover for the rope, to prevent the aforementioned contamination from happening as the rope wears out.

Where these changes have recently been put in place—a total of 98 cases in Ghana--the pumps are still in use and are "working perfectly". Users were enthusiastic in their assessments, even where the pumps are being used in hand-dug wells, the output of which does often decline in the dry season, as the Uganda report repeatedly pointed out. The main advantage is said in both countries to be that the water is much cleaner than that which comes from wells that lack these pumps. The device can lift up to 0.6 litres-per-second of water from wells up to 10 meters deep, but only 0.15 litres-per-second from wells up to 50 meters deep, so that the deeper the well of course the more effort that is required. Although the work involved is fairly strenuous, the users consulted felt that resulting fatigue and discomfort were tolerable given the magnitude of the benefit provided. All of this indicates that the Rope Pump is indeed promising, and that it may soon prove to be one of the most successful water-supply technologies in Africa.

4.2 The EcoSan Latrine

The EcoSan Latrine, considered promising by the Burkina Faso team--is basically the same facility as the UDDT, which was rated as a success in the Uganda report. The version described in the Burkina Faso assessment is a two-pit latrine, built either above ground or only halfway into the soil, in order to permit the periodic removal of accumulated dried faeces or sludge. The unique feature of the technology is the diversion of urine into a very large jerry can, in order to separate the liquid from the faeces which, after drying, can be used as an organic fertilizer. This latter feature is in this case seen as a promising one. In Burkina Faso, unlike the situation in Uganda, the production of the fertilizer is said by users and purchasers of the technology to be a major selling-point responsible for its local success, in addition to the control of odours. The Ecosan toilet is said to be especially popular among farming and gardening households in Burkina Faso for that reason. Such multi-functionality, in which a 'green' dimension has been added to a suitable and fairly low-cost sanitation facility, is promising indeed.

This option is especially suitable for areas with high daytime temperatures, areas where digging is difficult or, as in Uganda, areas where a high water table discourages the digging of a deeper and more conventional pit latrine. The costs of the latrine appear somewhat higher than those reported in Uganda, probably because of the larger two-pit latrine design, as compared to a one-hole latrine or toilet: 174,000 shillings (US$70) for the option with a cement-block superstructure, and 143,000 ($US60) for the option with an adobe brick superstructure. The main revelation coming out of the Burkina Faso assessment is that, regardless of whether the latrines were installed for institutional or for domestic use, a hefty subsidy was provided by the donor agencies. The figures given were a 70% subsidy provided by the NGO, with a 30% contribution provided by the household or the local community. No mention is made of any effort in the country to reduce this, for example by a social marketing programme designed to create a greater and more sustainable level of demand.

As for the reasons why the Ecosan is considered to be merely promising in this case, rather than an unqualified success, the answer is the usual one: the relatively short period of trial. The report mentions demonstration programmes of only three years' duration, and explicitly questions whether that is long enough to indicate success. As in Uganda, the technology has been piloted appropriately, and introduced along with the extensive training programmes that are needed to ensure proper use and maintenance at the local level. The number of beneficiary communities, although not specified, is clearly substantial in Burkina Faso, as the report refers to the latrines being introduced as part of a sub-regional development programme. It also points out that the technology has also been piloted in sizeable projects in six other African countries—notably not including Uganda in the list—all of which showed similarly promising results. All of this indicates that the Ecosan is likely eventually to be considered a success in several countries, including the one country, Uganda, where it is already regarded that highly.

4.3 The Tippy-tap

The Tipp-Tap, is a hygiene technology regarded as promising by the Uganda team. It is highly similar to the ***Veronica bucket***, another hand-washing device nominated by the Ghana partner in the same category. Both are very simple, low-cost options, consisting of a large jerry can (3 to 5 litres) with a spigot attached to the lower portion, along with a piece of bar soap on a string for people to use in cleansing their hands. The main difference between the two versions is that the tippy-tap is placed in a stand, and equipped with an attached string-and-lever device, both of which allow a person to tip the can by using their foot, thereby releasing a stream of water without having to use the hands. This of course greatly increases the tippy-tap's effectiveness as a sanitation device to be used after urination or defecation. Because the two versions are otherwise very similar, they will be discussed together here.

As with the majority of the technologies considered in this review, the two hand-washers are constructed out of commonly-used materials that are locally available, and at very low cost. The costs of buying or making one are said in the Uganda report (for the tippy-tap) to vary widely, from the equivalent of US$0.5 to as much as US$10. Both devices require hardly any maintenance, except for filling the bucket with water periodically and making sure that the soap is replenished on a regular basis.

The main investment required for the tippy taps to be successful, however, is an institutional one: a comprehensive training programme that enlists local people to act as “ambassadors” in promoting hygiene in general and hand-washing in particular, as a way of preventing contagious disease and controlling parasites. Such programmes have apparently been carried out in both Uganda and Ghana, leading to widespread use of both options, particularly in public or institutional settings such as schools.

No figure is given in either report for the total number of devices in use in each country, but the specific projects mentioned indicate that the numbers in each case must be in the thousands. Inspections were carried out by both country teams at a selection of sites, including households as well as public institutions, and all of the tippy taps that had been installed in these areas were found to be still in use. Perhaps the most significant point to note here is that, as one might hope with such a low-cost device, both types of taps are being acquired--and their use is slowly spreading—without any subsidies being provided by outside agencies. In both countries, households are able to either purchase the devices or make them without any outside help, which is fortunate because no financial assistance is said to be available. These, then, are two examples of truly grass-roots, bottom-up innovations, ones that have required training and education programmes in order to promote them, but which have been fairly successful nonetheless. The very low cost, the local availability of the materials, and the simplicity and appropriateness of the basic design, are all major factors that have led to this outcome in the two countries. Why, then, were the two technologies rated as merely promising, rather than successful?

This is not clear in either report. Although a great many taps of both types are already in use, in each country many more have recently been introduced. Given the scale on which this has happened, and the great promise that each of these technologies clearly shows, the two teams appear to have chosen, for now, to reserve final judgment. Such caution may well be justified. The taps are nearly ideal solutions to local hygiene problems, particularly in rural areas, and plans therefore appear to be underway to roll the technologies out to the maximum possible scale. In such an expanding situation, to call them successes would obviously be premature. (check about subisidies in Ghana)

5.0 New Opportunities

These examples are technologies that meet a local need, and appear to be appropriately designed, but their piloting and promotion have not yet gotten off the ground. The many unknowns in these cases appear to include questionable government support, and a lack of established buyer/provider relationships, not to mention uncertain local demand. But in some cases the partners in other countries have prior experience, either with the same technology or with a highly similar one, which makes it possible to look ahead and see just how promising, or perhaps discouraging, a particular option is. This kind of discussion again demonstrates the potential value of the Technology Assessment Framework and the WASHTech project.

Status	Water Supply	Sanitation	Hygiene
New Opportunities	***UGA pump*** (Uganda) ***Sand Dam*** (Burkina Faso)	***Ecosan technology*** (Ghana)	***Veronica bucket*** (Ghana) ***Tippy Tap*** (Uganda)

Table 4: New Opportunities

5.1 The Ecosan technology

The Ecosan technology, which includes both the toilet and the latrine designs previously discussed, has not yet been tried on a significant scale in Ghana. The fundamental principles on which it is based are, however, sound and promising, as we have seen: 1) preventing pollution rather than attempting to control it (by drying fecal sludge so that it can be removed); 2) sanitizing urine and faeces, while separating them; and 3) using the safe composted end-products for agricultural fertilizer. Given the fairly positive outcomes already observed in more advanced promotion programmes in the other two countries, there is every reason to expect the technology to be successful in Ghana, and every reason to encourage its adoption there. Its promise for Africa as a whole is equally clear, especially in areas where a high water table renders a more conventional latrine unfeasible or undesirable. The technology applies to a wide range of specific toilet and latrine designs, all of which can be adapted for use in different soil types, and adjusted in other ways to fit specific local conditions. The technology is not in fact new, as the Ghana report points out, but interest in it has grown in recent years after a long period of dormancy. This has resulted in it being tried out in a couple of institutional settings in the country. Although the preliminary results look positive, a major constraint on more widespread promotion is the fairly high cost: the report says that a household toilet now costs about US$1000 to US$1200.

The toilets and the necessary components were imported initially from Germany, but steps were taken to train local artisans to manufacture the parts to that same level of quality. Training courses have also been carried out to instruct people in the maintenance and use of the facilities, all of which got positive results. The same is true for the crucial role of preparing people to transport the sludge to local treatment plants for further processing into composted fertilizer. The report acknowledges, however, a second obstacle that will evidently be the major barrier to broader success (in addition to cost), if efforts are to be made to take the technology to scale: overcoming people's reluctance to use treated human waste as fertilizer. There is a natural revulsion to this, and people have to be convinced, both that the final product is safe and that the benefits are worth the effort involved.

The success of the technology in Uganda, where hundreds of these toilets have been purchased by fairly poor households, and without any subsidies being provided, clearly shows that the both the financial problems and the more 'cultural' problems can be solved. The promotion of Ecosan should therefore move forward now quickly in Ghana. The same can be said for the promising outcomes observed to date in Burkina Faso. Both situations, being based on more lengthy experience, suggest that NGOs and the government in Ghana can proceed with confidence, without having to 'reinvent the wheel' with this particular technology, and without running much risk of failure.

5.2 The UGA pump

The UGA pump, a new device discussed by the Uganda team, is another low-cost pump, specifically for use in drawing water out of shallow, hand-dug wells. Thus far it has been piloted only in a single district in the country, where it has been performing quite well for about a year in the 30 localities where it was first introduced. The UGA pump is easier to use than the successful India Mark II pumpm because it has foot rests which children, the elderly, and women can step on and pump water easily so the issue of height and bending of the body is minimized. It also self lubricating. Unlike the other pump types, this one can be built by local artisans (once such people are trained), entirely out of locally-available materials. Despite this it is still fairly costly, at about $670 per communal well, with the full monetary cost currently being paid through an NGO subsidy. The beneficiary communities have thus far provided only land, food for the artisans who build the device, as well as sand and other basic materials, and of course the necessary labour.

The establishment of the wells has been done almost entirely by an NGO, Voluntary Action for Development (VAD), with little support from the district government or from agencies at higher levels. VAD have thus had to struggle to put in all the necessary institutional elements, such as local artisans for construction and repair, and the local maintenance committees to oversee proper use and ensure that regular maintenance is carried out. The pumps are performing well despite this, but most have only been in place since 2010, so that the jury is still out on this option. Users are said to be confident that the pumps are durable and can easily be repaired, and they prefer them to the aforementioned other types, which are known to be harder to use. Taking into account the relative success of the U2 and the India pump in the two other countries, whose purchase, upkeep and use appear to have involved somewhat greater challenges, the UGA pump should now be widely promoted, as it is likely, eventually, to be even more of a success.

5.3 The Sand dam

The Sand dam, is a community water-supply technology that is newly being tried out in a few locales in Burkina Faso, after having been developed successfully in Kenya. Perhaps best described as a medium-cost water-supply option, it is being promoted by the Rain Foundation (Netherlands) and its partners WaterAid and WSA. Designed for construction ephemeral streams, these low dams temporarily restrain the flow of small rivers so as to facilitate the recharge and retention of groundwater stored in the sediment fans that naturally build up along stream channels. The cross-channel wall of the dam can be built entirely of local sand and stone—the lowest-cost version—or it can be reinforced with concrete, stone blocks or clay to make it stronger—the higher cost version. The latter option runs up the total cost to about $7500, for a feature with a storage capacity of 2000 cubic meters and an estimated lifespan of 50 years.

The idea of the sand dams is that they raise the water table locally and keep it at a consistent level, although this hypothesis is still being tested by a groundwater level monitoring programme. This in turn would greatly improve the performance of hand-dug wells, making shallower wells possible while helping to safeguard the water quality, although again this idea is untested. It is obvious that this technology is highly compatible with the various kinds of manual pumps that have already been discussed here and seen to be viable options, as it would reduce the depth of the wells and the amount of effort required to lift the water.

All of the necessary elements seem to be in place in the country for a major promotion effort for this technology, whose demonstration stage is now underway., assuming suitable sites can be identified. The sites for which it is appropriate have to be carefully chosen—fairly narrow streams with high banks, along channels that are straight and relatively stable. The initial cost may be fairly high, and require subsidies and other institutional support from governments and NGOs. Given the magnitude of the benefit, provided over such a long period of time, the costs involved have to be considered minor. The technology is new to Burkina Faso and has yet to be tried out at scale, but the NGOs involved are clearly gearing up for a major promotion effort.

6.0 Conclusion

The country technology reports have obviously achieved their purpose of laying the groundwork for the Technology Assessment Framework. They have amply demonstrated the value of the kind of systematic comparative analysis of technologies and outcomes that the WASHTech project was designed to promote. A great deal has been learned already, and it is obvious that the three country partners will benefit immediately from the resulting sharing of experiences, in obvious ways.

Based on that sharing of knowledge, the risks involved in moving ahead in the promotion of several relatively new technologies will soon be reduced, such as the Ecosan technology in Ghana, and both the Rope Pump and the U2 Pump in Ghana. The same can be said for the Ecosan Latrine in Burkina Faso. In all three countries the various kinds of hand pumps discussed here should now be considered highly promising options, based merely on this first WASHTech output, as should the Ecosan technology, which deserves even more widespread promotion. The various kinds of hand-washing devices—the Tippy-Tap and the Veronica bucket—have also been resoundingly endorsed, and promotion is already widely underway in all three countries. But regarding the assessment of other technologies in the future, a number of general lessons have been learned. These have to do with the initial design and its modification, the involvement of local artisans and businessmen as key private-sector entities, and the problem of institutional costs or overheads.

The need to promote technologies that can be built—and repaired as necessary—largely out of locally-available materials is paramount in Africa. Wherever possible this should continue to be done, but it is also important that new devices be piloted adequately and introduced widely enough to allow the designs to be modified and improved so that they are well-adapted to local conditions, to the actual circumstance of use. This can make all the difference for a technology that might otherwise be considered a failure, as we have seen with the Rope Pump in Uganda, a device which seems destined to prevail widely in rural parts of Africa. If a technology is imported and relies on a somewhat precarious and lengthy supply chain, there is of course no opportunity to do this. The actual design may be perfectly adequate, but if not then it will be difficult for practical information from local users to feed back to the manufacturers in appropriate ways.

The obvious solution to this problem is to introduce technologies that can subsequently be manufactured, as well as repaired, by local artisans, once they have been adequately trained. Here perhaps the most difficult challenge will be to ensure that such people are fully licensed to do this, without fear of violated copyright laws. Here again, the failure of the Enviro-Loo in Ghana is instructive, although it is not clear if any patents were involved in that situation. In any case, it seems clear that developers involved in the WASH sector have thus far generally steered clear of high-tech facilities that involve intellectual property rights. The advantages of technologies that are 'appropriate' in this sense are manifold and obvious, the primary one being that the money spent on buying, installing and maintaining the facilities will stay in the community and hopefully have a 'multiplying effect' on the local economy, rather than being exported to other communities and countries.

Equally paramount is the requirement that the technologies promoted cost as little as possible. The failure of the Aqua Privy and the Enviro-Loo to solve local sanitation problems in Ghana—and assumedly also in other countries--can be attributed to inadequate attention to the complexities involved in the latter. The Aqua Privy, in particular, seems instructive here, as it may reveal the limitations of installing a device that is henceforth entirely "owned" by the local people, and whose maintenance is subsequently entirely in their hands. Where there is no follow-up by outside agencies, and no ongoing relationship involving some kind of monitoring and supervision of local institutions by non-local ones, the risk of collapse and failure can be high, even with so simple a task as providing a single bucket of water per day for maintenance.

This is an important point, as developers today tend to embrace the achievement of a full sense of "ownership", and of the highest possible level of local autonomy in maintenance, by user communities as the ideal outcome of any project, not just in the WASH sector but in other domains as well. The analysis of outcomes at this early stage in the WASHTech programme has already shown that the ongoing presence of sponsoring NGOs, and of local, regional and national governments, may ultimately be required if success is to be achieved in most cases. Some kind of sustained and ongoing involvement of entities at each level may be required, even for the maintenance of technologies that appear, on the surface, to be quite simple, if one ignores their institutional requirements.

Selection process of technologies in Burkina Faso

A report produced by Water and Sanitation for Africa (WSA, formerly known as CREPA)
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The Water, Sanitation and Hygiene Technologies (WASHTech) is a project of the European Commission's 7th Framework Programme in Africa

Water, Sanitation and Hygiene Technologies
WASHTech, 2011

Authors
CREPA

The **Water, Sanitation and Hygiene Technologies (WASHTech)** is a three-year action research initiative that aims to facilitate cost-effective investments in technologies for sustainable water, sanitation and hygiene services (WASH). Through action research and the development of a set of methodological tools and participatory approaches, WASHTech embeds the practice of multi-stakeholder learning, sharing and collaboration – instilling individual and collective ownership and responsibility for sustainable WASH services.

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Contents

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Executive Summary

The WASHTech project is an IRC initiative in partnership with Cranfield University Centre for Water Science, Skat, a Swiss Foundation, WaterAid, CREPA, TREND, KNUST and NETWAS-U.

The following are the project's main objectives:

- assess through an innovative research approach the potential and sustainability of a wide range of new technologies and the strategies used to scale them up;
- Build the capacity of hygiene, sanitation and safe water players to invest appropriately in these new technologies;
- Help meet the MDG by encouraging and stimulating adequate investments in new technologies. In particular, focus will be on adopted technologies which have not yet been considered in the national strategic plans;

But right on the onset of such projects, there is to benchmark the new technologies in Burkina. This exercise has led to mapping out a number of new technologies to be considered as part of this project –see ToR WP 2.2. This document outlines the process used in identifying these technologies in Burkina.

1. Metholodology

As shown below, the selection of the 6 technologies in Burkina has gone through a **3-step** methodology.

Steps	Methodology
Step 1	Benchmarking Burkina Faso WASH technologies
Step 2	*Technology discussion and validation*
Step 3	*Description of the selected technologies*

2. The 3-steps approach of the methodology

Step 1: Benchmarking Burkina Faso WASH technologies

Using the WP2.2 TORs, a team of technicians, engineers and sociologists from CREPA and WaterAid have discussed and agreed on the technologies to be tested under the project. The selection has gone through a review of the available technologies based on their use in the sector but also their representativeness in the country.
Then, the team has selected the technologies with potential of being tested with TAF-Technology Assessment Form.

Successful	Promissing	Neither Nor	New opportunities
VIP Latrine	Rope Pump	Rainwater Harvesters	Sanddam
Sanplat latrine	EcoSan Latrine		

Step 2: work session to discuss and validate technologies as part of WASHTech project

The various WASH sector players attending this meeting have brainstormed to select/validate technologies to be tested. Identified technologies were categorised on criteria including their function and whether they fall under one of those four dimensions: successful, promising, or whether they offer a new opportunity to the sector.
Afterwards, a final selection was made after a classification.

Réussies	Prometteuses	Echouées	Nouvelles opportunités
Latrine à chasse manuelle	Rope Pump	Impluvium	Latrine EcoSan
Latrine VIP	Latrine EcoSan	Latrine sanplat	Pompe India Mark III
Latrine EcoSan	Impluvium		Incinérateur dans les CSPS
Pompe à motricité humaine (PMH)	ATPC		Filtre en céramiques
Latrine sanplat	Pompage solaire		Barrages de sable
Adduction en eau potable simplifiée (AEPS)	Latrine VIP		Latrine VIP
Impluvium			Impluvium
Lave-mains			Eseau en polyEthylène haute densité
Poste d'eau potable (PEP)			

Step 3: Description of the selected technologies

Subsequent discussions have led to one or two technologies selected by agreement under each category. The decision was on the following 5 technologies which will be reviewed in compliance with TAF.

Sector/critria	Successful	Promissing	New opportunities
Water	Rope pump	Hand pump (HP)	Sand dam
Sanitation	EcoSan latrine	Sanplat and VIP latrine	

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Annexes

Annexure1: WP 2.2 TORs ***(see Drop Box)***

Annexure 2: Attendance list

LISTE DES PARTICIPANTS A L'ATELIER D'ECHANGES ET DE PARTAGE D'EXPERIENCES SUR LE PROCESSUS D'INTRODUCTION DE NOUVELLES TECHNOLOGIES AU BURKINA FASO

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Annexure 3: Description of the selected technologies (05).

TECHNOLOGY: ROPE PUMP	CATEGORY: PROMISING
DESCRIPTION	
Background and invention of the product	The Rope Pump technology was designed, building on an old water collection technique used in China more than a century ago. Since then, different versions of this technology were developed and used worldwide. But this successful, low-cost and easy use technology was upgraded and refined in the 90s in Nicaragua, Central America.
Operating Characteristics and key components	It is a hand-pump which is generally fitted on wells less than 20 m deep even though it can be used on a borehole exceeding 40 m. It operates with a rope in a pipe end of which is immersed and bent. Pistons with same size as the pipe are attached on the rope at equal distance. When you turn the wheel upwards, the rope runs in the pipe and water is extracted as a result of the depression created by the pistons
Question 1 : TECHNOLOGY AND CONTEXT ***IS THE TECHNOLOGY APPROPRIATE/WELL ADAPTED TO LOCAL CONTEXT***	
PHYSICAL AND GEOGRAPHIC ENVIRONMENT	
Deployment Requirements • Frequency of the rainfall (if water is needed) • Water table if contamination risk • Geology • Replenishing and Quality of the underground water • Availability and quality of the surface waters	- can be fitted on lined wells and boreholes less than 50m as well as small scale irrigated areas - area with lots of wells already - a dry stone wall around the well is needed to avoid pollution of the facility
DEMAND AND FINANCIAL ENVIRONMENT	
• Who are the target beneficiaries? • How useful is the technology?	Rural communities Profitable to artisans, livestock breeders, local beer brewers, etc.
• Income/ living standard • Is it affordable to users and promoters?	- Communities can access given its low cost for deployment & maintenance.
• Willing to invest?	- collective/group interest
• Grant policies and programmes • Ability to pay • Saving schemes • Access to credit	DGRE is available

MATÉRIALS, COMMUNICATION AND COSTS	
• Main parts	- Wheel is made with used tyres - Concrete block and PVC pipes - the handle and the frame –ideally in galvanized iron, - plastic ropes - pistons made with used plastic materials.
Timely availability of inputs • Roads (accessibility in rainy season) • Electricity; Telephone	Produced locally using local materials available easily –used car tyres, recycled bottles and plastic, hand-made ceramic ware, ordinary rope, angle iron and galvanised iron rod
• Capital and repair/maintenance costs	75 000 XOF at zero m 95 000 XOF for the entire pump; 150 000 when slab is included Cost of the «Sahel» rope pump is 290 000 XOF (440€) and this includes training and maintenance.
INSTITUTIONAL FRAMEWORK (WASH PLAYERS)	
• Partners	WaterAid, CREPA, DGRE, 2iE and Associations, Observateur (a BF daily)
• Government' willingness and ability to promote this technology	Support
• Private sector capacity to promote the technology	7 manufacturing shops in some cities of BF Small scale engineer businesses; local small scale shops
• Availability of a committed and motivated civil society to promote the technology	Education on hygiene and sanitation for more quality water and improved access Set up women-led management committees to promote and own the technology Implementation is facilitated with an involvement of local associations
• Who owns the technology licence (private or public?	Public
• Donor priority areas	Increase access to safe water. Simple and low cost technology for the poorest to access to quantity and quality safe water with less effort.
Question 2 : Interface between the user and the technology ***IS THE TECHNOLOGY USEFUL AND DOES IT MEET THE USER NEEDS?***	
• Comparative advantages with other technologies	- Materials needed are available locally - Can be fitted on existing hand-dug wells (or boreholes).

	- Low cost (capital and maintenance cost), easy to manufacture using local materials such as used/recycled items. - Local manufacturing shops can make them. - Not heavy (~15 kg). - No need to depend on energy including fuel, wind, sun to get water - Very little impact on environment. - Can be changed to operate with wind, legs (pedal), fuel (engine), animals.
• Weaknesses /constraints	- Depth of the well/borehole: 40 m. - Limited user number -50 users, i.e., 10 households. - Limited discharge (10 -40l/mn depending on depth). -Quite long pumping time requested in deep wells before the pumps starts supplying water. - A regular maintenance is required - Splashes. - the galvanised steel is not as strong as the rustproof steel
• Maintenance/operations/constraints	- Local caretakers ensure the maintenance because the technology design allows for full ownership and requires use of simple materials/tools which are available. - No need to be a technical expert to assemble, use or maintain the pump - Recurrent breakdowns (disrupted ropes, broken handles, unstable frame, rusted metal)
• How will users organise and acquire the necessary skills to adequately install and use the technology?	- Very easy to use (even by children): the handle; a block is fixed to the wheel to keep the water column stable - Maintenance training is easy by the local artisans/care-takers. - No assistance required to use the technology.
Risks and threats • Is the technology likely to create conflict with the cultural habits? • Technology risks (to what extent can these be accepted by the community?)	- Has potential to be easily duplicated, subsequent risk being «poor duplications» which will lead to early abandonment. - Non-return valve needed for the wheel: at the end of pumping the handle may hurt users (children mainly) if the wheel turns the wrong way. - Risk of water contamination if the pump is not well protected: contaminants or foreign substances can enter the system.
• To what extent does this technology meet its objectives?	With a capacity of $5m^3/h$, the Rope Pump significantly reduces users' burden. Though the ideal depth for this technology is 20m, they can be used in

	wells/boreholes of 40 m. The pump will face challenge for waters deeper than this figure. The deeper the facility, the smaller the pipe/diametre and therefore, the more little yield we get. The Rope Pump yield ranges from 10 to 40 l/mn. This technology can be fitted both on hand dug wells and boreholes and are more appropriate for small communities of a dozen households. Can supply water for drinking, irrigation and income generating activities.
Question 3 : Innovation & scale up Process ***INTRODUCTION, IMPLEMENTATION, MONITORING AND EVALUATION***	
• Introduction in BF • Tests and results	The various pumps introduced in Africa record a qualified success: one year after they were installed, approximately 80% pumps were no longer operating. On the other hand, with the relevant design and training, over 90% pumps were reported to be functioning (Source: Akvopedia). Community accountability and consistency are some key factors of success. The technology was introduced in BF through the 4-steps « participatory » promotion project: - a learning trip in Ghana in July 2004 - set up of a technical committee to upgrade and promote the technology - first pumps imported from Ghana installed in December 2004 - training local manufacturers and repairers through another trip; set up of a manufacture shop ⇨ Ownership of the technology by the local caretakers ⇨ Good dissemination and high demand (NGO, Associations, individuals)
Demonstration • How much time was allocated? • Was it enough?	A 2-phase Project: 2004-2006, 2006-2008 Sensitisation: showing the technology performance using pumps installed in CREPA and WaterAid intervention areas.
Promotion & dissemination • Which level (national? local?) • WHO? What is the involvement level of private sector (local or external)?	- Involvement, right on the project's onset, of authorities and specialised institutions (partnership Agreement) - Steering bodies: technical committee (WaterAid, CREPA, DGRE, 2iE) and marketing committee (Associations, Journal Observateur)

	- Training local manufacturers - Research on the performance and added value for scale up purposes - Scale up through «4P» (Product/Place/Price/Promotion) approach
Upgrading /changes/adaptations	- 1st improvement: design of a cover was designed to avoid children choking the pipe with stones and breaking the rope - 2nd improvement: replaced rings by bearings to allow for easier rotation of the channelled handle which is now made full.
• Key stakeholders (institutions and individuals) who helped in making it a success? • How did they contribute?	WaterAid, CREPA, DGRE, 2iE: training, sensitisation, promotion Associations, «Observateur»: dissemination Trained caretaker: manufacturing and maintenance

Report on Framework for the Country Technology Reviews, Ghana

Work Package 2.2

A report produced by KNUST

October 2011

The Water, Sanitation and Hygiene Technologies (WASHTech) is a project of the European Commission's 7th Framework Programme in Africa

SEVENTH FRAMEWORK PROGRAMME

The **Water, Sanitation and Hygiene Technologies (WASHTech)** is a three-year action research initiative that aims to facilitate cost-effective investments in technologies for sustainable water, sanitation and hygiene services (WASH). Through action research and the development of a set of methodological tools and participatory approaches, WASHTech embeds the practice of multi-stakeholder learning, sharing and collaboration – instilling individual and collective ownership and responsibility for sustainable WASH services.

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Executive Summary

Sustainable access to safe water, improved sanitation and hygiene In most countries in sub-sahara Africa has been plagued by the combined effects of poor government prioritization, inadequate financing and targeting of available funds to meet the needs of the masses especially the poor. The importance of employing workable technologies to facilitate the provision and wider coverage of WASH services cannot be underscored. In a number of countries in Africa, Ghana included, there isn't a well structured policy and regulatory standards for the introduction WASH technologies. This situation has led to the influx of technologies, some of which have proven to be efficient and functional but have not been promoted and scaled up, others have been imposed on users by technology providers or investors whiles others have been inappropriate and thus unable to meet the WASH needs of the people.

In Ghana, till now, the introduction, diffusion and utilisation of various technologies in the WASH have been the resolve of a few sector players without any laid down standard governmental guidelines. The development, introduction and embedding of the technology assessment framework (TAF) will go a long way to help filter out the strength and weaknesses of both new and existing technology within the context of their services. The embedding of the TAF tool in technology assessment by the stakeholder institutions in the country may motivate the government to enact policies and develop standard guidelines for the introduction of technologies in the country. This anticipated move by the government would be another landmark achievement in meeting the WASH needs of the populace.
In order to develop an effective framework, an attempt has been made in this document to review the introduction, performance, the populace perception, the operation and maintenance practices the pertinent financial and economic issues associated with the promotion and scaling up of a few technologies in Ghana.

In this document the selected technologies have been assessed using the Rogers model; a historical background on the introduction of the technologies, the involvement of governmental and non-government in the introduction, operation and maintenance as well as the management of the facility and capacity building have been highlighted. The diffusion or promotion and scaling up issues have also been reported on where applicable. The technologies selected include: slow sand filtration, rope pump, Veronica Bucket, the Aqua privy (or pour flush) toilet, the Enviro Loo and Biofil digester toilets.

The Slow Sand filters (SSF) normally comprise a raw water source connected to a sand filter bed. The filter bed is often established over a large stretch of land with sand grains of average diameter 0.6 to 1.2 mm and supported underneath by large aggregates. At the base of the larger aggregates are the perforated under-drains that drain the system of the treated water. The tiny nature of the sand grains of the filter bed makes the latter less porous and relatively more susceptible to faster development of headloss. The Slow Sand Filters have low filtration rate and thus the need for vast parcel of land to install the technology. With such a space the filter can be drained to meet the need of the beneficial community. The top layer of the small sand grains is normally occupied by the 'dirty layer' often called the Schmultzdecke that contains a meshwork of biomass and suspended particles. This biomass layer help with the biochemical degradation of the suspended solids in the raw water and thus help with the purification process. Generally the SSF is able to achieve pathogen removal over 95%.
The technology has been employed as the main drinking water treatment technology for small towns occurring within the catchment of the Volta Lake. In this review the SSF at Mafi-Kumase, the Dangme East and West and North – Tongu districts have been assessed. Generally the perception of the populace rates the technology as successful and should be scaled up. The communities where the

technology exists practise ‘community ownership and management’ of their systems. Capacity exists in the communities that manage the technologies.

The rope pump, a water lifting device, prevalent in the northern part of Ghana, consists of a ‘wheel-like’ structure with a rope wound round it. As the wheel – like structure is rotated the rope which is lowered into the well through a PVC pipe is used to lift water from a depth of about 50 m up to a height of 10 meters. The initial design has been modified to incorporate a galvanized cover for the rope. The rope pump has the capacity to pump at a rate of 0.15 to 0.6 litres of water per second. The pump perform better with high yielding wells. The installation of the technology was initially funded by the Community Water and Sanitation Agency of Ghana. The technology is generally affordable and has a relatively low operation and maintenance cost. Local artisans have been to manufacture and repair the facility when necessary. It is a promising technology which if well promoted could be scaled up.

The Veronica Bucket, the only hygiene technology selected, normally comprise a container (a bucket) fitted with a tap to the base. This device is used mostly in institutions for hand washing. It is very affordable, easy to use and all materials for manufacture are locally available.

The sanitation technologies selected have all been branded as unproven technologies and they include the Aqua Privy and the Enviro Loo. The Aqua Privy toilets were introduced to Ghana in the 1930’s. The Aqua Privy toilet has a water tight settling tank with one or two compartments that serve as receptacles for the waste. The waste is flushed through a pipe submerged in a liquid layer and drops directly into the tank positioned immediately under the latrine. To operate the toilet, there should be the availability of water to maintain the water seal to help prevent odor. The installation of the technology has been funded by the Ghana government and it is constructed in mainly institutions. Since its introduction, capacity has been built for its operation and maintenance. Views gathered from users indicate interest and preference for this technology over existing toilet facilities. However, most of the installed systems have broken down possibly due to improper operation of the facility especially the maintenance of the water seal thereby making the system function like an ordinary vault latrine with associated occurrence of little odor.
The Enviro – Loo toilet comprise cubicles with vent pipes and a ventilation extractor fans. The cubicles have a rectangular shaped receptacles normally constructed outside of the cubicles and connected to the toilet bowls within the cubicles. This technology was introduced and piloted in the country in the 1990s. Cost of construction and installation is moderately high. Information gathered does not indicate that the initiators incorporated any training component for artisans to manufacture the various parts of the facility locally. This lapse has put a strain on the operation and maintenance of the facilities country – wide. Users indicate that the facility normally does not give any odor.

For the Eco-sanitation toilets, the Biofilm digester model was reviewed. This is a kind liquid separating system with the toilet bowl connected directly to a two chamber system normally constructed outside the toilet cubicle. As the excreta enters the chambers the solid matter is separated from the liquid by a porous partition and the solid material is seeded with worms and maggots to facilitate degradation. The urine and compost produced could be used for agriculture if well stabilized. This technology has been designed and introduced into the country by the Annor Engineering Limited in 2002 and promoted by the Ghana Institution of Engineers. It is recommended technology for low income communities where the water table is high. Its affordable and environmentally friendly technology.

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Acronyms and Abbreviations

AMURT – Anada Marga Universal Relief Team
CBRDP – Community Based Rural Development Programme
COM – Community Ownership and Management
CWSA – Community Water and Sanitation Agency
DANIDA – Danish International Development Agency
DFID – Department for International Development
3-DWSS – Three District Water Supply System
EHSD - Environmental Health and Sanitation Directorate
EJMA – Ejisu – Juaben Municipal Assembly
GETfund – Ghana Education Trust Fund
GoG – Government of Ghana
HIPC - Highly indebted poor country
HLT – High Level Tank
KVIP - Kumasi Ventilated Improved Pit latrine
NGO – Non- governmental organization
PVC – Poly vinyl chloride
SHEP - Shool Hygiene Education Programme
SPIP – School Performance Improvement Plan
SSF – Slow Sand Filter
TAF – Technology Assessment Framework
TDC – Town Development Council
VVU – Valley View University
WASH – Water Supply Sanitation and Hygiene
WSBD – Water and Sanitation Development Board

Chapter One

1.0 Introduction

This report presents a review of the Water, Sanitation and Hygiene (WASH) technologies in Ghana. The study is part of the WASHTech project and was conducted in accordance with the TOR for work package 2.2 developed by Cranfield University. The TOR provides an analytical framework for the project partners in Burkina Faso, Ghana, and Uganda to use in preparing their respective reviews, including an overview of the task and an outline structure for the written report. This brief seeks to select and analyze five examples of specific WASH technologies that have been tried out in specific countries. This will ultimately be used in the process of constructing the Technology Assessment Framework (TAF), the main project deliverable. Each technology chosen is expected to fall into one of three WASH functional types: - Water Supply, Sanitation, and Hand-washing for Hygiene.

1.1 Objective of this assignment

The objective of the country technology review is to describe the process of introducing the technologies and the innonovations in testing and piloting, as well as the performance of the technologies from the perspectives of the stakeholders including the users.

1.2 Selection of Technologies

The technologies considered were classified as follows:

1) technologies that have been tried and tested, and found to be ***successful*** in the country, in the sense that they have achieved impact, scale and sustainability;

2) technologies that have been tried and appeared to be ***promising***, based upon some encouraging stories from successful pilots that have not yet gone to scale;

3) technologies that have clearly ***failed***, meaning they have not achieved impact, scale or sustainability and are no longer used;

4) technologies that are untried but present ***new opportunitie****s* worth investigating, in that they have been proposed, and perhaps marketed well, but are yet to be tested.

The main criterion for categorizing each technology was the presence or absence of the following: i) the positive *impact* that it had—or perhaps promises to have based upon its influence on the quality of life in the household and /or on the community; ii) the technology's capacity to be *scaled up* from the household level to community, district or even national level; and iii) the technology's *sustainability*, as seen from a technical, financial, institutional, and environmental view point.

The specific questions listed in the tables in the Annex are designed to assist in the detailed assessment of these three dimensions of success. Table 1 shows the technologies that were selected by the WASHTECH Task force using the mentioned criteria at a meeting in Accra.

Table 1: Selected Technology for detailed assessment

Status	Water	Sanitation	Hygiene
Successful	Slow Sand Filtration (Small Town Water Supply)		
Promising	Rope Pump		Tippy Tap *(Veronica Bucket)
Unproven		Aqua Privy Enviro-Loo	
New Opportunities		Ecosan – Biological "Latrines using local material"	

*The Tippy Tap was later substituted with "Veronica Bucket" due to lack of information and real examples of the Tippy Taps in Ghana.

This report provides a review, analysis and discussion on the status of six technologies using various case studies. The technologies are presented in separate sections of the report. The discussion of each technology showcases the reasons why a particular technology is classified as successful, promising,unproven or presents new opportunities.

1.3 Methodology

The methodology employed in this review involved survey of various case studies and administration of questionnaires. With this approach, various districts or communities in Ghana with the target technologies were used as case study areas. Interviews and questionnaires (both close-ended and open-ended) and field observations were used to gather information from the various stakeholders and end users of the technologies.

1.4 Structure of the Report

Chapter 1 introduces the Technology Review Assessment
Chapter 2 presents Successful Technologies
Chapter 3 presents Promising Technologies
Chapter 4 presents unproven Technologies
Chapter 5 presents the New Opportunities
Chapter 6 presents the Summary and Conclusions
Chapter 7 presents the Bibliography
Chapter 8 presents the Annex - Methodology

Chapter Two

2. Successful Technologies

The successful technologies that were considered for the assignment are small towns slow sand filters (SSF) where two case studies were conducted.

2.1 Small Towns Water Supply with SSF

2.1.1. Brief description of technology

The use of Slow Sand Filters (SSF) goes as far back as 1804, where the first actual municipal water treatment with filters were designed by Robert Thom in Scotland. In Ghana, the application of slow sand filters for small towns was first introduced in 1989 with the Mafi-Kumase Water Supply Project in the North Tongu District in the Volta Region.

Slow sand filtration is a water purification process in which water is passed through a porous bed of filter medium. Slow sand filters are typically characterized by certain design components: the supernatant (water above the filter sand that provides hydraulic head for the process), filter sand bed varying in depth, the under drain medium (usually consisting of graded gravel), and a set of control devices (sims). In a mature sand bed, a thin upper sand layer called a Schmutzedecke forms. The Schmutzedecke consists of biologically active micro-organisms that break down organic matter while suspended inorganic matter is removed by processes like straining, interception, sedimentation and adsorption. Slow sand filters are distinguished from rapid sand filters by the biologically active - Schmutzedecke, and the slow filtration rate and longer detention time.

2.1.2 Appropriateness of Technology

Physical features and local context

Aside the conventionally treated water from the various water treatment headworks in the country, the first choice of water supply systems in most rural and peri-urban communities has been the boreholes. Drilling of wells or boreholes to abstract groundwater is a common feature in most of these communities because of the generally good quality and readily available groundwater source in most places around the country. However in areas where there are challenges of seawater intrusion (normally in the coastal regions), low water table - especially in Northern Ghana and occurrences of contaminants such as fluoride, arsenic etc; surface waters have been resorted to in order to salvage the situation. Where surface waters have been employed in drinking water production, the treatment scheme normally adopted is the slow sand filtration. Slow sand filtration may be the most suitable filtration technology for small systems, when used with source water of appropriate quality (i.e low turbidity and low content of suspended solids) (EPA, 1998).

In Ghana the application of SSF for water supply systems is mostly found within the catchment of the Volta Lake and in small towns with spring sources because of its low levels of turbidity. There were about 20 SSF plants in Ghana as of 2004. Two cases of these SSF (Mafi-Kumase Water Supply and the three districts water supply system) were selected for this assessment in this project. The key feature for the use of SSF is surface water with very low turbidity.

Case Study 1: Mafi-kumase Water Supply

Background

Mafi-Kumase area was not endowed with reliable water sources prior to 1970. The communities therefore depended on household rainwater storage, seasonal ponds and dug-outs infested with water fleas (cyclops), the ingestion of which results in guinea-worm disease. As the years passed and population grew the sources could no longer sustain the increasing water needs of the people. Several borehole interventions failed to improve the situation as the ground water yields were low and of unacceptable quality. Water scarcity and prevalence of guinea-worm disease affected life in the community; women and girls, who traditionally are the carriers of water for the household, were most affected; children dropped out of school and families lost their sources of livelihood. Different water treatment techniques introduced at that time, including water boiling, could not be sustained, and the adverse situation continued. Between 1970 and 1971, an earth dam was constructed in the community by the government. A few years after its completion, the dam had filled up with rainwater and provided the villages with access to adequate water source which, like the other sources was soon infested with disease causing organisms (e.g. guinea-worm and bilharzias).

Under the leadership of the Mafi- Kumase Town Development Committee, the communities collectively initiated and constructed the piped water supply system with SSF from 1986-1989. Mafi Kumase is the first fully community owned and managed (COM) piped water supply in the country. The system comprises a Roughing filter system (that pre-treats the raw water to the required water turbidity), Slow Sand Water Filtration Plant (SSF), Pipe networks, and uses a dam as the source of water supply. Currently, there are 23 communities being served by the system with a total estimated population of 15000. The communities include Havenu, Mebiawoe, Nukporte, Dzogadzie, Agbodrafor, Dekpoe, Gagorme and Adelekpoe. The design capacity of the system is $90m^3/d$. Initially the system started with a water demand of $70m^3/d$. Over the years some expansion and network extensions have been carried out to connect needy communities to the present total of 23 communities. The funds for these extensions were provided by the Danish International Development Agency (DANIDA) and Anada Marga Universal Relief Team (AMURT). The expanded system has a design capacity of 300 m^3/d but actual water delivery right after the expansion works was $120m^3/d$.

After 22 years in operation it can be concluded that the main purpose of eradicating guinea-worm and bilharzias in Mafi-Kumase and its environs has been achieved. Moreover, water is currently available always and at a short distance to users.

Case Study (2): The Three-District Water Supply Scheme (3-DWSS)

The 3-DWSS involves three different districts; Dangme East, Dangme West and the North Tongu District Assemblies. Dangme East and West districts are in the Greater Accra Region whiles the North Tongu district is in the Volta Region. The Districts are predominantly rural. Before the provision of the water facility, only 43% and 52% of the population in Dangme East and West respectively had access to potable water and all people living in the North Tongu district depended on raw water from the Volta Lake. The 3-DWSS is presently the biggest small town water supply scheme in Ghana, serving a population of about 115,092 in 130 communities and 18 institutions (Maple Consult, 2008).

Figure 1. Slow Sand Filter for Three District Water Supply

Figure 2. Overhead tanks for the 3-D project

The 3-DWSS comprises the following main components. The system is connected to the national power grid and has a standby Baifa diesel generator rated as 100KVA. A booster station with 400m^3 ground tank located at Dawa in the Dangme West District and fifteen pumps. The booster station also has three Grundfos pumps. There are eight High Level Tanks (HLT) of various standardized storage capacities with a total capacity of 1,450m^3 spread over the three Districts. The system has a roughing filter and a slow sand filtration (SSF) installations with a capacity of 3,600m^3/d on a per capita water demand of 28l/d; and a pumping station – all located at Aveyime. A clear water tank at the treatment plant at a capacity of 2,000m^3 collects the treated water from the SSF and serves the high-lift pump. A network of pipelines of varying sizes between 50mm and 250mm in diameter up to a total length of approximately 400km. Currently there are about 223 household connections and 63 commercial entities.

2.1.3 Cost and Financing of technology

Mafi-Kumase Water Supply Project Funding

The system was constructed through communal labour. The project cost of approximately GH¢11.50 million (USD 52,320) was financed through contributions by the community, Caritas Swiss (SWISS Organisation), the City Council of Zurich, the Council of Elgg / Zurich and friends in Switzerland. Engineering and construction works were undertaken by the citizens through communal labour and local material contributions. All residents and non-resident citizens of Mafi-Kumase contributed to the project in diverse forms. Out of the total cost of the project, the community contributed 18% whiles the remaining 82% was from Caritas/Swiss. These costs mentioned however, do not include costs in kind such as communal and individual voluntary works. Average cost of maintenance and repairs at the SSF treatment plant stands at Gh¢2,000 per month.

Three-District Water Supply -Project Funding and Community Involvement

This project was funded by DANIDA, the Department for International Development (DFID), the Government of Ghana (GoG) and the community. The cost of the scheme was approximately 11 million US dollars (US$11million) including engineering and consultancy. Out of the total cost of the scheme, DANIDA provided 23%, DFID provided 41%, and the GoG provided 31% whiles the community provided 5% towards the construction of the systems. On the average, the annual maintenance cost of the system is estimated at GH¢150,756.

Capacity and involvement of stakeholders

SSF systems are in-expensive to operate relative to rapid sand filters because of the very minimal amount of chemicals used. However, they require laborious and time-consuming maintenance and relatively high quality raw water source. The relatively low operational requirements make SSF suitable for use in small communities. Local communities are able to build the filters if required materials are available with minimum supervision.

Mafi-Kumase Water Supply - Management and Operations Capacity

The water supply system is fully owned and managed by the community. The Traditional Development Council (TDC) and a central Water Board is assigned with oversight responsibility while a seven (7) member caretaker team is in charge of system operation and maintenance. There are 68 commissioned water vendors, mostly women from various communities who operate and clean the public standpipes.

Three-District Water Supply -Operation and Maintenance Capacity

To promote sustainability and complete the concept of community ownership and management (COM), the Three District Water Supply Project (3-DWSP) is under the management of the Water and Sanitation Development Board (WSBD). There is a private operator mandated to see to the day-to-day operation and maintenance of the system. Supporting materials for the maintenance of the facility is readily available locally and there are personnel with the requisite skills to carry out repairs and maintenance as and when the need arises. In general, the major problems of the plant are frequent clogging of the SSFs and algae growth due to penetration of the sun's rays. Moreover, the control panel also lacks an extraction fan and thus results in frequent burning of its components.

2.1.4 Innovations in SSF Technology, Piloting and full Scale Uptake

Introduction of Technology

The technology was introduced at Mafi-Kumase (Volta Region) by Mafi- Kumase Town Development committee, with assistance from donors. The construction of the infrastructure and installation of the SSF facility started in 1986 and was completed in 1989.

Testing and Piloting of Technology

Prior to the installation of the SSF in Mafi-Kumase there was no such community owned and managed system in the country. So the Mafi-Kumase system became the first community managed SSF pilot project. The construction of the facility involved local materials such as cement, sand aggregate, pipes, valves that are available locally.

Promotion, scaling-up and adaptation

Currently there about 20 other SSF systems installed country-wide following the success story of Mafi-Kumase and the 3-districts. The scaling up of the SSF was done mainly in the Volta Region where the first DANIDA/GoG project was undertaken in 1993. Over 80% of the SSF systems are in Volta Region. Depending upon the raw water quality of a particular area, other accessory components like various types of roughing filters, high capacity chlorinating units, overhead tanks etc. have been incorporated in the design. Basically the design of the Mafi-Kumase system has been adapted for all the new systems.

Private Sector and Key Actors Involvement

In the case studies undertaken it was realized that the beneficiary communities have been involved in the planning and they also provided the required labour for the construction. The communities select operators or private operators to manage the systems. These operators are trained by the consultants and/or contractors. The GoG and donors jointly finance new SSF systems.

2.1.5 Users' assessment of technology suitability

Desirability and Advantage of Technology

Users have generally positive comments about the SSF systems as it is normally based on surface water sources which they used previously. Although, for Mafi Kumasi, users complained of the occasional coloured nature of the water from the system, they also asserted that water from the systems is far better than that from streams and dug out ponds which are infested with guinea worms. In terms of distance from the communal stand pipes, respondents are very satisfied because the stand pipes are very close to them and they do not have to travel far for water now. Water flows for about 6-8 hrs in the day and almost throughout the week. Normally the stand pipes are opened from 6:00am to 10:00am and 4:30 to 6:00pm.

For the 3-DWSS, the water quality as per the users of the system is very good and is being used for the drinking purposes. Users assert that they feel more comfortable drinking water from this source since it is comparatively 'cleaner' than other sources. For the 3-DWSS, users access the water via communal standpipes which according to them are closer to them as compared to the other sources of water (streams and dug outs). Water flows for more than 6 hrs in the day and is available almost throughout the week (5 days within the week). Normally the stand pipes are opened in the mornings and early evenings.

Operational Capability

Training programmes for O&M have been organised for the communities by NGOs to build capacity.

Risk and challenges associated with Technology

With respect to the operation of the facility, no risk(s) have been documented. Currently the facility at Mafi-Kumase is operating beyond its designed capacity due to higher population thus compromising the water quality. Most installations including pumps and electro-mechanical equipment have become obsolete and no longer functioning effectively.

Affordability of Technology

An assessment of the system at Mafi-Kumase indicated that a bucket of water (18L) costs Gh¢0.02. This is affordable to most respondents interviewed.

For the 3-DWSS, the cost of a bucket of water (18L) is Gh¢0.02 and it is considered affordable by most of the respondents.

Maintenance and Spare Parts Availability

Maintenance on stand pipes is done regularly by the water vendors who have been trained by the district assembly to do so. The stand pipes are in good condition upon observation. All respondents are pleased with the technology than other sources of water (streams and dug-out). The operation and maintenance of the system is undertaken by the community. Maintenance costs of the system are paid from the monthly revenue accrued from the system.

For the 3-DWSS, maintenance of stand pipes is undertaken by the Water and Sanitation Committee in the community. The stand pipes are in good condition upon observation. Respondents are very pleased with the technology than other sources of water (streams and dug-out).

Chapter Three

3. Promising Technologies

3.1 Rope Pump

3.1.1 Description of technology

The 'rope pump' is a simple technology hand pump that has been gaining popularity in many countries especially since the mid-nineties. The pump is based on a centuries-old design that was refined during the 1980s and 1990s. The rope pump comprises a loose rope lowered into a well through a PVC pipe that has its bottom immersed in the well water. The rope is used in raising water from the well and can normally pump about 3000 litres per day. It is made of simple, cheap and locally available materials and the cost has always been just a small fraction of other imported pumps.

In Ghana, the rope pump existed in certain parts of the country even as far back as 1988. However, attempts to streamline its use began in May, 1999 with support from the World Bank. Currently there are more than 2,000 rope pumps installed nationwide (WaterAid, 2004a).

Figure 6. New Rope Pump design

Figure 7. Old design of Rope Pump design

3.1.2 Appropriateness of technology

Physical features

The rope pump has been used successfully for supplying both communities and individual families, but until recently was typically suitable only for groundwater depths of less than 10 meters. It can be used to lift water from depths as deep as 50 m and the water can be raised to 5 m above ground level. It is capable of pumping up to 0.6litres/s at 10m and 0.15litres/s at 50m (WHO, 2003) and costs about one fifth of other pumps currently in use. In addition, it is manufactured with locally available materials with cheap and available spare parts. It is also easy to operate and maintain at the community level.

Capacity of Stakeholders

Generally, local artisans in the beneficiary communities have been trained through several capacity building programmes initiated by the CWSA and other NGOs. At present, the fabrication and installation of the pumps has been contracted out to a local artisan; Musah Ali, who is paid by "Pumping for Life" to fabricate and install the facility in the various communities. Spare parts are readily available and manufactured locally by the local artisan who also trains members of various households during installation to undertake any form of repairs on the facility. The NGO after installing each facility gives to the head of each household a certificate of responsibility which entrusts operation and maintenance of the facility into his/her care. Thus, individual households are now responsible for the repair and maintenance of the facilities to ensure their sustainability.

Cost and Financing

The cost of installing one pump is estimated at GH¢379 ($253; at an exchange rate of $1 = GH¢1.5) and is fully borne by the NGOs (Rural Aid & Water Aid; Rotary International). This is extremely cheaper as compared with other available technologies like Nira AF85 which was $700 per installation as of 2004. The annual maintenance cost is GH¢20 ($13) which is the cost of only the rope – most vulnerable part of the technology. However, some people still cannot afford the cost of only the rope and will require subsidies from the NGO to sustain the facility.

3.1.3 Innovations in the introduction of technology, piloting and full scale uptake

Introduction of Technology

In Ghana, efforts to introduce the technology countrywide commenced in May, 1999 when the Community Water and Sanitation Agency (CWSA), with support from the World Bank, sent a delegation to Nicaragua to study the rope pump system in line with efforts to provide low-cost and sustainable rural water supply.

Following the CWSA's visit to Nicaragua, the Water and Sanitation Program (WSP) agreed to fund a three-phase technology transfer process. Under the first phase in 1999, Bombas de mecate SA (BOMESA) of Nicaragua helped identify several Ghanaian workshops suitable for the production of the rope pump. The local availability of materials required for manufacturing was confirmed while some parts (such as the ceramic guide box and the pistons) were supplied from Nicaragua. This was during early stages of the transfer and was deeply promoted by the World Bank, WSP and CWSA.

Testing and Piloting of Technology

It was later established that the capacity to produce the rope pump and its spare parts existed in the country. Two local manufacturing firms were identified for support to start piloting the rope pump technology in Ghana. Representative technicians from the firms were sent to Nicaragua to be trained in the production and marketing process and were expected to transfer the newly acquired skill to Ghana. Unfortunately, however, the process could not succeed in the country and the interest in the technology subsided in the country since then. According to WaterAid (2004a), the decline in the interest in the technology was due to the following factors: -

- lapses during technology transfer,
- lack of promotion to stimulate social interest,
- poor relationship between pilot communities and manufacturers due to inaccessibility,
- over-reliance on the private sector to do the promotion of the technology, and

- little political will to test and systematically improve the technology.

Promotion and Scaling Up

To promote the rope pump in Ghana, Rural-Aid went into a partnership with Jenamise Enterprises, a local firm manufacturing rope pumps in Bolgatanga. From October, 2003 the two organizations began to test the pump on 30 open wells in the Bongo, Bolga and Kasena-Nankana Districts of the Upper East Region (WaterAid, 2004b). The selected wells for piloting were those that were high yielding and were at least more than two years old but had not been fitted with hand pumps. Ten communities were selected from Kassena-Nankana District, twelve from Bongo District and eight from Bolga District. From the pilot project, modifications and improvements were made in the design of the technology. These include fixing a smooth bottle in the concrete guide block to reduce friction between the rope and the concrete guide block; fixing a metal brake in-between the spokes of the wheel to prevent it from turning in the opposite direction; covering the rope with metal casing to prevent secondary contamination; and painting the metal frame with anti-corrosive paints.

The "Pumping is Life" project first piloted the technology in Gyenga with 16 pumps for about five years. The number of installed rope pumps was increased to 52 during the five-year period to include other nearby communities namely, Overseas, Kpargu, Sanda Fongo, and Nayuku. During the period the technology was based on an old design that used to be installed on only hand dug wells. After five years, of commissioning all the rope pumps did not work any longer and thus had to be redesigned. Some of the draw backs to the old design included improper handling by communities, exposure of rope and wheel to users, lowering of water table in the hand dug well and caving in of hand dug wells. Subsequently, the pump was redesigned to include a galvanized sheet casing to cover the rope and wheel and a drilled hole (14 – 19m). The installation of the new model in the West Mamprusi District once again commenced in April, 2011 now with the active participation of end users. Currently, there are now 98 rope pumps in the districts all working perfectly. The pumps are now entrusted into the hands of the head of a household who bears the cost of maintenance and repairs.

Private sector and key actors involvement

In the West Mamprusi District of the Northern Region of Ghana, the technology was introduced in 2001 by "Pumping is Life" - an NGO under the Rotary Project of Rotary International.

3.1.4 Users' Assessment of Technology Suitability

In the West Mamprusi District in Northern Ghana, case studies were conducted in five communities namely, Sanda Fongo, Nablugu, Kpargu, Nayuku and Kukua. These communities depend mostly on the rope pump technology for their daily water supply needs. The rope pumps, had all been installed by Pumping is Life, an NGO under Rotary International. The old models of the rope pump in Sanda Fongo, Nayuku and Kpargu which were installed some five years ago are currently not working due to either lowered water table and/or torn rope. The new models of the rope pump which have been in use for only a year at Nablugu, Kpargu, Kukua are all working.

Desirability and advantage of technology

Users of the technology in a household at Sanda Fongo assert that, the pump is only able to pump a few litres of water (18L) during the dry seasons. The water table perhaps falls below the reach of the PVC pipe after pumping a bucket of water and thus cannot pump any more water. In all the communities used for case studies, users pointed out that comparatively 'cleaner' water from rope pumps is the major plus to the use of the technology. According to some users water from the hand dug wells made them sick but that from the rope pumps do not. Although users accept that water from the rope pump is not always as 'clean' as that from the borehole with Afridev, they still prefer the use of rope pumps because it is closer to their households. Normally the boreholes are sited at the central area of the communities and residents living at the outskirts have to travel some distance to fetch water.

Operational capability

As indicated earlier, the rope pump is capable of pumping up to 0.6litres/s for wells of depth 10m and 0.15litres/s for those of depth up to 50m (WHO, 2003). Generally, users assert that, the technology works perfectly well in the rainy season and also when used at the household level instead of communal level. The case studies established that, the frequency at which the technology breaks down depends upon the number of users – on household basis, the technology takes approximately a year before the rope is changed. Children play with the rope pumps used on communal basis so they breakdown often. With the training programme organized for the beneficiary communities the pumps are regularly maintained to ensure the pump remains in service.

Risk associated with technology

In spite of the several merits of the technology as indicated by users, the pain usually felt in their shoulders upon using the facility for a longer period is the major drawback to the use of the technology. It is however acceptable to them since the water they need for domestic and farming activities is closer to them. At a focus group discussion at Nablugu, some users identified that, "it is better to feel pain in fetching clean water from the rope pump than to feel pain in fetching dirty water from hand dug wells". Users indicated that they feel similar kind of pain in using the Afridev (i.e. borehole fitted Afridev pump).

Moreover, because the rope pumps tap groundwater at a shallow depth (14 – 19m), users indicated that they are not able to pump water during the dry season. This is due to lower water table during such times of the year. Consequently, they revert to the use of hand dug wells, dug outs and boreholes for their daily water supply needs. Some users complain of pains in their arms upon prolonged pumping especially during the dry season.

Affordability, maintenance and spare parts availability

Users identified that, the cost of maintenance of the facility is affordable considering the benefits it provides. "Depending on how fast the pulley wheel is rotated, the rope (the most vulnerable part) can last up to a year and costs only GH¢20 ($35) to replace it", says Musah Ali, a local artisan at Walewale who fabricates and installs rope pumps. The faster the wheel is rotated the more it wears out and thus the weaker it becomes. "Though users are made aware of this basic principle after installing the facility, they always do it their own way accounting for the frequent tearing of the rope", says Bismark, a local artisan at Walewale who fabricates and installs rope pumps. Considering the benefits this technology offers the beneficiary communities, scaling up this technology may offer other communities the opportunity to improve upon their livelihood.

Promising Technology 2

3.2. Hand-Washing using the Veronica Bucket

3.2.1.Brief background

The subject of hygiene and sanitation are not well discerned to a lot of people in the country. It is in this regard that educational instructions on personal hygiene should be directed to all who are old enough to learn; be he/she a literate or illiterate individual. Hygiene is the science dealing with the preservation of health. Better hygiene through hand washing, food protection and better preservation method and domestic hygiene brought about a reduction of 33% in diarrhoea incidence, whereas improved water supply led to an average reduction of only 15 – 20% (Esrey, 1996). A recent review of all the available evidence suggests that hand-washing with soap could reduce diarrhoea incidence by 47% and save at least one million lives per year (Curtis, 1998).
Hygiene behaviour is a whole range of actions associated with the prevention of water and sanitation-related diseases. One of the domains of hygiene behaviour identified (Boot and Cairncross, 1993) is water and personal hygiene. Personal hygiene behaviours include the following:

- Washing of hands and cleaning of nails
- Washing of face
- Body wash / bathing
- Hygiene after defecation
- Washing of used clothes, towels and beddings
- Washing / cleansing activities after natural events like menstruation, birth, death and illness.

Other activities relating to personal hygiene that need mention include:

- Washing of hands with soap and water immediately after evacuating bowels or bladder, handling a patient or his belongings
- Washing always before handling food or eating
- Keeping hands and unclean articles, or articles that have been used for toilet purposes by others, away from the mouth, nose, eyes, ears, genitalia and wounds.
- Avoiding the use of common or unclean eating utensils, drinking cups, towels, handkerchiefs, combs, hairbrushes and pipes.
- Avoiding exposure of other persons to emissions from blown nose and mouth as in coughing, sneezing, laughing or talking

3.2.2 Description of technology

Washing of hands and body with soap is the most effective behaviour for the prevention of diarrhoea as well as for the prevention of roundworm and whipworm; skin infections like scabies, ringworms, louse-borne relapsing fever etc. Effective hand washing requires thorough rubbing of the hands with more attention focused on the fold of the skin and the skin between fingers while using soap and sufficient running water to rinse off the dirt. In Ghana, the Veronica bucket has been the recommended facility in especially institutions for hand washing. The Veronica bucket was invented by a Laboratory Technician by name Veronica Bekoe in Accra in the year 1998-1999 during the training session of the DANIDA Water and Sanitation Sector Programme Support Phase 1. The mentioned training programme was an initiative borne through a collaborative effort of Ghana Education Service, Ministry of Health and DANIDA.

The Veronica bucket normally comprises a container normally a bucket with a tap fitted to the base of it (Plate 8). The bucket is filled with water and covered and a cake of soap is placed by it. During hand-washing the tap on the bucket is opened and the running water used together with the soap for the hand washing activity.

Figure 8. Different forms of the Veronica Bucket

3.2.3 Appropriateness of Technology

The Veronica Bucket hand washing facility has been adopted in basic schools throughout the country. The technology, as simple as it is can be installed and maintained by the schools authorities. However the implementation of this technology in some of the schools in the arid regions has not being smooth because of non-existence or insufficient water supply.

Capacity and involvement of stakeholders

Since its invention and introduction, capacity has been built for all School Hygiene Education Programme (SHEP) coordinators with the aim of promoting handwashing with soap under running water. Afterwards the trainees were dispatched to the various regions and districts to conduct downstream training on the technology. The government and for that matter the Ghana Education Service (GES) has adopted and captured the technology in the Performance Improvement Plan (SPIP) from the Capitation Grant for use in schools.

Chapter four

4. Unproven Technologies

Under this chapter, two technologies (Aqua Privy and Enviro-loo) have been discussed as technologies that have not been proven to be successful.

4.1 Aqua Privy

4.1.1. Description of Technology

The Aqua Privy is a toilet technology fitted with a water-tight settling tank with one or two compartments, to which waste is carried by water flushing down a pipe connected to the toilet. Excreta drop directly into a tank immediately under the latrine through a pipe submerged in the liquid layer. The pipe should extend at least 75mm into the liquid layer so that a water seal is formed. In order to maintain the water seal, the fluid level in the tank must be maintained and this requires a bucketful of water each day to compensate for evaporation losses. Overflow from the pipe must be connected to a soak away, drainage trench or sewer. The system does not dispose of wastes; it only helps to separate the solid matter from the liquid. Some of the solids float on the surface, where they are known as scum, while others sink to the bottom where they are broken down by bacteria to form a deposit called sludge. Every tank must have a ventilation system to allow escape from the tank of explosive methane and malodorous gases, generated when bacteria decompose some of the sewage constituents (WHO, 1992).
Since aqua privies have a very low water usage the volumes of effluent discharging from the tank are small but very concentrated. The tank needs to be periodically de-sludged and so a removable cover for the tank is normally provided. The cost of constructing an aqua-privy is higher than building a raised or step latrine and it needs to be well designed and maintained to ensure that it has an adequate design life. There is also a risk that the tank may provide a breeding ground for mosquitoes unless it is perfectly sealed from the external environment. Aqua privies are also known as Septic Tank Latrine or, sometimes, the “Bomba” Toilets.

4.1.2 Appropriateness of Technology

Physical features

The technology can be adapted very well in various terrains and preferably in dry areas with low water table. As the technology employs the application of small volumes of water, it can be connected a source of domestic wastewater or – generally wastewater can be carried by hand to the latrine. Access to mechanical emptying of contained waste, and suitable subsoil drainage (high reliance on the soil environment in rendering the effluent harmless) and/or availability of sludge treatment and disposal is required for this technology.

Financing Technology

The installation of the Aqua Privy toilets has been funded by the government of the Gold Coast / Ghana since the colonial era. In a case study conducted in the Ejisu-Juaben Municipal Assembly, the technology is not used on communal basis but rather used in schools. The construction of the facilities was sponsored by the Ghana Educational Trust Fund (GETFund) in two Junior High Schools at Onwe and Kwaso in 2008 and 2010 respectively.

Capacity and involvement of stakeholders

Since its introduction in the colonial era, capacity has been built to oversee the installation and operation of the facilities. In the various communities, the facility is owned and managed by the Town Council staff and Town Development Committee members with the District Assemblies playing oversight role. Communities normally appoint attendants (always a resident in the community) who are tasked to collect the fees charged per visit to the facility. These attendants see to the maintenance of hygienic conditions around and within the facility.

4.1.3 Innovations in the introduction of technology, piloting and full scale uptake

Introduction of Technology

In 1930, Aqua Privy was introduced in Ghana for public use. At that time, sanitation was part of health delivery by the British Colonial Administration in Gold Coast (now Ghana). In 1939, a legislation was passed in Ghana for the provision of sanitary facilities in all domestic dwellings. The use of Aqua Privy then became a common practice in the 1940s throughout Ghana, and now new ones are being constructed.

Testing, demonstration and key actors

The technology has been scaled up over the years until about 2005. In the Ashanti region 35% of the population depends upon shared public toilet facilities (Mensah, 2011). The public toilet facilities comprise Aqua Privies, Water Closet units and VIP (or KVIP) units. Presently about 16% (i.e. about 200 000) of the population in the Ashanti region is serviced by this technology. Similar trends in terms of population serviced occur in the other regions of the country.

A case study on the technology at the Ejisu-Juaben Municipal Assembly (EJMA) indicated that, the technology was introduced into the Assembly by the Community Water and Sanitation Agency (CWSA) and Community Based Rural Development Programme (CBRDP). It was piloted in 1997 for three years in the municipality and commissioned in 1998. The technology was actively promoted by CWSA, CBRDP and the municipality for ten years. End users were not involved during the piloting of the technology. Currently, EJMA has four aqua privies located in four communities; Kwaso, Onwe, Apemso and Odaho. Predominantly, the facility is used by schools in the Municipality.

According to the Assembly, the use of the technology has shown a positive impact on the target communities in terms of health improvement and improved access to the utility. In terms of repair and maintenance, materials and spare parts are readily available locally.

4.1.4 Users' Assessment of Technology Suitability

Desirability and Advantage of Technology

The technology is preferable to other existing technologies like the KVIP and the Water Closet toilets. Views gathered through the survey in the schools using the technology indicate that, the KVIPs are undesirable due to the offensive odour from the facility. With respect to Water Closets, users of the aqua privy assert that since WCs require a regular supply of water for their operation this technology is undesirable and inappropriate for them. This is due to the intermittent flow of water in the community.

The presence of some form of offensive odour from the facility (although not comparable to that from KVIPs) however is the major demerit for the use of the technology. But this is acceptable to the users of the technology since they have put in place mechanisms to reduce it. This they do by cleaning the facility with disinfectants on a daily basis.

Operation and Capability

Nationwide the technology has been deemed to have failed because most of the facilities that were installed could not be maintained possibly due to improper operation of the facility especially in the maintenance of the water seal thereby making the system to function like an ordinary vault latrine with associated occurrence odour. Improper training of attendants has been a major contributing factor to the failure.

Risk Associated with Technology

In spite of the generally acceptable nature of the technology to users, the surveys found that, the facilities, due to the odour it generates sometimes are mostly located farther from the classrooms (closer to the bush) to prevent diffusion of the foul smell to the classrooms. This however makes the facilities susceptible to snakes although users indicate there has not been any instance of that nature.

Maintenance and Spare Parts Availability

Maintenance of the facilities is supposed to be carried out by the schools as and when it is needed. However, according to management of the schools, their meager annual budgets (i.e. Capitation Grant) cannot cater for any major maintenance of the facility should that become necessary in the near future. Therefore, the cost of maintenance is a major setback to the sustenance of the technology although materials for maintenance are readily available. Although the facility at Onwe has been in use for only three years, there are already cracks in its outer wall which appeared only six months after construction of the facility. This indicates a flaw in the construction of the facility and poses a risk to users. Generally, on the country-wide basis, there have been challenges with the management of the facility with respect to keeping the level of water in the septic tank. This attitude tends to affect the proper functioning of the technology in the long run. National players (e.g. the Ministry of Local Government) therefore discourage application of the technology.

4.2 Enviro - Loo

4.2.1 Description of Technology

The Enviro - Loo is a toilet technology comprising cubicles with vent pipes, fly traps and storage compartments or receptacle for the faecal matter (Plate 9). The individual cubicles have toilet bowls or pedestals and a patented ventilation extraction unit, positioned on top of an outlet vent pipe to ensure adequate ventilation. The facility was designed to produce minimal odour. It can be used as a domestic, institutional and communal facility.

The Enviro-Loo system was invented by Dr Brian La Trobe, in his response to the sanitation challenges facing the African continent. His research, starting in the 1980's and extending into the 1990s; culminated in the development of a waterless, on-site sanitation system - the Enviro-Loo. Although the Enviro-Loo was developed in South Africa and is still predominantly manufactured there, other countries have joined in the manufactured of the Enviroo-Loo and its use has spread to 39 other countries. To date 53,000 units have been installed worldwide.

Figure 9. Back view of Enviro - Loo toilet facility

4.2.2 Innovations in Technology, Piloting and Full Scale Uptake

Introduction of Technology

The provision of sanitation technologies in Ghana does not at times follow the formal process, involving piloting and approval by sector ministry, due to political inference in the process. The Enviro-Loo toilet technology came about as a result of a political arm pushing. According to the Environmental Health and Sanitation Directorate (EHSD), someone saw the technology in use in South Africa and decided to introduce it in Ghana. The EHSD started the approval process for the Enviro-Loo but did not complete the process. The formal process takes time especially at the pilot stage in the field. There was undue political pressure to get the technology introduced within a short time. As a result the EHSD could not complete the piloting process. Eventually the Eniviro-Loo was allowed entry without following the due process

Testing and Piloting of Technology

The technology was piloted by installation of 60 number 2-seater facilities in schools from 1990 to 1995 in each of the then 60 electoral areas of Kumasi - Ashanti region of Ghana. During the piloting the population served stood at about 3000. Presently the population serviced by this technology is in excess of 118 000.

Promotion and Scaling Up

Since its introduction in Ghana in 1990s, over 3,500 units of the Enviro - Loo have been installed throughout the country. The cost of installation of a five seater Enviro-Loo facility as at 2005 was quoted as ₡1068 ($712 using exchange rate of $1=1.5). In all the ten regions, the facility has been installed for schools, communities, mining companies, farms, recreational and beach resort and prisons. Despite the initial seemingly scaling-up of the technology, it has not been well promoted and adequate plans have not been put in place to ensure constant supply and availability of spare parts like toilet bowls, vent pipes and fly traps. The surveys conducted in a number of communities revealed some of the facilities having broken down components that have not been replaced. Moreover, information available does not indicate whether or not the initiators of the Enviro-Loo project in the country incorporated any training component for artisans to manufacture the various components of the facility locally. Eventually, the technology has not been sustainable. The technology has not been used as a household toilet in the study areas the survey covered.

Private Sector and Key Actors Involvement

ECMP (GH) Ltd is a Ghanaian registered company affiliated to a South African company that deals in the manufacture of the Enviro-Loo. ECMP (GH) Ltd was introduced to Enviro-Loo technology in 1996 by the South African partners.

4.2.3 Users' Assessment of Technology Suitability

In soliciting for information on the technology and the perception of the users about the Enviro-Loo toilet facility, a case study was conducted in the Ayigya community of Kumasi.

Case study of Ayigya community in Kumasi

The Enviro-Loo in the Ayigya community in Kumasi was constructed through the HIPC Benefits fund in 2001 and has been in use for ten years. An assessment of the Enviro -Loo at Ayigya indicated that the technology is being used by the public on commercial basis. It is operated by the Oforikrom sub-metro at a cost of GH¢0.1 per visit which according to respondents is considered affordable. There are three attendants managing and operating the facility within the day. Each attendant is paid Gh¢90 /month from the per capita visiting fee. The facility can be accessed from 4:30 am to 11:00pm. Until recently, there was no offensive odour from the facility but problems and challenges in securing spare parts for maintenance is changing the story.

Desludging is done once every month at a cost of Gh¢ 90 per trip. The facility is connected to the national electricity grid. Cleaning of the facility is carried out with detergents (Detol and Azar) which cost Gh¢30 every four months.

Figure 10. Enviro-Loo with defective components

The survey of the facility and responses from users revealed that Enviro-Loo cubicles were extremely warm and the toilet emits odour because most of the ventilation extraction units which are supposed to extract the heat and odour from the cubicles were broken and non functional. Most of these ventilation fans and pipes were malfunctioning (Plate 10). The doors of all the visited Enviro - Loos were found to be removed due to the complaint of discomfort by users or prevention of squatting on the pedestal. In view of this there is no privacy. In addition there were delays in de-sludging and this compounded the odour problem. The technology has therefore been deemed to be unproven because of the lack of spare parts for O & M and thus sustainability.

Chapter Five

5. New Opportunities

5.1 Ecological Sanitation Technology (Ecosan)

5.1.1 Description of Technology

Ecological Sanitation (ECOSAN) is a sanitation technology based on the idea that faeces, urine and water are resources in an ecological loop. The fundamental principles on which ECOSAN is based are:

- Preventing pollution rather than attempting to control it
- Sanitizing urine and faeces and
- Using the safe composted products for agricultural purposes

The sanitation solution developed from these principles ensures that faeces and urine are separated at source and not mixed with water. The Ecosan facilities operate as digester with mechanisms that enhance accelerated decomposition of the faecal matter. Ecological Sanitation covers a wide range of toilet designs as well as different techniques for the collection and treatment of urine and faeces and so can be adapted to suit any situation encountered.

5.1.2 Appropriateness of the Technology

Physical features and the environment

The technology is one of the known technologies that can be used in the communities with high water table. The system can be adapted or designed to suit different soil types.

The Eco-sanitation technology includes low- and high- tech solutions which can be designed for either urban, peri-urban or rural settings and can be designed to be either dry or waterborne decentralised or centralised systems. There are also designs for residential and communal use.

It can also be used in areas where water is not available by employing its dry form. For the low-tech option, locally available materials could be employed in its construction. Also, depending on the technology option employed, the level of expertise required for operation and maintenance ranges from skilled, unskilled through to semi-skilled labour.

The ecological sanitation concept presents a new technology opportunity for Ghana. Although it has been proposed as a technology with potential to solving the sanitation problems in the country, not much efforts have been made by the sanitation sub-sector to test its potential to do this. The only known cases of its usage in the country include: the Valley View University, the Avenor and Dworwulu communities in Accra, Ayidiki – New town, the Iduaprim mine estates and the Ghana Home Loans – Airport residential areas also in Accra. Aside solving sanitation problems, the ECOSAN technology can serve as a source of manure for agricultural purposes in the country.

Financing technology and installation materials

As of now the few existing established eco-sanitation toilet facilities have been financed by the beneficiary institutions and private individuals. In a few cases the cost of installation of the facility has been borne by donor agencies e.g. the Ecosan system installed at the Valley View University.

Presently it cost between GH₵1500 to GH₵1700 (i.e. $1000 to $1133) to construct a household Enviro-Loo toilet facility. The mentioned cost includes the cost of transportation and installation. The Biofil Digester, which works on the ECOSAN principle is one form of the ECOSAN technology currently being used in Ghana. The biofil digester facility is being marketed by K.A. Anno Engineering.

5.1.3 Innovations in the introduction of Ecosan and Piloting

The Introduction of technology

Sanitation solutions based on ecological principles are known to have been in use by many cultures for many centuries. ECOSAN is therefore not a new invention, although the revival of interest in its usage as a sanitation technology is recent. The technology has therefore not gone through a process that can be analysed using the Diffusion of Innovations approach. The Biofil Digester, which uses the Ecosan principle was first introduced into the country by K.A. Annor Engineering Limited, Accra.

Although it has been mentioned as a potential sanitation solution, not much has been done by way of major promotional campaigns to formally introduce it into the country. Some amount of relatively low key promotion however, has been conducted by the Ghana Institute of Engineers, BIOFILM, CHF International and some NGOs like NIMCOSS.

Valley View University (VVU), a private tertiary institution located in the Greater Accra Region of Ghana received funds from the German Ministry of Research and Education for the purpose of transforming the university into an ecological institution in the year 2002.

The project developed an ecological master plan for the university. As part of the ecological master plan, a special concept for reuse of greywater, waste water, urine and organic matter was to be realised at the university. This incorporated ecological sanitation facilities, biogas technology, solar systems, rainwater harvesting technology among others.

Testing, piloting and scaling up of technology

The version of ECOSAN adopted at VVU required the use of water. Urine diversion toilets were designed to use minimal amounts of water for flushing. The designed facility uses between three to six litres of water to flush toilet instead of the conventional nine to twelve litres. The urine and faeces were processed into manure which was tried on mainly tree crops. The idea was piloted for three years from 2002 to 2005. Tests were carried out on the products that were derived from the technology. The analyses were carried out in Germany by the University of Hoehoeham and Palutech Company. Samples of waste water were tested to analyse the nutrient content. Analysis of the urine derived from the urine diversion toilets which were installed as part of the ECOSAN technology showed that its content was equal to that of NPK 15:15:15.

Aside the VVU installations, the technology was re-launched by the Ghana Institute of Engineers in 2008 and piloted under the WASH-UP project from 2008 to 2010 in slum communities in Accra. Presently the technology is being adopted and patronised in residential communities of Dworwulu, Ayidiki – New Town, Ghana Home Loans-Airport residential and Iduaprim mines estates.

Private sector and key actors involvement

The local/private sector was involved in the manufacturing process of certain components of the ECOSAN facilities in the case of the VVU. Initially, most of the components were being imported from Germany. It was later realised that local artisans could manufacture those components to the same quality. Local artisans were trained on how ECOSAN works, its importance and its operation and maintenance. They were given specifications and designs for cisterns and they came up with materials and moulds for manufacturing them.

5.1.4 Users' Assessment of Technology's Suitability

Desirability and advantage of technology

The version of ECOSAN adopted at VVU required the use of water. Urine diversion toilets were designed to use minimal amounts of water for flushing. The designed facility uses between three to six litres of water to flush toilet instead of the conventional nine to twelve litres. The urine and faeces were processed into manure which was tried on mainly tree crops. Crops that were cultivated using the manure as fertilizer from the technology could be distinguished from those that had no manure applied to them; the manure- applied crops were bigger and of better quality.
In the communities where the technology has been piloted, residents interviewed re-countered that there has been positive impact in their lifestyle in that their health status has improved and that amount of water hitherto wasted in flushing has markedly reduced and thus increased the amount of potable water now available for consumption.

Operation and operational requirements

So far there has not been any need for any re-designs of the system as the results for the piloting and testing phases have been encouraging. For the facilities installed at VVU, cleaners (predominantly semi-skilled labour) have been employed for cleaning and maintaining the system. Other duties they engage in include sanitising and converting the faeces and urine into manure. Training courses were conducted for the various levels of users of the facilities. Craftsmen, cleaners, operators, students and faculty staff were all trained after the new ECOSAN technologies were installed. Posters on how to use and maintain the facilities were also disseminated.
Wastes generated at the facility are transported to the faecal sludge treatment plant where various processes are carried out for up to 90 days. Worms and maggots were seeded into the excreta to facilitate the degradation of the organic matter. The work of the operators involves using saw dust to speed up the drying of the degraded matter. For sustainability, training programs have been organised for users of the technology. Users have been educated on issues such as when to use the products, the number of days required for achieving full stabilization and pathogen removal, etc.

Risks and challenges

Initially, there were problems with users accepting the whole ECOSAN concept. This was however dealt with through education of the university community. They were made to realize that the wastes were sanitized and was safe for agricultural purposes. Posters educating users of the facilities on how to use them well were distributed.
Contact between handlers and faecal matter was the major potential risk of using ECOSAN. To counter this, operators were educated on how to avoid this.

Chapter Six

6. Summary and Conclusion

With the purpose of devising a framework for technology assessment, this report has been prepared covering the review of the process of introducing various technologies and their performance in several communities. At a meeting in Accra, the WASHTech Task force has selected the following technologies and classified them under different categories indicated in parentheses below:

- the SSFs,(Successful)
- Rope pump and Veronica bucket (Promising)
- Aqua Privy and Enviro-Loo (Failed)
- Ecosan (New Opportunities)

This report covers assessment of successful, promising and failed technologies and new opportunities. In the case studies conducted for the successful technologies (i.e. the SSFs) the key issues that emerged as the factors that promoted the technologies included the suitability and adaptability of the systems to the prevailing conditions in the beneficiary communities. The technologies were found to be fully owned and managed by the communities. The users or beneficiary groups of people within the user communities were well informed / trained and equipped with skills to operate and maintain the system. Users appreciated and asserted to the benefits derived from the application of the technologies.

With respect to the promising technologies, the rope pumps were found to be of service to both the communities and in some cases private individuals who could afford to acquire them. The technology was adjudged to be relatively cheap to procure, operate and maintain. Beneficiary communities have been educated concerning the installation, operation and maintenance of the technology. Users claimed spare parts for the technology were readily available. Aside the rope pump technology, the Veronica Bucket facility used as a hand-washing technology in institutions mainly was also considered as promising. In terms of documentation on the application of this hygiene technology in Ghana, very limited information exists.

For the failed technologies the Aqua privy and Enviro-Loo were considered. Users of the Aqua privy claimed the facility was relatively expensive to construct and operate and at times had odour problems. These technologies have failed mainly due to unavailability of material locally for repairs and maintenance. Moreover adequate capacity was not built to ensure efficient management of the schemes.

In connection with technologies classified as new opportunities the eco-sanitation technology was considered. A number of case studies were generally assessed. The wide range of eco-sanitation toilet facilities is showing to be versatile and a very promising technology capable of tackling the sanitation menace under a wide variety of environmental conditions. Basically the operating principle of separation of urine from the excreta in the dry form of the technology helps reduce the odour problems often associated with other toilet facilities. The sanitizing of the excreta and subsequent use as manure in agriculture is another plus for the technology. The following tables give the summary of the whole exercise.

Annexes

Slow Sand Filter – Small Town Water Supply Suitability of technology from users view point		
1	Advantage	Water produced from the SSF is devoid off pathogens and generally of better quality than the water they had been obtaining from the dug outs and streams. Harnessing of rainwater in dams. Eradication / limited incidence of water related diseases e.g. Guinea worm
2	Desirability	Desired because quality of water pumped is far better than the water they formerly used from dug outs
3	Operation	Training programmes for O&M organised for them by NGO
4	Capability	The system is able to meet appreciably the water demand of the beneficiary communities. System able to supply enough water (8 hours)
5	Risks	Very minimal risk of bacteriological contamination of treated water.
6	Affordability	Affordable to most people (18 litres of water attract a fee of ₵0.02)
7	Availability	Materials for O&M – readily available
8	Maintenance	₵2000 as maintenance cost for Mafi - Kumase and ₵ 151 000 for the 3-Districts Water Supply

Slow Sand Filter – Small Town Water Supply Technology Appropriateness		
1	Physical environment	Availability of surface water: Technology suitable for communities with raw water source with low turbidity. Mafi-Kumase takes it water source from a constructed dam The 3 districts takes their source from the Volta Lake
2	Financing Technology	Government and community owned (Mafi – Kumase) Other donor agencies (Caritas – Swiss, DFID, Danida)
3	Cost of Technology	$52320 (for 15000 people) – Mafi – Kumase $11 000 000 (for 115 000 people) – 3 districts
4	Capacity and involvement of stakeholders	Community Ownership and management – 1989 – MK Private management (Watsan Development board) – 3 districts

Slow Sand Filter – Small Town Water Supply Innovations in introduction, piloting and scale uptake		
1	Introduction of Technology	1986 – 1989 Mafi- Kumase Town Development committee – currently servicing 23 communities 3 – districts – DANIDA, DFID and GoG
2	Testing of Technology	Commissioned with end-users involvement Community owned and managed
3	Demonstration Key actors	No information on piloting for the Mafi- Kumase Commissioned and operating with a dam and pipe network system
4	Private sector Involvement	Facility has been extended to other needy communities. Cost of extension was borne by DANIDA and AMURT
5	Promotion and Timing	-
6	Adaptation and modification	-
7	Key actors	Traditional Development Council and Central Water Board Commissioned vendors

Rope Pump Suitability of technology from users view point		
1	Advantage	Cheaper; could be installed for households; close proximity to community Spare parts locally available
2	Desirability	Desired because quality of water pumped is far better than the water they formerly used from dug outs
3	Operation	Training programmes for O&M organised for them by NGO
4	Capability	Pumps perform better with high yielding wells. Capability limited during dry season when water table falls low.
5	Risks	Some users complain of little pain in the arm upon prolong pumping especially during the dry season
6	Affordability	Affordable to most people
7	Availability	Materials for O&M – readily available
8	Maintenance	Annual maintenance cost ₵20 (cost of rope)

Rope Pump Technology Appropriateness		
1	Physical environment	Could be employed mainly for high yielding wells. Lifts water from wells with depths of 10 – 50 m (pumping rate – 0.6 litres/second – for wells of depth 10 m and 0.15 litres/second for wells of depth 50m). Used at community and household level.
2	Financing of Technology	-Initially funded by agencies like CWSA with support from the World Bank. -Training programmes for capacity building were also funded. -Currently majority funded by NGOs (Water Aid & Rural Aid, Rotary International) -Some individual households fund their facility
3	Cost of Technology	Cost of installation of one rope pump – ₵ 380 ($253): Nira AF 85 cost $700 (as at 2004). Annual maintenance cost ₵20 (cost of rope)
4	Capacity and involvement of stakeholders	Local artisans involved and responsible for manufacture and repair; NGO involvement mainly; no government involvement.

Rope Pump Innovations in introduction, piloting and scale uptake		
1	Introduction of Technology	May 1999 Introduced by CWSA with support from the World Bank. (Problems encountered) Re-introduction by Rotary International in 2001 in Northern region Re-introduction by Jenamis Enterprise in 2003 in Upper East.
2	Testing of Technology	Piloted in October 2003 in Upper East region (Bongo, Kasena Nankana districts) for 5yrs. 52 pumps installed with the involvement of end users. Re-designed to include a galvanized sheet casing to cover rope and wheel.
3	Demonstration Key actors	Currently 98 new pumps, fabricated and installed by local artisans in the Mamprusi. Installation commenced in April 2011.
4	Private sector Involvement	Facility has been extended to other needy communities. Cost of extension was borne by DANIDA and AMURT
5	Promotion and Timing	-Yet to be very actively promoted and scaled up
6	Adaptation and modification	Initial design has been modified to incorporate a galvanized cover for the rope

Aqua Privy Suitability of technology from users view point		
1	Advantage	Relatively minimal occurrence of odour when operated well and uses far lesser amount water than the Water Closet toilets.
2	Desirability	Gives relatively less incidence of odor compared with VIP.
3	Operation	Requires availability of water to maintain the water seal
4	Capability	No information available to that effect
5	Risks	Normally located at the outskirts because of the probable odour problem
6	Affordability	Affordable to most people (at the pay per use level)
7	Availability	Materials for O&M – readily available
8	Maintenance	Annual maintenance depends upon the frequency of desludging

Aqua Privy Technology Appropriateness		
1	Physical environment	Availability of a source of water to maintain the water seal – a basic requirement: Technology suitable for communities with raw water source.
2	Financing Technology	Technology funded by Ghana Government through the GET fund for the Ejisu Juabeng Municipality in the Ashanti Region
3	Cost of Technology	Information not available
4	Capacity and involvement of stakeholders	Technology introduced and piloted during the colonial era – in the 1930s. Aqua privies installed in all the regions of the country

Aqua Privy Innovations in introduction, piloting and scale uptake		
1	Introduction of Technology	Introduced during the Colonial era - the 1930s. Ever since several units have been installed countrywide up to date but many have failed because of poor maintenance.
2	Testing of Technology	Commissioned with end-users involvement Community owned and managed
3	Demonstration Key actors	The Government of Ghana
4	Private sector Involvement	No information available to that extent
5	Promotion and Timing	Promoted but has not being sustainable because of improper operation and maintenance scheme adopted.
6	Adaptation and modification	-
7	Key actors	Traditional Development Council and Municipal assemblies and formerly the City councils.

Enviro - Loo Suitability of technology from users view point		
1	Advantage	Cheaper; could be installed for households; close proximity to community Supposed to give very minimal odor / stench
2	Desirability	Preferred by users because of its very minimal odor when managed properly
3	Operation	Attendants trained to man
4	Capability	Services the community well.
5	Risks	In the event of lack of spare parts to ensure proper maintenance the occurrence of stench and warmth with the cubicles makes the use of the facility very uncomfortable and unpleasant. Such a situation has led to the failure of the technology in Ghana at the moment.
6	Affordability	Affordable to most people
7	Availability	Materials for O&M – not available
8	Maintenance	Poorly maintained because of lack of spare materials and the capacity to fabricate the spare parts locally

Enviro - Loo Technology Appropriateness		
1	Physical environment	Could be installed in a variety of soil types Currently 3500 units installed country-wide, mainly in institutions like schools
2	Financing Technology	Ghana Government through the GET Fund and the HIPC Benefits Fund. (Case study – Ayigya, Ashanti region)
3	Cost of Technology	Information not available
4	Capacity and involvement of stakeholders	Technology Community Ownership and management – 1989 – MK Private management (Watsan Development board) – 3 districts

Enviro - Loo Innovations in introduction, piloting and scale uptake		
1	Introduction of Technology	Introduced into the country in 2001 through a South African company in collaboration with partners in Ghana
2	Testing of Technology	
3	Demonstration Key actors	No information on piloting available
4	Private sector Involvement	
5	Promotion and Timing	No promotion officially launched.
6	Adaptation and modification	No modification made to the original design
7	Key actors	The Ghana Education Service and the Municipal Assemblies in the various regions

Eco- sanitation Suitability of technology from users view point		
1	Advantage	Compost and urine produce for agriculture
2	Desirability	Initial acceptance of technology was a problem but was eventually accepted after some episodes of community education
3	Operation	Users trained to manage facility
4	Capability	Technology services the people and meets their need.
5	Risks	Contact between the handlers and feacal matter
6	Affordability	Affordable to most people
7	Availability	Users have access to facility always.
8	Maintenance	Easy to maintain

Eco - sanitation Technology Appropriateness		
1	Physical environment	Suitable for low income communities where water table is high. The compost is potential and environmental friendly by-product.
2	Financing Technology	Financed by NGOs WASH-UP, Private sector (VVU)
3	Cost of Technology	Between ₵1500 – 1700 per unit
4	Capacity and involvement of stakeholders	Designed by the private sector. Users involved in the implementation

Eco - sanitation Innovations in introduction, piloting and scale uptake		
1	Introduction of Technology	First introduced by Biofilm – Annor Engineering Ltd, in 2002
2	Testing of Technology	Valley View University pilloted from 2002 – 2005. Piloted by CHF in communities from 2008 - 2010
3	Demonstration Key actors	NGOs, Private sector, communities
4	Private sector Involvement	Design, marketing and construction executed by the private enterpreneur
5	Promotion and Timing	-Promotion by the Ghana Institution of Engineers, BIOFILM, CHF
6	Adaptation and modification	-

Chapter Seven

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Chapter Eight

8. Annex – Methodology Technology Appropriate for Site Conditions, and Rural and Urban Context

The first thing that needs to be considerered is *whether or not a technology is appropriate for, or fits well into, the particular local context*. Using our previous example, rainwater harvesting is not highly useful or advantageous in areas where there is not enough rain and where groundwater must be the main source. Hand pumps, on the other hand, cannot work in places where the groundwater lies too far beneath the surface. Although these are obvious examples, there are many known cases where people have tried to introduce technologies in contexts where the innovations were simply not appropriate. Table 2 sets out the kinds of questions that should be considered when analysing the fit between technology and context. The table focuses on an example of a particular water supply technology: vessels for household rainwater storage. Note that the is not exhaustive, and there may be other questions that should be asked in attempting to explain a particular outcome.

Table 2 Technology Appropriate for Site Conditions

Is the technology appropriate or fits well into the local context? In terms of the following

Aspect of the context	Variables
Physical environment	Site conditions (topography, soil stability, percolation capacity, groundwater pollution)
	Urbanization pattern (population densities, degree of urban planning)
	Existing service level (water supply availablity, desludging,
	Others, specify
Financing technology by:	Household Income/Wealth
	Access to Credit or Subsidies or Savings schemes
	Grants/Investments/Programmes by doners/Gov't
Cost of technology (Materials, Equipment)	Cost of the technology
	Availability & cost of inputs (e.g. Sand, cement) Cost of transport
Communicating technology	Road network
	Telephone
Capacity and Involvement of Stakeholders	Government capacity
	Existing programmes and projects
	Private sector capacity
	NGO capacity
	Donor priorities

Suitability of the technology from the standpoint of the user

The second thing that needs to be considered in discussing outcomes is *the suitability of the technology from the standpoint of the user*. The sudden surge in uptake known as the tipping-point" usually reflects the fact that the technology is well-designed and user-friendly, having the features of being advantageous, desireable, culturally appropriate, etc., as listed below. These key features or principles, to be considered for each technology, are set out in the Table 3 and listed as questions that, again, should be asked in each particular case, and addressed in the report if they are deemed highly relevant.

Table 3 Suitability of the technology from the standpoint of the user

Advantage	○ What advantages does the technology have over existing technologies/habits which serve a similar purpose (e.g. proximity, use for productive purposes)? ○ Are these advantages obvious to the user?
Desirability	○ In which way is the technology desirable to the members of the social system in which it is to be operated?
Operation	○ How can the users of the technology acquire the skills and organisation required for operation of the technology?
Capability	○ To what extent is the technology able undertake the task that it is designed for?
Risks	○ What are the risks associated with the utilisation of the technology, and ○ to what extent are these acceptable to the users?
Affordability	○ What are the capital and running costs of the technology and are these within the means of the potential operators and users?
Availability	○ To what extent are the supporting materials or consumables required to operate the technology package readily available?
Maintenance	○ What are the maintenance and repair costs of the technology?, and ○ Are they feasible?

Technology Review Report, Uganda

A report produced by Network for Water and Sanitation Uganda

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The **Water, Sanitation and Hygiene Technologies (WASHTech)** is a three-year action research initiative that aims to facilitate cost-effective investments in technologies for sustainable water, sanitation and hygiene services (WASH). Through action research and the development of a set of methodological tools and participatory approaches, WASHTech embeds the practice of multi-stakeholder learning, sharing and collaboration – instilling individual and collective ownership and responsibility for sustainable WASH services.

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Tables

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Abbreviations

CBO	Community Based Organization
DWD	Directorate of Water Development
DWO	District Water Officer
MWE	Ministry of Water and Environment
NGO	Non Governmental Organization
PAF	Poverty Alleviation Fund
RUWASA	Rural Water and Sanitation
SARAR	Self Esteem, Associative strength, Resourcefulness, Action planning, Responsibility
SCDO	Senior Community Development Officer
SMC	School Management Committee
SWTWS	South Western Towns Water and Sanitation
UDDT	Urine Diversion Dry Toilet
UNICEF	United Nations Children's Fund
USD-	United States Dollar
UGX	Uganda Shillings
ToT	Training of Trainers
VAD	Voluntary Action for Development
WASH	Water, Sanitation and Hygiene

Executive Summary

The Uganda Technology Review is a study under the WASHTech project, conducted mainly to select and analyze the innovation/ introductory process, appropriateness and suitability of five specific WASH technologies that have been tried out in Uganda. This report will be used to inform the process of constructing a Technology Assessment Framework/ tool (TAF).
The five WASH technologies fall under one of the following categories;

1. **Successful-** meets real need, in an appropriate way (socially acceptable, financially affordable, environmentally appropriate, Technically sustainable), tolerated or accepted by government, there is a clear provider (buyer user relationship), well established and reached scale in a local region/ district.
2. **Promising**- meets real needs, is appropriate (Socially acceptable, financially Affordable, Environmentally appropriate and technically sustainable), questionable on support or tolerated by government, not so clear on provider/ buyer relationship, not so clear on whether it has gone to scale.
3. **Failed**- Not clear whether it meets needs, in appropriate way (SFET), Not clear on support by government or tolerated, not clear buyer/ provider relationship, not gone to scale,
4. **New**- meets needs, is appropriate (SFET), NOT clear with government support, no clear buyer/ provider relationship, Not gone to scale.

Technologies reviewed under the different categories

Successful	Promising	Failed	New Opportunity
• UDDT • U2 Water pump	• Tippy tap	• Rope pump	• Uganda (UGA) pump

METHODOLOGY

Data collection was carried out in 5 selected districts of the country based on the fact that these technologies have been promoted widely in those particular districts. The Urine Diversion Dry Toilet was reviewed in Kabale Municipality where majority of unsubsidized toilets were constructed, the U2 Water pump was reviewed in Mukono District, being one of the districts where quite a number of pumps have been installed and are functional, the Tippy tap in Mbarara District where the District Local Government and ACORD an NGO are spearheading its promotion, the Rope pump in Iganga District with Busoga Trust NGO and the UGA pump in Wakiso District where they are primarily being implemented by Voluntary Action for Development a Non Governmental Organization.
The methods of data collection included;

- Desk review of relevant documents
- Household Questionnaire Interviews
- Institutional Questionnaire Interviews
- Key Informant In-depth Interviews
- Focus Group Discussions

- Technical assessments

Quantitative data from household and Institutional questionnaires, and Technical Assessment forms were entered and analyzed in the Statistical Package for Social Sciences.
Qualitative data from notes of desk review, focus group discussions and Key Informants Interviews were summarized, analyzed using thematic and content analysis methods.

KEY FINDINGS

1. Urine Diversion Dry Toilets

Innovation and introduction

The Urine Diversion Dry Toilets (UDDT) is reported to have been introduced in Kabale district in 1997 under the South Western Towns Water and Sanitation project of the Ministry of Water Lands and Environment. The technology was piloted in a number of places within Kabale district as well as in Kisoro. Awareness creation was done through radios and pilots, which attracted and enabled a number of people to pick interest in the technology. 7 toilets at household level and 1 at schools level within the municipality are reported to have been constructed by the SWTWS project on up to 80% subsidy. It is reported that currently over 300 toilets have been constructed at household level without subsidy and 82 at institutional level with individuals, NGO & School Facility Grant funds.

Appropriateness

73.3% of the respondents gave the advantage of the UDDT being appropriate in water logged areas or areas with high water table where a conventional pit latrine would not be appropriate. Other advantages cited were; lack of smell and general cleanliness & hygienic when properly used. It is then a good replacement for pit latrines that have to go over 10 meters deep. It was also found that the toilet can be built both **indoor** and **out door**. Only 2 facilities were found constructed indoors by the South Western Umbrella of Water and Sanitation organization in Kabale. However, there are still fears that even though the UDDT toilets could be built indoor, this could bring bad smell from malfunction. It was emphasized that it therefore requires strict management.

Suitability

The UDDT is reported to have gone through several modifications both on its structures and type of construction material i.e squatting type, sitting type, as well as use of mud and wattle, plastic, bricks and tiles for its structure. The possibility of the UDDT to undergo different levels of modification and beautification (sitting types, tiles, and plastic squatting pans, indoor or outdoor options) made the UDDT a suitable alternative to pit latrines even for the middle income municipal areas of Kabale. Plastic squatting pans were being made by Crestanks Uganda Limited a private company with a selling outlet in Kabale town.
80% of the respondents said they found the toilet affordable, with only the initial cost of about 800,000UGshs (306USD) for a household toilet being costly. However, the operation and maintenance costs at households level did not exceed 300,000 UGshs (115USD) annually, and this was found affordable.

The operation of the UDDT is reported to need careful attention by the users both during use and maintenance. Wrong use is said to affect operation by blocking urine pipes, wetting of the faecal material and causing smells if ash is not added. When well used, operated and maintained, the UDDT toilets serve their purpose and last years without failures. They oldest toilet visited was 13 years in use (since 1998) at the District Water Office in Kabale while the newest toilet in use was one year at Nyakambu, Kabale municipality.

2. U2 water pump

Innovation and Introduction

The India Mark II hand pump is said to have been introduced in Uganda in the early 1980's by UNICEF during the rehabilitation under emergency programmes. A Ugandan company - Victoria pumps Limited was formed to manufacture the pump and its spares. This company has been able to supply all components of the Ugandan standardized versions.

The Directorate of Water Development (DWD) under the Ministry of Water and Environment (MWE) introduced a hand pump standardization policy in 1995 which was eventually adopted in 1999. This policy was designed to enhance sustainability by ensuring that only a small range of hand pump models were used in the country for which spare parts and repair skills were widely available. The hand pumps selected were the Uganda manufactured India Mark II (U2) and India Mark III (U3). The modified 'corrosion-resistant' version of the U3 (U3M) is manufactured in country and is now used widely.

Appropriateness

In regard to financial and affordability aspects of the U2 pump, 90% of the beneficiaries are aware they have to contribute to capital cost of the pump before they acquire it. Their capital cost contribution has been an average of about 100,000UGshs (41USD), on top of which they contribute materials in kind like; stones, water, food and labour.

It was found that the U2 pump has quite a strong institutional support structure in the districts; Key players in the installation of U2 pumps is the Directorate of Water Development (DWD) and the District Water Office. At community level, Water Source and Sanitation committees are existent to do the management of pumps at different sources. The districts have trained groups of artisans/pump mechanics who to do routine maintenance of the pumps on request from the water committees. The pump mechanics receive refresher trainings from the District water office which also maintains quality checks and controls.

Suitability

The pump was found to be suitable for areas with low water tables and in areas that experience frequent dry spells. Some of the respondents cited the ease with which to operate the pump even by children. The spare parts are also readily available in Kampala, and easily accessed by hand pump mechanics. A Ugandan company- Victoria pumps Ltd. Is the main manufacturer of this pump in Uganda, although there are also other companies that import parts of it from India.

The pump is mainly managed and maintained by individual Water Source and Sanitation Committees who include community members and local leaders. Collected user fees are kept and used whenever the pump breaks down. Users collect about 500 shillings per month, while vendors pay 50 shillings per two jerry cans of water. When a pump breaks down and the savings are not enough, which is the commonest scenario, the water committee raises additional funds from the users. The frequency of break downs is said to be about once in every four months due to the high number of users and the poor quality parts which are provided by the pump mechanics.

3. Tippy Tap

Innovation and Introduction

In Uganda introduction of the tippy tap is dated back to the 1990's, during which a team of officials from the Ministry of Water and of Health were trained in Zimbabwe on the SARAR approach (Self Esteem, Associative Strength, Resourcefulness, Action planning and Responsibility), which promoted hand washing as a practice and the tippy tap technology alongside other sanitation technologies. However, particularly for the tippy tap model in Uganda, a health Assistant from Butagaya sub-county in Jinja district, Mr. Musada Henry designed a local design/ set up of the present tippy tap which was later taken up by the RUWASA project and thus widely adopted in the country.

Appropriateness

The tippy tap is said to be a low cost technology among beneficiaries, and that forms the basis for its uptake. Its cost was found to be between 1,000UG shs (0.5 USD) and 20,000 UG shs (9.5USD). Most of its components are self-made apart from the plastic container and the soap.

It was also found to be easy to install, required material is readily available i.e pieces of stick for the frame, a rope and a jerrican. Most of these can be easily acquired without money. Communities have gone further to get used bottles instead of purchasing jerricans from the shops, making it even cheaper.
Agencies and organizations in the Water, Sanitation and hygiene sector are promoting the tippy tap as a hygiene technology alongside water supply projects to enhance hygiene behaviour.

Suitability

The tippy tap was found easy to construct by household owners with no need for a technician to install. It is easy to operate by children and the elderly.
Maintenance activities of the tippy tap included; cleaning the jerrican, refilling the jerrican with water, providing soap, clearing the soak pit. Respondents estimated maintenance costs from 500 UG shs (0.2USD) to 11,000 UG shs (5.3USD) per month. And between 7,000 UG shs (3.4 USD) and 99,000 UG shs(48 USD) per annum.

4. Rope Pump

Innovation and Introduction

In Uganda, rope pumps were introduced by the Directorate of Water Development in collaboration with Water Aid in 2005. They were piloted in two areas; the Busoga and central region. Busoga trust as a local partner with Water Aid carried out the pump promotion through training of communities especially beneficiary communities and held sensitisation meetings. Currently its the only agency dealing with this technology in the region.

Appropriateness

The rope pump has been found to work best in communities with not more that 300 Households. In the past it has been subjected to capacities beyond what it can serve, thus frequent break downs. Only a few agencies have been installing the rope pump, Water Aid through its local partners, as well as JICA.

Those interviewed mentioned that the pump is affordable, costing between 400,000UGshs (194USD) to 800,000 UGshs (388USD). Whereas for the pumps provided by NGOs, the households had to pay 5000UGshs (2.4 USD) towards construction costs, and locally available materials like; sand, water and labour for excavation.

Suitability

Most users reported that the rope pump is easy to operate although a few said it does give them back ache. The pumps visited were found being managed by Water Source and Sanitation Committees who collect about 500UGshs from each household per month.
Although the rope pump is presently fabricated in Uganda, the pump is not readily available on the market, one can only acquire it after placing an order which takes some time.
The main risk mentioned by beneficiaries is the frequent breakage of the rope, all the rope pumps visited have at least had their ropes replaced once since installation. Particles of the rope found in water also raises suspicion among users on the water quality.

5. Uganda (UGA) pump

The Uganda pump is a new technology that was introduced by Voluntary Action For Development (VAD) a local NGO in collaboration with WatCom technical services, a private company which fabricates the pump. The company is presently exploring opportunities of introducing the technology to the ministry of Water and Environment.
The pump is presently being piloted in Wakiso district, no other pilots are available. it was noted that neither the Districts, Local authorities nor the users are experienced in the operation of the UGA pump since the present installments are serving as pilots. So far 30 UGA pumps have been installed by VAD in the District.

KEY CONCLUSIVE ISSUES

The ***UDDT*** toilet was reviewed as a successful technology though district leaders see the technology as suitable for water logged areas, not suitable for public toilets unless a very good O&M system is in place. and that government support was still necessary for promotion of the technology. They said they were good for private households since operation and maintenance required attention to details. Among the gaps identified in the introduction process especially at piloting was design availability for “washer communities”.

The ***U2 Water pump*** was also selected as a successful technology and field results show similar situation. The Health assistant under the DDHS said that there was a problem with the piloting phase because baseline surveys were done without them being informed. The feeling was that all stakeholders should be involved in introduction, piloting and implementation as much as possible and awareness on activities and steps to be taken should be communicated to sector workers. It was reported that still missing is community sensitisation on operation and maintenance especially the water committees of the U2 pumps since the only trained people are the technicians who at times abuse the trust of the water committees by quoting hiked spare part prices or quoting unnecessary parts for their benefit.

As was the selection criteria which stipulated that the ***Tippy tap*** was a promising technology***,*** results confirm so. It is viewed as promising by implementers, leaders and users mainly because of continuity of use. Implementers said users at times do not refill the jerry cans with water making the tippy tap a useless installation near the toilet. It was estimated that about 20% of technology adopters do abandon them while replication was estimated at about 30% (ACORD). One gap identified is the lack a policy framework and standards.

Although the ***Rope pump*** was selected as a failed technology based on literature available, results from the field show that it is viewed as a promising technology. Until now rope pumps are being used and apart from the previously recorded three pumps, about 7 exist in practice, but replication is very low. The biggest challenges using the rope pumps include drying up of the well during the dry season where people go back to old sources (attributed mainly to poor sitting of the well rather than the pump), the frequent rope breakages, and the particles of ropes that appear in the water making the people sceptical about the technology.

The ***UGA Pump*** remains a new technology since it has been in use since 2009 in Rakai as provided by literature and since June 2010 as per the results from Wakiso district. Both the users and the leaders do not have experience in the operation, maintenance and durability of the technology. So far they are still being studied. . Since installation, no breakdowns have been experienced and the number in use is said to be 30. Based on the above, it is so far commended as a good option for shallow wells in rural poor communities.

1.0 BACKGROUND

1.1 Introduction

Water Sanitation and Hygiene Technologies (WASHTech) is a research project aimed at assessing why WASH technologies have remained at pilot stages, and never taken to scale nor taken up by private enterprises. WASHTech's overall objective is to strengthen sector capacity to make effective investment in new technologies through research and development of a Technology Assessment frame work (TAF).

In line with this objective, the Uganda Technology Review study was conducted mainly to select and analyze five examples of a specific WASH technology that have been tried out in Uganda, and this will ultimately be used in the process of constructing the Technology Assessment Framework (TAF) which is the main project deliverable. Each of the technologies chosen fall into one of three WASH functional types-Water Supply, Sanitation, and Hand-washing for Hygiene.
The five technology examples chosen also fall into each of the following categories based on development outcomes:

1. **Successful-** meets real need, in an appropriate way (socially acceptable, financially affordable, environmentally appropriate, Technically sustainable), tolerated or accepted by government, there is a clear provider (buyer user relationship), well established and reached scale in a local region/ district.
2. **Promising**- meets real needs, is appropriate (Socially acceptable, financially Affordable, Environmentally appropriate and technically sustainable), questionable on support or tolerated by government, not so clear on provider/ buyer relationship, not so clear on whether it has gone to scale.
3. **Failed**- Not clear whether it meets needs, in appropriate way (SFET), Not clear on support by government or tolerated, not clear buyer/ provider relationship, not gone to scale,
4. **New**- meets needs, is appropriate (SFET), NOT clear with government support, no clear buyer/ provider relationship, Not gone to scale.

This report therefore presents findings of the technology review on the 5 Water, Sanitation and Hygiene technologies selected in Uganda.
Technologies reviewed under the different categories;

Table 1 A table showing the five technologies that were selected for review

Successful	Promising	Failed	New opportunity
UDDT	Tippy tap	Rope pump	Uganda (UGA) pump
U2 Water pump			

Data collection was carried out in 5 selected districts of the country based on the fact that these technologies have been promoted widely in those particular districts. The Urine Diversion Dry Toilet was reviewed in Kabale Municipality where majority of unsubsidized toilets were constructed, the U2 Water pump was reviewed in Mukono District, being one of the districts where quite a number of pumps have been installed, the Tippy tap in Mbarara District where the District Local Government and ACORD NGO are spearheading its promotion, the Rope pump in Iganga District with Busoga Trust NGO and the UGA pump in Wakiso District where they are primarily being implemented by Voluntary Action for Development a Non Governmental Organization (NGO).

1.2 Technology selection criteria

Technology selection was based on reported cases of success, failure, or newness of technologies and their presence in different parts of the country. The selection of the technologies to be reviewed was also based on literature review of key sector documents and reports as well as findings of the stakeholder Knowledge Attitude and Practice (KAP) study on technology introduction process.

1.3 Methodology

The review comprised preparation and actual field work activities. The preparation phase included a desk study of relevant literature, identification of required data and design of questionnaires, developing contact with all the stakeholders involved, determining the sample space (stake holding offices and number of interviewees per technology) as well as determining the travel plan. Fieldwork on the other hand involved the actual data collection from households, key informants from the District and local leaders, institution heads, and NGOs.

Questionnaires: Five sets of questionnaires were produced considering each selected technology and in accordance with the TOR of the review. Of each set, the following distribution was used; 5 for household users, 2 for institutions, 3 for District leaders (Chief Administrative officer or the District chairman, District Water Office and the District Directorate of Health Services), 1 for Local council 3 leadership, 1 for Local council 1 leadership, 2 for implementers of the technology (NGOs, CBOs) and 1 for technicians dealing with the technology. The total number of questionnaires for each technology was 15. For the UGA pump however, only 12 respondents were available.

Field visits:
Field visits were made to:

- Kabale municipality for the UDDT,
- Mbarara Town Council to the implementation area of Kyoma 1, Kigaga parish for the Tippy Tap,
- Mukono District - Kalagi town for the U2 water pump,
- Iganga District- Busowobi, Nakalama, Bukoona, and Kakongoka implementation areas for the Rope pump,
- Wakiso District; Masulita and Sisa parishes for the UGA pump.

Observation: Observation formed an important part of the review to validate some of the data collected through the questionnaires. No specific schedule for this was formulated but any observations were noted and used in the report writing.

1.4 Brief description of selected technologies

UDDT

A Urine Diversion Dry Toilet (UDDT) is a toilet in which urine is separated from faecal matter; it consists of two processing chambers each with a volume of about 0.3 cubic meters. It is built entirely above ground with the processing chambers placed on a solid floor of concrete, bricks or clay. The floor is built up to at least 10cm above ground so that heavy rains do not flood it. The processing chambers are covered with a squatting slab that has two drop holes, foot rests and a groove for urine. At the back are two openings 30cmx 30cm for the removal of the dehydrated material. In the Ugandan context the abbreviation EcoSan is commonly applied for Urine Diversion Dry Toilet (UDDT) systems, although other technologies for ecological sanitation are also known***. (Ten Year National Strategy on Ecological Sanitation 2008 – 2018)***

Uganda Pump (UGA) Pump

The UGA Pump is the Ugandan version (fabrication) of the Nira pump which is a direct action pump for Low Lift Wells. It uses a buoyant pump rod that helps to reduce the forces on the handle. It is designed for heavy-duty use, serving communities of 300 persons. The maximum recommended lift is 15 m. The UGA Pump is fully corrosion resistant. It is easy to install and has excellent potential for community-based maintenance. It is based on a buoyant pump rod that is directly articulated by the user, discharging water at the up- & down stroke. The Pump is completely corrosion resistant http://www.rwsn.ch/prarticle

Although the origin of the Nira pump is in Finland, it is commercially produced in Tanzania. It is from Tanzania that the Nira pump was introduced to the Ugandan market as a rural water supply technology for shallow wells ranging within 15 – 20 meters of water depth. The oldest Nira pump was encountered in Wakiso district having been installed by WaterAid during the last ten years. The importation of the Nira pump proved costly and alternative fabrication within Uganda was done, thus the UGA Pump. The difference between the Nira pump and the UGA pump lies in the sizes of the raising main, handle pipes, and the material of raising main pipes. Whereas the Nira uses 50mm pipes, the UGA uses 40mm pipes and whereas the Nira uses HDPE pipes, the UGA pump uses UPVC pipes.

U2 Water Pump

The U2 Water pump is the Ugandan variant of the India Mark 2 pump. It was said to be ideal for Africa, and Uganda in particular having been adapted to local conditions. It is designed for both deep well of a maximum of 50 metres and shallow well of 25 metres and less. A Ugandan company Victoria pumps Limited was formed to manufacture the pumps and spares. However, "en.wikipedia.org/wiki/Mark_II_hand_pump" says that major criticism of the India Mark II is that its design makes it difficult to repair at the village level and hence, without government support, NGO intervention, or community savings systems in place, the pump is more susceptible to extended periods of non-function or permanent failure. Lower upfront hardware costs and widespread adoption of the Mark II pump makes replacement parts more accessible. The U3 had some improvements in design over the U2 but was more expensive due to the bigger rising mains.

Rope Pump
The Rope pump is a simple, cheap and easy to handle technology with capacity to pump huge volumes of ground water. The pump can easily be manufactured out of locally available materials like scrap, polythene materials, used plastic materials and old tyres ***(Water Aid 2003)***

The principal elements of the rope pump are a pulley wheel, a rope with pistons attached, a pipe that enters the well, and at the base of this pipe, a guidance device for the rope. As the crankshaft is turned the rope drags the pistons up the pipe, trapping the water above them and ejecting it at the surface. The pump functions well at groundwater depths of up to 50 meters. Due to the simple and sturdy design of the pump, maintenance needs are very limited and can easily be handled by the community or local artisan. The rope itself is the most likely part to break down, and can either be easily and cheaply replaced locally or patched up without difficulty. Makeshift repairs do not significantly detract from pump performance ***(WSP 2001).***

Tippy Tap
A tippy tap is a hand washing facility much used in rural setting. It consists of a small (3 or 5 litre) jerry can filled with water and suspended from a wooden frame. A string attached to the neck of the jerry can is tied to a piece of wood at ground level. Pressing on the wood with the foot tips the jerry can, releasing a stream of water through a small hole. Soap is suspended from the frame beside the jerry can. A tippy-tap located close to a latrine provides a cheap and potentially convenient means of washing hands after latrine use.

The tippy tap is also described as a simple device for hand washing with running water. A container of 5 litres with a small hole near the cap is filled with water and tipped with a stick and rope tied through a hole in the cap. As only the soap is touched with the hands, the device is very hygienic. A gravel bed is used to soak away the water and prevent mosquitoes.

2.0 SUCCESSFUL TECHNOLOGIES

2.1 Urine Diversion Dry Toilet (UDDT)

2.1.1 INNOVATION AND INTRODUCTION

The introduction of UDDT toilets in Kabale town is said to have been done in 1997 by the South Western Towns Water and Sanitation project which had operational offices in Kabale from 1996 to 2006. The project is said to have operated under the then Ministry of Water, Lands and Environment, now the Ministry of Water and Environment, and coordinated by Engineer Austin Tushabe. From the District Water office, it was gathered that the first pilots were constructed at the water office and the project office which shared the same compound, a school toilet demonstration was built at Kikungiri Primary school. Other pilots at all levels were constructed in Kisoro District where Leaders in Kabale and other parts of the country were taken for study visits and tours. The UDDT was advertised under the name Ecosan on the radio and interested users came for pilot visits at the offices and the school from where they decided to build them.

The UDDT is reported to have gone through several modifications and testing with different materials including mud and wattle structures, squatting types, sitting types and semi permanent structures. The capacity of the UDDT to undergo different levels of modification and beautification (sitting types, tiles, and plastic squatting pans, indoor or outdoor options) made the UDDT a suitable alternative to pit latrines even in the middle income municipal areas of Kabale. Plastic squatting pans were being made by Crestanks Uganda Limited a private company with a selling outlet in Kabale town.

Table 2 List of stakeholders involved in the Introduction of UDDT

	Introduction	Piloting	Promotion	Remarks
CAO	Not consulted	Taken to see pilots and sensitised	Passes budget for promotion and implementation.	
DWO	Consulted and sensitized	Involved and first pilot constructed at office. Given Training of Trainers (ToT) by the SWTWS project.	Responsible for promotion, implementation and recording uptake	Has maintained records of toilets constructed by the government but not NGOs and private owners.
DDHS	Not involved	Not involved	Called for workshops by AMREF	Office responsible for health promotion and implementation in the District. UDDT is a relevant topic.
LC3	Not involved	Not involved	Not involved	
LC1	Not involved	Not involved	Not involved	
SCHOOL AUTHORITIES	Not involved	Consulted, trained, pilots built.	Not involved	

Local masons were invited and given trainings at the SWTWS office and took on the role of selling the technology to the town dwellers who were faced with pit digging problems. The support received was only as far as the training was concerned and the announcements made on radio. In Kabale town, the spread of UDDT is largely attributed to the trained masons and the local environmental conditions. 7 toilets at household level and 1 at schools level within the municipality are reported to have been constructed by the SWTWS project on up to 80% subsidy. It is reported that currently over 300 toilets have been constructed at household level without subsidy and 82 at institutional level with individual, NGO, SFG funds (DWO 2011).

2.1.2 TECHNOLOGY APPROPRIATENESS

Physical or geographic aspects: The UDDTs visited are mainly household toilets that are constructed near or attached to the house. Only two belonging to the South Western Umbrella of Water and Sanitation organization were built indoor. Even though the UDDT toilets could be built indoor, there is still fear of the smell that could arise from malfunction and other users at construction time, did not fully trust that there would be no smell. A few cases reported that given an opportunity to rebuild their toilets, they would place them indoor since time and space has proven that when well looked after, UDDT toilets do not smell.

The toilets were all constructed due to high water table that was an encumbrance to the digging of pit latrines of more than 10 meters. Kabale is mainly a water logged area. A minimum of 4 hours and a maximum of 10 hours (7 hours average) of sunshine daily to enable dehydration of faecal material were reported.

Financial aspects: Institutional 2 stances, 4 chamber toilets cost between 3 and 6 million Uganda shillings (USD 1152 – 1535). Household toilets were reported to have cost between 300,000 and 1,500,000 million, average of 800,000 Uganda shillings (306 USD). However the toilets visited were constructed between 2001 and 2009 when the dollar rate was between 1500 and 1800 shillings to 1 dollar. Although the dollar rate is currently volatile, it fluctuates between 2600 and 2950. Apart from 7 toilets which were constructed with 80% subsidy from the SWTWS project, the rest of the household toilets about 300 reported were constructed at individual household initiative and funding.
It was reported that Centenary bank offers loans for home improvement which includes sanitation improvement; it also give bank guarantees and loans to private contractors who build big facilities like at schools.

Logistical aspects: Materials used in the construction of the UDDTs including timber, rion bars, pipes, squatting pans, tiles, wire mesh, plastic containers, iron sheets, sand, aggregates, bricks and cement were available in shops and quarries within the area not further than 5 km. They were easily available at variant costs and were delivered to the construction sites with ease.

Communication aspects: The road network within Kabale municipality is mainly defined and clear hence sites were easily accessible making delivery of materials on site easy. During the rainy seasons, roads become quite slippery without disrupting movement of vehicles.
Five major telephone networks are available; MTN, WARID, ORANGE, AIRTEL and UTL making communication between contractors and employers possible.

Institutional aspects: After the closure of the South Western Towns Water and Sanitation (SWTWS) project, the District Water Office under the District Local Government has been spearheading the implementation of UDDT toilets mainly at public levels; at markets and schools. The public toilets have been found to be problematic in management and the majority are now closed. AMREF which also wound up in Kabale District in early 2011 was crucial in implementing UDDT toilets at schools. The current main implementer of UDDTs is the Rotary Club of Kabale which is doing so in schools, as well as individual households funding their own toilets. The success of UDDT toilets uptake at household level is mainly attributed to local masons who were trained initially under the SWTWS project and have had a role in market search and promotion of the UDDT coupled with the water logged nature of the area that forces people to build an above ground toilet option.

2.1.3 SUITABILITY OF THE TECHNOLOGY

Advantage: All the UDDT owners said they had used the pit latrine previously. They said it was hard to dig pits since it is a water logged area, the pit latrines were smelly and being a municipal area, there wasn't so much land to make pit shifting possible whenever it collapsed or got filled. Therefore, a wide range of advantages of having UDDT toilets were reported, including space saving, convenience, cleanliness/hygiene, heath and reduction of diseases, no smell, permanency and avoidance of the cost of pit digging. The lack of smell, cleanliness/hygiene are outstanding issues and generally common amongst the UDDT owners although the inconvenience of the high water table was the commonest reason (73.3%) for owning the UDDT and as such an advantage over the pit latrine.

Although recovery of nutrients from the excreta was mentioned as an advantage, it did not play a driving role in the ownership of the UDDT toilets. In general, the respondents would recommend UDDT to others on the basis of permanency of the toilets, hygiene, non-smelly nature of the toilets and the possibility to recover nutrients from urine and faeces.

Cultural Aptness: A number of years (since 1997 to present) using UDDT toilets have proved that there is no major taboo or cultural problem related to using the technology. Urine and faeces can both be used in agriculture either as pesticides and/or fertilizer. Social or cultural taboos against the use of urine and faeces were not found to be significant although 3 respondents mentioned them as having been a threat in the past, more specifically; pouring ashes on someone's faeces was seen as a witchcraft practice.

Operability: The operation of the UDDT is said to need careful attention by the users both during use and later on maintenance. Wrong use is said to affect operation by blocking urine pipes, wetting of the faecal material and causing smells if ash is not added. Ignorance of the users was cited among the issues affecting operation and especially during functions and parties when there are new and uncontrolled users. At public and school level, the operation of the toilets is affected by the big number of users who do not pay user charges. It was said to have been the main cause of toilet failures leading to their closure at markets and public places.

These issues have been tackled mainly by placing educational charts in the toilets and training household visitors on the use of the toilets. Although the District Water Office and the Directorate of Health Departments are aware of the need to have toilet operators at public places in order for it to function well, they have not done so and opted for closure of the toilets or limiting use to only the neighboring households.

Masons who construct the toilets are largely responsible for passing on operational information to the users who contract them for construction. Other institutions such as the Rotary Club of Kabale also train users on operation and maintenance wherever they implement a project. School managers and house holders reported to have the capacity to operate and manage their toilets. Information is said to be available at their local radio station Voice of Kigezi which was running adverts on Ecosan during

2002 – 2005, Rotary office, AMREF and World Vision NGOs. Some users had also learnt of the UDDT from their church.

Maintenance: The toilets are maintained by users at household levels, at schools they have care takers who report any operational or management issues to the school administration while at markets they have failed due to lack of management. Management issues include payment of emptying costs, ensuring the supply of additive materials like ash, disposal of the sanitised material and replacement of old or broken down parts. The operational costs are not calculated in daily or monthly costs since emptying is done once a term for schools, once every two years for households and is not yet done for market toilets. The cost for emptying is not more that 300,000 UGX (115USD) (per emptying at school toilets and 50,000 UGX (19 USD) at household level. One reported problem was the failure to easily find toilet emptiers at school level, while the visited household users did the emptying themselves with either household labourers or household members.

Capability: When well used, operated and maintained, the UDDT toilets serve their purpose and last years without failures. The capacity for the toilet to serve its purpose depends mainly on the use and management. They oldest toilet visited was 13 years in use (since 1998) at the District Water Office in Kabale while the newest toilet in use was one year at Nyakambu, Kabale municipality.

Affordability: Although some users reported UDDT toilets as being expensive both in terms of initial cost as well as operation and maintenance, the majority (80%) said only the initial cost was the problem while operation and maintenance costs did not exceed 300,000 Uganda shillings (115 USD) annually. The major costs incurred in the O&M was the emptying charge (in cases of people who did not do it themselves) as well as replacement of the urine pipe. All the toilets visited were built without subsidy.

Desirability: The alternative for sewer connection was viewed as expensive and not viable since only a few households within the central division were connected to the sewer line, while household septic tanks were another expensive option. The UDDT was hence viewed as the most viable and desirable as such alternative to pit latrines.

Riskiness: Risks associated with the use of UDDTs are possible disease outbreaks (diarrhoeal) in case of misuse and mishandling of excreta especially if not well sanitised, and smell in case of poor management.

2.2 U2 WATER PUMP

2.2.1 INNOVATION AND INTRODUCTION

Variant accounts were given as to when the U2 water pump was introduced in Mukono. The years given were 1990 by UNICEF, 1995 by RUWASA, 2001, 2002, 2004, 2005 and 2006. These years given by the respondents (LC chairmen, HA, and users) depended on the time their U2 pump was installed.

The India Mark II handpump is said to have been introduced in Uganda in the early 1980's by UNICEF during the rehabilitation under emergency programmes. After years of civil strife, there was an urgent need to re-equip and rehabilitate the country's water facilities. In the rural areas, this effort was spearheaded by UNICEF, with Sweden as a major financier. Initially, interventions were borehole drilling programmes which focussed on the North, but activities were soon shifted to southern Uganda. A Ugandan company Victoria pumps Limited was formed to manufacture the pumps and spares and it is able to supply all components of the Ugandan standardized versions though as said above, there are several other companies which import the India Mark II pump from India, which are available at lower prices than the U2 from Victoria.

However P.A. Harvey says that Under UNICEF influence, the Directorate of Water Development (DWD) under the Ministry of Water and Environment (MWE) introduced a hand pump standardization policy in 1995 which was eventually adopted in 1999. This policy was designed to enhance sustainability by ensuring that only a small range of hand pump models were used in the country for which spare parts and repair skills were widely available. The hand pumps selected were the Uganda manufactured India Mark II (U2) and India Mark III (U3). The modified 'corrosion-resistant' version of the U3 (U3M) is manufactured in country and is now used widely.

Below are some of the ways in which different stakeholders were involved in the introduction process;

Table 3 A table showing stakeholders involved in the different stages of technology Introduction

	Introduction	Piloting	Promotion	Remarks
DWO	Meetings, workshops and technician identification	Selection of sites	Monitoring, refresher trainings to technicians	Implement U2 under PAF funds.
LC3	Consulted, sensitized and requested to list water stressed areas.	Provision of UGX 100,000 as part of community contribution per source.		
LC1	Consulted, sensitized and participated in community mobilisation	Selection of sites and mobilisation for community contributions		
USERS	Sensitized	Contributed land, housing for masons, food for masons, sand, dug pits and bricks.		
UNICEF	Community and leadership contacts, sensitization, and mobilisation.	Project implementation	Sensitization, advocacy, community support	
RUWASA	Community and leadership contacts, sensitization, and mobilisation.	Project implementation	Sensitization, advocacy, community support	
Trained Technicians		Were trained and later installed the pumps	Do repairs	

2.2.2 TECHNOLOGY APPROPRIATENESS

Physical or geographic aspects Visited facilities are located within the community within walking distance of not more than 2 kilometers. The water depth is as follows:

Table 4 A table showing the water depth of community sources

WATER SOURCE NAME	DEPTH
Old bore hole	27.4M
Kalagi - Nabale	9.1M
Kalagi Bosa	33.5M
Kyabakadde p/s	9.1M
Nalubowa - Kabembe	27.4M
Nalubwama	21.3M
Kalagala mosque	24.3M
Mwanje -Kakoola	7.6M

Apart from the Kalagi Bosa source which produces rusty water with a low yield, the rest of the sources give odourless, clean and clear water. The water is reliable though shortages sometimes occur at Kyabakadde source which serves Kyabakadde Primary school.

Financial aspects: Users are not aware of the cost of the U2 pump. At construction they were asked to provide housing and meals for the masons, land and locally available materials like sand and bricks. The pumps were brought and installed by the Rural Water and Sanitation (RUWASA) project, the Directorate of Water Development under the Poverty Alleviation Fund (PAF) and the United Nations International Children's Fund (UNICEF). The Sub County contributed 100,000 UGX (49 USD) per pump installation. No financing institutions were found available for water and sanitation.

Logistical aspects: Materials used in the installation of the U2 pumps (including the well superstructure) include aggregate, sand, Cement, Culverts, Pipes, rods, Stones, and were all available in Mukono town. The pump was delivered from Kampala through NGOs and the Local Government. They were easily available at variable costs and were delivered to the construction sites with ease.

Communication aspects: The road network is good and sources are easily accessible making delivery of materials on site easy.

Institutional aspects: Key players in the installation of U2 pumps is the Directorate of Water Development (DWD) working for the government of Uganda and the District water office also working for the government. Water committees, representing the communities, were set up to do the management of pumps at different sources. A group of artisans/pump mechanics were trained to do routine maintenance of the pumps on request from the water committees.The pump mechanics receive refresher trainings from the District water office which also maintains quality checks and controls. At Sub county level, for every borehole dug, the sub county contributes 100,000 UGX (38.3 USD) as part of installation costs and as such has the mandate to monitor the operation of the pumps within the sub county helped by the sub county health inspector. The health inspectors at times help the communities to cross check costing by the pump mechanics to ensure realistic costs are invoiced and genuine spare parts are installed.

2.2.3 SUITABILITY OF THE TECHNOLOGY

Advantage: Advantages cited with using the U2 Pump are ease to use even for children as compared to U1 which was heavy, provision of safe and clean water, the pump is reliable, and reduction of distance to water source. The users said that before the introduction of the U2, options in place included the U1 which had a heavy wooden handle, unprotected springs and ponds. According to the pump mechanics and the DWO, the pump is cheaper to buy compared to U3 and spare parts are easily found in Kampala,

Cultural Aptness: There are no cultural related problems with using the U2 pump.

Operability: The pumps are operated by caretakers who oversee fetching of the water, collect user fees from commercial vendors, and maintain the general cleanliness of the area. At some pumps, the caretaker ensures that the pump is locked, opening at scheduled times especially in the morning and evening hours. The pumps are reported to be easy to operate although some careless users bang the handles and they may break but generally, they are said to be easy to operate. The money collected is given to the water user committees who keep the money until repairs are needed.

Capability: The pump is able to supply water to community of up to 400 users. In some cases particularly Kalagi Bosa, the users escalate causing frequent breakdowns and long queues.

Desirability: The U2 was viewed as desirable and viable since the water table is low and the area experiences some dry spells. The pump has proved being reliable although breakdowns with increased usage are frequent. The limitation is that because of the expense, individuals and small communities cannot install them.

Riskiness: No risk was associated with using the pumps at 7 sources. At one source Kalagi Bosa, it was reported that the water has some particles; it is rusty and has a bad smell. The pipes are corroded hence the rusty water. The risk of falling sick after taking this water was reported yet the community still uses it.

Affordability: Most individual community members could not afford installation of the pump. All visited pumps were installed either by NGOs or the government, however one pumps was reported in Kalagi as being owned by an individual who was not willing to divulge information.

Availability: Although Victoria Pumps Limited is the only company in Uganda which is able to supply all components of the Ugandan standardized versions, there are several other companies which import the India Mark II pump from India, which are available at lower prices than the U2 from Victoria. Due to the Government's policy of economic liberalisation there are no attempts to limit importation of such pumps which threaten the long-term security and sustainability of local manufacturing. Some local artisans also manufacture the U2 pump-head, pedestal and handle, which are generally of poor quality. Although this is not authorised there appears to be no attempt by Government to control this.

Maintenance: The pumps are managed and maintained by the individual water user committees who include local leaders. Collected user fees are kept and used whenever the pump breaks down. Users collect 500 shillings per month, while vendors pay 50 shillings per two jerry cans of water. When a pump breaks down and the savings are not enough, which is the commonest scenario, the water committee raises additional funds from the users. The frequency of break downs is said to be about once in every four months due to the high number of users and the poor quality parts which are provided by the pump mechanics. In cases of breakdowns, the mechanics who were trained by RUWASA at every sub county are called to do the repair works. It is reported though, that due to community ignorance of prices and necessary parts, the mechanics sometimes cheat the water committees which contract them. The mechanic are also said to be few in number with some sub counties lacking a single one. Repairs cost between 300,000 UGX (115 USD) and 500,000 UGX (192 USD).

3.0 PROMISING TECHNOLOGY

3.1 TIPPY TAP

3.1.1 INNOVATION AND INTRODUCTION

The first version of the Tippy Tap was designed by Dr. Jim Watt of the Salvation Army in Chiweshe, Zimbabwe, and was called the Mukombe. The Mukombe is a type of gourd or calabash, which can be used as the can. But many vessels can be used in the same way, such as those used for cooking oil or milk. "*http://www.akvo.org/wiki/index.php/Tippy_Tap*"

In Uganda, a team of officials from the MWE and MoH had training in Zimbabwe on the SARAR approach which promoted hand washing as a practice and the tippy tap technology alongside sanitation technologies. However, a local Ugandan model of tippy tap was invented by a health Assistant from Butagaya sub-county in Jinja district, Mr. Musada Henry who had a local design and had his own set up of the technology.

In Mbrara ACORD introduced the Tippy tap in 1995 after attending UWASNET study visit to Rukungiri District where the technology was among those studied. ACORD decided to include this hand washing technology as part of the holistic sanitation program because of its simplicity, its "almost local" characteristic and the "do it yourself" quality. The Mbarara District through the DDHS office started promoting it in 2010 after having attended a ToT by AFRICARE which was an activity under the National hand washing campaign. The District staff after the training solicited for interested individuals under different sub counties whowere trained as Hand washing ambassadors, responsible for promotion and monitoring of hand washing activities based largely on tippy tap technology.

Table 5 List of stakeholders who were involved in the introduction of the Tippy tap

	Introduction	Piloting	Promotion	Remarks
CAO	Not involved	Not involved	Not involved	Know tippy taps from reports
DWO	Not involved	Not involved	Not involved	Know Tippy taps from demonstration at World Water day
DDHS	Consulted by UWASNET, sensitized, visited pilots attended ToT, assisted in selection of hand washing ambassadors.	Did not pilot, full scale implementation, participated in overseeing construction of first 70 installations, trained hand washing ambassadors.	Sensitisation and mobilisation on hand washing, demonstrations at World Water day and household monitoring, monitoring activities of hand washing ambassadors.	
LC3	Consulted by DDHS and ACORD, sensitized and participated in community mobilisation	Not involved	Not involved	
LC1	Consulted by DDHS and ACORD, sensitized and participated in community mobilisation	Not involved	Community mobilisation whenever required and construction at own home.	
USERS	Sensitized	Construction of tippy taps	Construction of tippy taps.	
ACORD	Community and leadership contacts, sensitization, and mobilisation.	Project implementation	Sensitization, advocacy, community support	
CAO	Not involved	Not involved	Not involved	Know tippy taps from reports

3.1.2 TECHNOLOGY APPROPRIATENESS

Physical or geographic aspects: The taps are located at homesteads, near the toilets/latrines for visibility and accessibility reasons. They are not affected by rain or any environmental conditions. At schools they are located at every toilet facility and are used by about 600 pupils. 3 schools, 5 households, and 1 office facility were visited for the study.

Financial: The tippy tap is said to be a low cost technology and that forms the basis for its uptake. The most expensive tippy tap was found at 20,000 UGX (9.5 USD) while it could go as cheap as 1000 UGX (0.5 USD). Most of the components of the tippy taps are self made apart from the plastic container and the soap. No financiers for tippy tap were available.

Logistical: Required materials are delivered on site, the main parts bought are a jerry can and soap which are bought by individual households. Installation is mainly done by owners who seek advice from the health assistants and hand washing ambassadors at no cost. Users reported having the capability to buy the jerry can and in cases where it is not possible, they have improvised with used water bottles acquired from restaurants and shops at no cost.

Communications: Road networks do not affect implementation of tippy tap

Institutional: The tippy tap is viewed as a convenient cheap and easy to make and manage hand washing technology. Organizations in the Water, Sanitation and Hygiene sector working mainly in the rural areas are willing to promote it. ACORD promotes it in its area of work alongside water provision, currently in 8 sub counties of Mbarara, Rakai, Isingiro and Kiruhura districts. The Mbarara District Local government has made it a priority area and is heavily campaigning for hand washing with soap. The Local government has staff in every sub county (Health Assistants) who are given the mandate to promote WASH technologies and advocate for behavioral change in the communities, as well as monitor change processes and progress. These health assistants are trained civil servants on government payroll.

3.1.3 SUITABILITY OF THE TECHNOLOGY

Advantage: It is cheap, easy to construct even by household owners (they do not necessarily need a trained technician to install), and easy to operate and maintain. Uses local available materials apart from low-cost bought components (jerry can and soap); it uses little water.

Cultural Aptness: Promotes dignity, health and hygiene.

Operability: Simple and easy to use even by children and elderly.

Riskiness: Water logging under the tippy tap may occur if a soak pit is not provided.

Affordability: All households visited (6), schools (2) and office (1) had installed the tippy taps without any subsidy. Both Agency for Cooperation and Research in Development (ACORD) and the District Directorate of Health Services (DDHS) do not subsidize Tippy taps. Adoption is done without coercion.

Availability: Components are locally available. Information is availed on charts and posters distributed in the local offices, health centres and schools. Hand washing ambassadors have been formed and trained in every sub county of Mbarara District; they promote the technology and provide any required information.

Maintenance: Main maintenance issues include replacing of soap, refilling of water and replacing old components. There are inconstancies in the maintenance costs given ranging from 500 UGX (0.2 USD) to 11,000 UGX (5.3 USD) per month, 7,000 UGX (3.4 USD) to 99,000 UGX (48 USD) per annum. The respondents gave estimate figures since no records were being taken on a weekly or monthly basis.

Uptake: Since 1995 to present ACORD has registered 9,000 tippy taps. The DDHS started promotion in June 2010 and 70 tippy taps were installed. By June 2011, 1,000 tippy taps are recorded.

4.0 FAILED TECHNOLOGY

4.1 ROPE PUMP

4.1.1 INNOVATION AND INTRODUCTION

In Iganga, rope pumps were introduced by Busoga Trust and DWD in collaboration with Water Aid in 2005. They were piloted in three areas; the Busoga region; Sempya village Namayumba Parish, and Wakiso District. Busoga trust did the promotion through training of communities especially beneficiary communities and held sensitisation meetings. Currently its the only agency dealing with this technology in the region.

(*Ahmed & Danert, K. 2007)* reports that the original plan of installing the rope pumps on hand dug wells to be constructed by the private sector could not be undertaken as it was not approved by the contracts committee of DWD. Thus, discussions were held with Busoga Trust, an NGO based in Jinja with experience of shallow well drilling, hand digging, and hand pump installation. Memorandum of Understanding (MoU) between DWD and Busoga Trust was signed in June 2004.

Water Aid piloted the technology in Wakiso district; Busoga Trust piloted it in Iganga, Mbale and Mpigi districts.

Table 6 The list of stake holders and their role in introduction of tippy tap in Mbrara District.

	Introduction	Piloting	Promotion	Remarks
CAO	Not involved	Not involved	Not involved	
DWO	Not involved	Not involved	Not involved	Know Rope pumps from reports
DDHS	Consulted and trained by Busoga Trust	Identified pilot area with Busoga Trust and mobilised for contributions	Not involved	
LC3	Not involved	Not involved	Providing	

	Introduction	Piloting	Promotion	Remarks
			information at LC3 office.	
LC1	Not involved	Not involved	Not involved	
USERS	Sensitized	Use of the rope pumps	Not involved.	
BUSOGA TRUST	Community and leadership contacts, sensitization, and mobilisation.	Project implementation	Commissioning, sensitization.	

4.1.2 TECHNOLOGY APPROPRIATENESS

Physical or geographic aspects: 3 of the visited facilities are located within the community within walking distance of not more that 2 kilometers while two are located at schools. The water depth is at 25 – 30 meters.

Table 7 List of Rope pumps, their location and Number of people being served

PUMP LOCATION	YEARS IN USE	NUMBER BEING SERVED
Nakalama	9	400 - 500
Kakongoka	9	150 - 200
Busowombi	7	400
Kigulu High school	9	600
Ibun Baz Girls school	4	400

Financial: Households contributed 5,000 UGX (2.4 USD) towards construction of the rope pumps while as a community they provided locally available materials like sand and at the same time provided manual labor for excavation. The rest of the costs of the pump like pump components, skilled labor, cement and bricks were covered by Busoga trust.

Logistical: Materials used in the construction of the pumps and superstructure of the well included aggregate, sand, cement, stones, and were available in local shops in Iganga town.. The pump was delivered from Kampala by Water Aid and Busoga Trust NGOs.

Communications: The road network is good and sources are easily accessible making delivery of materials on site easy.

Institutional: The first promoters of the Rope pump in Uganda, Water Aid, considered it to be appropriate and worth promoting due to its low-cost and locally available materials. However it is perceived negatively in some circles. One reason given is that because parts of it are exposed to the air, it is susceptible to contamination. Another is that bits of the rope contaminate the water as the rope wears.

Although three pumps serving communities and two serving institutions were visited, it was communicated through dialogue with users that several (3) more are available in Iganga district, constructed both by Busoga trust and individual farmers who wanted to boost their production. In Iganga district only Busoga trust is promoting the Rope pump.

(Ahmed & Kerstin 2007) report existence of rope pumps also in Wakiso district installed by Water Aid and write that the original plan of installing the rope pumps on hand dug wells to be constructed by the private sector could not be undertaken as it was not approved by the contracts committee of DWD

4.1.3 SUITABILITY OF THE TECHNOLOGY

Advantage: Available water sources before the rope pump introduction were ponds, water holes, wells, springs and boreholes fitted with U2 and U3 pumps. The users of boreholes say that the rope pump has greatly reduced their maintenance costs since it is a low cost technology. Distances to the water sources have reduced safe and clean water has been provided and the technology is user friendly and cheaper.

Cultural Aptness: No cultural taboos and hindrances.

Operability: The system is operated by the users who pump the water at fetching. A caretaker is appointed to communal sources to maintain the cleanliness. Though it is said to be easy to use by some respondents, others claim it is hard to pump and causes back aches.

Riskiness: Users find it risky to use rope pumps especially when ropes get worn out. Rope particles appear in the water. The respondents say this happens regularly since ropes are the parts that get more often broken down and need regular replacement.

Capability: The rope pumps are serving communities between 150 and 700 people. When well maintained lasts more than ten years.

Affordability: Rope pumps are quite affordable. They cost between 400,000 UGX (194 USD) and 800,000 UGX (388 USD).

Availability: Rope pumps are not available on the market. Although they are fabricated in Uganda, they are done on order. It is difficult to privately own a rope pump since only NGOs can place such orders for fabrication.

Maintenance: The in use pumps are managed by the water committees who collect 500 UGX (0.2 USD) from house holds every month. All the pumps visited have had their ropes replaced in the past year.

5.0. NEW OPPORTUNITY

5.1 UGA PUMP

5.1.1 INNOVATION AND INTRODUCTION

The UGA pump was introduced by VAD to the local authorities by contacting the Community Development Officer at sub county level to select water stressed parishes that were in ardent need of assistance. The Local authorities provided a list of water stressed areas which were contacted by VAD at parish and village levels. The Local council 1 was tasked to mobilise the communities and arrange for meetings with VAD. After the meetings with the communities, which were mainly advocacy sessions and information sharing, the Local council 1 were again requested to select sites with the communities, and provide requested contributions up front before installation.

The major constraints registered are lack of district support during mobilisation and implementing. It is reported also that while some community members provided the required materials willingly, others were unable to contribute.

The communities served with the UGA pump are so far the first in the country and no other pilots are available. Neither the Districts, Local authorities nor the users are experienced in the operation of the UGA pump since they are serving as the pilots. Thirty UGA pumps have so far been installed by VAD in Wakiso District.

Table 8 The table below shows roles of stakeholders at the different levels.

	Introduction	Piloting	Promotion	Remarks
DWO	Not involved	Not involved	Not involved	Have heard of UGA pump
LC3	Consulted, sensitized and requested to list water stressed areas.	Installed pumps are acting as pilots.	Still observing the UGA Pump operations.	
LC1	Consulted, sensitized and community mobilization	Selection of sites and mobilisation for community contributions	Still observing the UGA Pump operations.	
USERS	Sensitized	Contributed land, housing for masons, food for masons, sand, dug pits and bricks.		
VAD	Community and leadership contacts,	Project implementation	Sensitization, advocacy,	

	Introduction	Piloting	Promotion	Remarks
	sensitization, and mobilisation.		community support	
WATCOM Technical services.	Fabrication of the UGA Pump.	User manual and masons training	Market solicitation	

5.1.2 TECHNOLOGY APPROPRIATENESS

Physical or geographic aspects: They are located in privately owned land which has been allowed for use by the different land owners. They are communal shallow wells fitted with the UGA pump, within longest half a kilometer of walking distance. The water depth is at 20 meters, neither affected by drought nor by rainy conditions. The technology has been in use since June 2010.

Financial: The communities are not aware how much the water pump costs, nor were the local leaders aware. During the implementation, the community was required to provide land, lunch and housing for skilled technicians, sand as part of their contributions as well as excavate the pit. These contributions were calculated at 1.450,000 million UGX (670 USD). Voluntary Action for Development (VAD) project on the other hand provided the bricks, the pump, construction labor and supervision. No other financial institutions were found providing water and sanitation loans at individual level.

Logistical: Construction materials needed included interlocking blocks, UPVC raiser pipes, sandstones, bricks, plastic pipes, and steel metals. Apart from one site on which materials could not reach, the rest had materials delivered with ease from Wakiso town to the sites... For the one where materials did not reach, they were dropped 100 meters away and carried by the community to the site.

Communications: Although there incidences of poor road network, the majority of the sites are accessible.

Institutional: The District Water Office is aware of VAD's activities in Wakiso District but does not play a major role in implementation or promotion of the UGA Pump. VAD deals mainly with Sub County authorities, trickling information down to the Parish and village levels. Every Shallow well has a Water committee which undertakes the management of the facility while a selected care taker does the day to day operational activities.

5.1.3 SUITABILITY OF THE TECHNOLOGY

Advantage: Before the UGA pump, communities were fetching water from unprotected springs and ponds. The one community encountered which was using a DANIDA donated protected spring; it had been worn out and needed rehabilitation. Basing on the previous sources, the users realised safety of water, user friendliness (children and elderly can also use the pump) and durability as some of the advantages of the UGA pump. The pumps although said to be good and easy to use, are not yet compared with other types of pumps to clearly state their advantages in comparison with other pump types like the U2 and U3 which are known to the community because of their newness. This comparison was also not available at the DWO. It was learnt that a comprehensive comparative study would be done after a period of at least one year. At the District however it was said that so far they observed that the pump was easier to use and pumping was less laborious than the U2 pump.With the introduction of the UGA pump distance to the water wells was reduced from up to 3 kilometres walking distance to a maximum of half a kilometre. The water provided is clean, clear and has no smells and there no more fears of children falling into the well as previously experienced with open wells and stagnant spring water.

Cultural Aptness: There is no cultural challenge using the UGA Pump. It was suggested that it instead enhances dignity and better health.

Operability: The pumps are operated by local community members who serve on the water committee and who are the nearest homestead to the well. In some cases, these are also the land owners. The pumps are said to be easy to operate and use, where old people who were found at the well also expressed ease of pumping. Every user operates the pump on fetching the water without a specific standby person to help the fetchers. The care taker is said to inspect the pump every evening to ensure that the area is clean; there are no breakdowns and the water quality is always the same. User fees are not collected each time people fetch water, but a flat rate fee is collected monthly for emergency. However no break downs have been experienced since installation (June 2010).

VAD conducted O&M trainings for the pump caretakers, the Water committees and the users as a whole. All the caretakers visited expressed the ability to operate the pumps; in case of minor breakdowns since they were trained by VAD to carry out minor repairs. However none of the communities talked to, had yet acquired spanners that were advised by VAD as stand by necessity tools in case of repairs. Major repairs are referred to trained pump mechanics who were also trained by VAD to install and repair the pumps.

Capability: Each UGA pump is said to serve a population of about 150 users; it takes a short time to fill a jerry can of water and thus no major queues have been experienced so far at water wells.

Riskiness: No risks are seen as yet as associated with the use of the UGA Pump.

Desirability: Based on the advantages of the UGA pump, users find the pumps desirable. They however find it expensive to own at individual level. The fact that it is risk free especially for children compared to open water holes and ponds, they would much rather opt for use of these sources. At district level, the UGA pump is still being studied over time to determine durability, cost of maintenance and community response.

Maintenance: The pumps are managed by a water committee selected by the community and the local leaders. They are mandated to solve any emerging issues concerning use, operation and management of the pump as well as collecting the monthly fee for future use. The committee reports to the local leadership and are accountable to the selecting communities. At the time of the study no management issues had yet arisen, the pumps had not broken down since installation; the water is reliable and sufficient.
No maintenance costs have been recorded and the availability of the spare parts on the market is not yet determined. However users believe that since this is a pump fabricated in Uganda, the spare parts are easy to find from the fabricators located in Kampala - Katwe.

Acceptance : The UGA pump has easily been accepted because the users feel that they do not easily breakdown; since they have not experienced any since June 2010, they find them easier to use as compared to other pumps, they provides clean water whose volume is sufficient, ease to pump and usability for both children and elderly. 76 years old Mzee Yonasan Mbaziira Mirenzo, caretaker of Nankonge village well, says “even I can still pump the water without pain. I find this pump very user friendly.”

6.0 CONCLUSION

This conclusion captures emerging issues on each case and summarises the gaps identified in the introduction of each case.

The ***UDDT*** toilet was reviewed as a successful technology though district leaders see the technology as suitable for water logged areas, not suitable for public toilets unless a very good O&M system is in place. and that government support was still necessary for promotion of the technology. They said they were good for private households since operation and maintenance required attention to details. Among the gaps identified in the introduction process especially at piloting was design availability for “washer communities”.

The ***U2 Water pump*** was also selected as a successful technology and field results show similar situation. The Health assistant under the DDHS said that there was a problem with the piloting phase because baseline surveys were done without them being informed. The feeling was that all stakeholders should be involved in introduction, piloting and implementation as much as possible and awareness on activities and steps to be taken should be communicated to sector workers. It was reported that still missing is community sensitisation on operation and maintenance especially the water committees of the U2 pumps since the only trained people are the technicians who at times abuse the trust of the water committees by quoting hiked spare part prices or quoting unnecessary parts for their benefit.

As was the selection criteria which stipulated that the ***Tippy tap*** was a promising technology***,*** results confirm so. It is viewed as promising by implementers, leaders and users mainly because of continuity of use. Implementers said users at times do not refill the jerry cans with water making the tippy tap a useless installation near the toilet. It was estimated that about 20% of technology adopters do abandon them while replication was estimated at about 30% (ACORD). One gap identified is the lack a policy framework and standards.

Although the ***Rope pump*** was selected as a failed technology based on literature available, results from the field show that it is viewed as a promising technology. Until now rope pumps are being used and apart from the previously recorded three pumps, about 7 exist in practice, but replication is very low. The biggest challenges using the rope pumps include drying up of the well during the dry season where people go back to old sources (attributed mainly to poor sitting of the well rather than the pump), the frequent rope breakages, and the particles of ropes that appear in the water making the people sceptical about the technology.

The ***UGA Pump*** remains a new technology since it has been in use since 2009 in Rakai as provided by literature and since June 2010 as per the results from Wakiso district. Both the users and the leaders do not have experience in the operation, maintenance and durability of the technology. So far they are still being studied. . Since installation, no breakdowns have been experienced and the number in use is said to be 30. Based on the above, it is so far commended as a good option for shallow wells in rural poor communities.

7.0 TECHNOLOGY EVALUATION FROM THE FIELD

Table 9 The table below shows number and type of responses got from the field on the different technologies

TECHNOLOGY	SELECTION CRITERIA	FEED BACK – Very Successful	FEED BACK – A little successful (promising)	FEEDBACK – Not successful (Failed)	TECHNOLOGY
UDDT	**Successful**	*9 Respondents* Advantages of using UDDT are visible. Masons to construct them are available and the materials are also on the market. Easy to manage and maintain Use of the manure in agriculture. People have embraced the technology. Occupy less space, lasts long.	*5 Respondents* Due to high subsidization of SWTWS replication has been on a small scale. Emptying is a problem. Expensive to construct. Few in the community.	**UDDT**	**Successful**
U2 PUMP	**Successful**	*7 Respondents* Reliable technology. Cheaper to buy spare parts. Was drilled to water table. Water is reliable (not seasonal). Clean and safe water. Provision of enough water.	*5 Respondents* . Breaking of pipe is frequent. Rusting, water has a lot of iron particles. Replacements are made after every 3-7 months.	**U2 PUMP**	**Successful**
TIPPY TAP	**Promising**	*5 Respondents* Construction is done with locally made materials. Improved sanitation and hygiene. Mobilizers convinced community to adopt it. New technology, attractive and easy to use. Reduction in disease outbreak.	*8 Respondents* It has been adopted by many people. Improves hygiene. More people who did not like them in the first instances are now picking up interest. Pupils like it.	**TIPPY TAP**	**Promising**
ROPE PUMP	**Failed**	*1 Respondent* No reason.	*11 Respondents* Dry up in dry seasons; some completely dried up.	**ROPE PUMP**	**Failed**

TECHNOLOGY	SELECTION CRITERIA	FEED BACK – Very Successful	FEED BACK – A little successful (promising)	FEEDBACK – Not successful (Failed)	TECHNOLOGY
			Not increased in number. Only in one area. Works well only during rain seasons. People got alternatives. Working fairly well for the school.		
UGA PUMP	**New technology**	*5 Respondent* Program has promoted leaders. VAD implemented the program with transparency, accountability and social networking. It is made in Uganda. Easier to use as compared to other pumps. No breakdowns since installation.	*3 Respondents* They have just been introduced. All hand pumps need good care and it is the community's responsibility. Not many challenges have been faced yet.	**UGA PUMP**	**New technology**
UDDT	**Successful**	*9 Respondents* Advantages of using UDDT are visible. Masons to construct them are available and the materials are also on the market. Easy to manage and maintain Use of the manure in agriculture. People have embraced the technology. Occupy less space, lasts long.	*5 Respondents* Due to high subsidization of SWTWS replication has been on a small scale. Emptying is a problem. Expensive to construct. Few in the community.	**UDDT**	**Successful**

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Annexes

1. List of interviewees

UDDT

Table 10 List of Interviewees for UDDT

No.	Name	Designation
1	Mayira Mukasa Joseph	CAO Kabale District.
2	Mbaruka I.M	DHI Kabale District
3	Sabiti Teophil	Ag. DCDO Kabale District
4	Turinawe Baganwhunda	DWO Kabale District
5	Louis Bazirakye	LC3 Chairman
6	Bakaruhire John	UDDT contactor
7	Byabasheija J. Bosco	LC1 Chairman
8	Byamugisha Julius	Manager SWUWS
9	Byamukama Bernard	User
10	Kibabi Robert	User
11	Adella kabuchu	User
12	Tushabomwe Mauda	User
13	Sanyu Sadayo	User
14	Mary Cross	H/T Bishop Asili Primary School
15	Byekwaso Jotham	H/T Canaan Primary school

U2 Pump

Table 11 List of Interviewees for U2 pump

No.	Name	Designation
1	Kalule Joseph	Ass. DWO Mukono District
2	Akorat Eunice	HA Kyampisi Subcounty - DDHS
3	Kalemba Simon	LC3 Chairman
4	Nanfuka Mulu	Opinion Leader
5	Nsubuga P	Pump mechanic
6	Sowedi Bossa	LC1 Chairman Kalagi Bossa
7	Kiwanuka Denis John	Secretary Water Committee

No.	Name	Designation
8	Nsubuga Charles	Trained Technician Technician
9	Lubwama Francis	User
10	Kato Joseph	User/ Village Heatlh Team member
11	Namuswe Gorretti	User
12	Muyingo Isa	User
13	Namuswe Gorretti	User
14	Jemba Patrick	SMC Kyabakade Primary School
15	Ndebaleba Iybu	SMC Kalagala Mosque P/S

Tippy Tap

Table 12 List of Interviewees for Tippy Tap

No.	Name	Designation
1.	Tumusiime Godfrey	Ag CAO/Ass CAO
2.	Edrida Musinguzi	SCDO – DW Office
3.	Masereka	DHI Mbarara District
4.	Rurema Vanance	LC3 Chairman
5.	Tibalira Aisha	HA Mwizi Sub county
6.	Mukugu Geoffrey	LC1 Chairman
7.	Ddamulira Paul	Head WATSAN ACORD
8.	Kyomukama Dinavence	User
9.	Byaruhanga Richard	User
10.	Kasajja Stanley	User
11.	Nuwenshaba Frugyensi	User
12.	Taamarungi Victoria	User
13.	Ndagijimana Hamad	User
14.	Musinguzi Elias	HM Rwemiyaga P/S School
15.	Matsiko Cyprian	DHM Mwizi P/S

Rope Pump

Table 13 List of Interviewees for Romp pump

No	Name	Designation
1.	Mabtya Wilberforce	DWO
2.	Kitakufe George	DHI Iganga District
3.	Ssekamate Siraji	LC3 Chairman
4.	Tusiire Alfred Tibita	LC1 Chairman
5.	Wambuga M. W	Opinion Leader
6.	Madwa Edson	Technical

No	Name	Designation
		supervisor Busoga Trust
7.	Mugenyi Baisi Joseph	SCDO Busoga Trust
8.	Tigasitwa Patrick	User
9.	Zahara Aliyenza	User
10.	Naigaga Florence	User
11.	Isabirye John	User
12.	Walubo John	User
13.	Mugoya Peter	Student/user
14.	Mbasa Richard	Welfare Master Kigulu High School
15.	Maganda Ali	DOS Ibun Baz Girls school
16.	Mabtya Wilberforce	DWO

UGA Pump

Table 14 List of Interviewees for UGA pump

No	Name	Designation
1.	Galabu Isaac	County Water Officer -DWO Office
2.	Ruraro John	Sub County Chief
3.	Bogere Joseph	LC1 Chairman
4.	Kagwa Asumani	Technical Officer VAD
5.	Waswa Jonnie	Team Leader WATCOM Technologies
6.	Emmanuel SSenkungu	Pump Technician
7.	Makumbi Muhamood	Pump Technician
8.	Flugencio Mayungwe	User
9.	Yonasan Mbazira Miirenzo	User
10.	Cotilda Nalongo	User
11.	Edward Selwanga Magulu	User
12.	Kyambadde Fred	User.

Who is involved in WASHTech?

WASHTech is a consortium research project comprising national and international NGOs, academic institutes and training centres in Africa and Europe.

WASHTech in Africa is spearheaded by the following institutions:

In Burkina Faso:

- Water and Sanitation for Africa (WSA) (formerly known as CREPA), Burkina Faso
- WaterAid Burkina Faso

In Ghana:

- Training, Research and Networking for Development (TREND), Ghana
- Kwame Nkrumah University of Science and Technology (KNUST), Ghana
- WaterAid Ghana

In Uganda:

- Network for Water and Sanitation (NETWAS), Uganda
- WaterAid Uganda

European partners include:

- IRC International Water and Sanitation Centre (The Netherlands)
- Cranfield University (United Kingdom)
- Skat Foundation (Switzerland)
- WaterAid (United Kingdom)

WASHTech is coordinated by IRC International Water and Sanitation Centre in The Hague

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