Low Cost Technology Options for Sanitation in India as per the Demand of the Local Surrounding

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INTRODUCTION

"**Civilization is the distance that man has placed between himself and his own excreta**." Brian W. Aldiss

Sanitation is the hygienic means of promoting health through prevention of human contact with waste. The impact of waste can be physical, microbiological, biological or chemical agents of disease.

Lack of clean drinking water and improved sanitation facilities are the major causes for a high incidence of waterborne diseases and a serious cause for environmental pollution in India. According to United Nations Human Development Report: “Every 20 seconds, a child dies from a water related disease.”

The worst sanitation facilities usually exist in areas inhabited by the poor.
Construction of a toilet is generally regarded as the householder's responsibility but investments in sanitation by the poor households are often constrained by various issues including affordability and uncertainty over land tenure. Having a proper sanitation facility leads to a hygienic living conditions, which is a fundamental right of people of India under Article 21 of the Indian Constitution which provides protection of life and personal liberty to each and every person in India.

But only subsidies and awareness campaigns cannot alone unravel the problem, we need cost-effective technology options along with a proper operations and maintenance plans, which suits the local context of the poorest sections of the community.

Traditionally public policy on basic urban services in India has focused on water supply, which has enjoyed primacy in investments while sanitation has lagged behind. Even today, almost one-fourth of the urban populations in India do not have access to safe and adequate sanitation facilities. Inadequate access to sanitation especially in high density urban slum settlements is one of the key impediments to improving the quality of life and productivity of urban centers. In the absence of quick and effective remedial measures, we also run the risk of rapidly increasing vulnerability to diseases caused by such conditions.

While urban India has invested significantly in sanitation infrastructure, this has essentially been focused on a conventional sanitation system, like community or public toilets for economically backward classes. These efforts have failed to provide a safe sanitary environment in urban India and also did not succeed in removing the problem of open defecation completely, as they typically lacked the comprehensiveness to address the full

dimension of the sanitation challenge existing in the country. In particular, these efforts have failed in terms of targeting the sanitation needs of all sections of urban society and understanding the triggering behavior and demand of the local community. Also, there is lack of proper communication on the part of various stakeholders in generating demand and consensus on the preferred technological options. Thus, it is imperative that future efforts should consider a range of technical options that are comprehensive and inclusive enough to cover all geographical locations and all sections of society.

Capacity building in this regard through documentation of appropriate sanitation technology options and their techno-economic implications, along with active participation by Government, non-profitable organizations and private players, is a key need of the hour.

Keeping this is view; I have decided to focus my research question on: "**Whether sanitation can emerge as a profitable opportunity for local entrepreneurs with the available low cost technological options.**" I hope my research notes aid the decision makers, urban local bodies, local entrepreneurs and the non-governmental organizations in understanding a holistic sanitation plan that could lead to sustainable sanitation in urban India.

DEFINING SANITATION

The World Health Organization defines Sanitation as:

"Sanitation generally refers to the provision of facilities and services for the safe disposal of human urine and feces. Inadequate sanitation is a major cause of disease world-wide and improving sanitation is known to have a significant beneficial impact on health both in households and across communities. The word 'sanitation' also refers to the maintenance of hygienic conditions, through services such as garbage collection and wastewater disposal.

Thus, it is important to understand that this involves service delivery, not just the installation of infrastructure; both service providers and users need to act in defined ways. This means that the success of sanitation investments cannot be measured only in terms of physical outputs such as the number of toilets built or kilometers of sewer laid. Instead, the focus of attention should be on outcomes, primarily the use and maintenance of those facilities.

Challenges of Urban Sanitation:[1]

Broadly speaking, the challenges fall into four categories:

- Low infrastructure
- Limited Access to Services
- Low service usage
- Weak institutional arrangements.

Low Infrastructure Coverage

Due to certain constraints like affordability, lack of space, uncertainty over land tenure and lack of knowledge of hygiene or low priority given to sanitation by poor people in urban slums, the sanitation infrastructure is underdeveloped. This has led the great majority of urban residents to being dependent on unhygienic sanitation facilities. It even leads to the shameful act of open defecation, creating privacy, security and health issues for the people in urban slums.[2]

Limited Access to Services

The existing sanitation arrangements can be described as deficient in a number of ways:

- There is often a complete lack of facilities. For example, there may be settlements with no toilets at all.

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[1] A.K. Mehta "Urban sanitation," December 22, 2012. http://www.urbanindia.nic.in/programme/uwss/slb/urban_sanitation.pdf.
[2]Wikipedia: The Free Encyclopedia. "Sewage treatment." http://en.wikipedia.org/wiki/Sewage treatment . [Accessed: December 20, 2012]
Wikipedia: The Free Encyclopedia. "Sanitation." http://en.wikipedia.org/wiki/Sanitation. [Accessed December 20, 2012].

17. "Thally Sanitation," January 6,2013. http://www.gramalaya.in/thally_sanitation.php.[Accessed January 6, 2013]

"Urban Sanitation," January 6, 2013. http://www.gramalaya.in/urban_sanitation.php. [Accessed January 6, 2013].

Wikipedia: The Free Encyclopedia. "Water Supply and sanitation in India,"

http://en.wikipedia.org/wiki/Water_supply_and_sanitation_in_India [Accessed: January 7, 2012].

■ Sanitation facilities may be available but are at times inconvenient, unpleasant or unhygienic. This may be the result of inappropriate design or construction, or inadequate management arrangements or due to lack of proper communication about its operation and maintenance.

■ People's access to available sanitation facilities might be limited. For example, people may not be able to afford to use an existing public toilet due to high usage charge.

■ Improper operation of sanitation facilities can also constitute a problem. Poor operation and maintenance of a facility shortens its useful life ` and could, at worst, result in rapid total failure.

■ There may be no provision for the treatment of wastewater or excreta. Local drains and sewers may simply relocate waste to another part of town where it causes local pollution.

Low Service Usage

Due to lack of effective communication in sanitation programs, community awareness, preferences and behavior are not properly understood. So there is either misuse or underuse of the toilets, with family members defecating outside most of the time or not using and maintaining the facilities properly. For an instance, in case of twin pit toilets ,some people fear that the pits will fill rapidly if the toilet is used too often; and they may not know that the contents of a full pit can safely be removed once they have been given time to degrade.

Weak Institutional Arrangements:

There are some inherent weaknesses in the part of decision makers which have led to failure of the existing sanitation system:

■ The investments are made on an ad hoc basis when funds become available, without reference to an overarching strategy or plan.

■ Within the state government and municipalities, sanitation has no 'institutional home', meaning that no single department or agency is accountable for it. Responsibilities for different aspects of sanitation are often assigned to a number of agencies, and coordination between them is not always good. There have been cases, for example, where a state agency has developed a sewage treatment plant even when there are no sewers in the town, then handed it over to a municipality that does not have the technical capacity or financial resources to operate and maintain it.

■ Large capital investments are rarely matched with detailed arrangements—both practical and financial—for future operation and maintenance.

■ Improvements are often implemented on a norms basis, meaning that technologies are selected without reference to local conditions or to the preferences of users. Therefore, the

new facilities may not function properly, or may not be used as intended.

- Especially in smaller towns, municipal and line agency staff tend to have limited technical expertise or awareness of the range of nontechnical factors that affect the outcome of sanitation investments.[3]

Legislation and Standards for Urban Sanitation

While there are no specific legal provisions relating to urban sanitation, there are a number of provisions relating to sanitation services.

74th Constitutional Amendment Act, 1992

Responsibility for the planning and delivery of urban services, including sanitation, lies with urban local bodies under local municipal laws and the 74th Constitutional Amendment Act, 1992. The 12th Schedule of the Act sets out a list of critical issues for the urban local bodies including, amongst other things:

- Urban planning;
- Regulation of land-use and construction of buildings;
- Water supply for domestic, industrial, and commercial purposes;
- Public health, sanitation, conservancy, and solid waste management;
- Protection of the environment and promotion of ecological aspects; and
- Slum improvement and upgrading.

Municipal Bylaws

These enable local bodies to discharge their functions and typically include, for example, a requirement for property owners to discharge wastewater without causing nuisance; and an obligation to discharge wastewater into sewers where available. There are, however, no specific provisions for the safe removal, cartage, and disposal of sewage in urban areas.

The Environment (Protection) Act, 1986

This Act applies in principle to every establishment, agency, or individual discharging any pollutant into the environment. 'Pollutant' includes treated or untreated sewage. In principle, municipalities are required to comply with discharge norms for effluent released from sewage treatment plants and to pay water cess under the Water Cess Act, 1977.

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[3]A.K.Mehta "Urban sanitation," December 22, 2012. http://www.urbanindia.nic.in/programme/uwss/slb/urban_sanitation.pdf.

Technical Norms for Best Practice in On-Site Sanitation and Wastewater Management

The Manual on Sewerage and Sewage Treatment of the Central Public Health and Environmental Engineering Organization, Ministry of Urban Development (MoUD), sets out technical norms for best practice in on-site sanitation and wastewater management.

The manual covers planning, design, and construction aspects for a wide range of technical options; it also includes operation and maintenance aspects and safeguards to prevent water pollution under different soil and groundwater conditions. The norms set out in the manual are not mandatory but provide guidance for engineers. The manual also makes reference to relevant Indian Standards and Codes of Practice notified by the Bureau of Indian Standards.

The most relevant include the following:

■ IS 1172:1993 – Basic requirements for water supply, drainage, and sanitation.
■ IS 12314:1987 – Code of Practice for sanitation with leach pits for rural communities.
■ IS 2470 (Part 1):1985 – Code of Practice for installation of septic tank: design criteria and construction.
■ IS 2470 (Part 2):1985 – Code of Practice for installation of septic tank: secondary treatment and disposal of septic tank effluent.
■ IS 9872:1981 – Precast concrete septic tanks.
■ IS 5611:1987 – Code of Practice for waste stabilization ponds (facultative type).
■ IS 10261:1982 – Requirements for settling tanks (clarifier equipment) for wastewater treatment.
■ IS 13496:1992 – General requirements for suction machines for cleaning sewers, manholes and so on.

In addition, the MoUD prepared a document entitled 'Technical Guidelines on Twin-Pit Pour-Flush Latrines' in 1992, which broadly follows the lines of IS 12314:1987 on leach pit construction in rural areas. All Indian Standards' codes represent a standard of good practice and therefore take the form of recommendations. They are not mandatory unless made so under contract conditions and some are routinely ignored, for example the recommendation for the construction of soak ways, dispersion trenches, and biological filters to deal with the outflow from septic tanks; and for the cleaning of septic tanks using specified equipment.

UNDERSTANDING SANITATION TECHNOLOGIES[4]

Wet and Dry Sanitation

All sanitation technologies can be described as being either 'wet' or 'dry':
Wet technologies require water to flush feces. Most urban sanitation in India is 'wet', involving some form of flush toilet connected to a leach pit, septic tank or sewer.

Dry technologies do not use water for flushing. They include a range of different types of traditional pit latrines, ventilated improved pits, as well as contemporary designs that promote the safe reuse of excreta.

Pit latrines are rarely used in India, though in recent years some small-scale initiatives have promoted ecological sanitation (known as ECOSAN), a form of dry sanitation that involves the separation of feces and urine at source and the reuse of treated excreta. In principle, ECOSAN has some important advantages including:

(a) Reduced water demand for flushing;
(b) Reduced wastewater management problems (no black water production); and
(c) Improved nutrient recycling, particularly the nutrients in urine.

However, the traditional practice of using water for ablution and the availability of water to the majority of households in Indian cities, mean that flush toilets are likely to remain the preferred option for most households.[5]
On-Site, Off-Site Systems and Hybrid Systems:

Sanitation systems may be:
- On-site, retaining wastes in the vicinity of the toilet in a pit, tank or vault.
- Off-site, removing wastes from the vicinity of the toilet for disposal elsewhere.
- Hybrid, retaining solids close to the latrine but removing liquids for off-site disposal elsewhere.

In urban areas, even nominally on-site systems will normally require periodic removal of the fecal sludge . As a result, no urban sanitation system is completely self-contained. To achieve total sanitation in a town, consideration must be given to the way in which household services are linked with higher level transport and disposal facilities.

On-site systems may be either wet or dry. If properly designed and managed, both wet and dry on-site systems can provide a service that is as hygienic and convenient as sewerage. Indeed, if water use is low, on-site sanitation may provide a better service than a poorly functioning sewerage system.

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[4] A.K.Mehta "Urban sanitation," December 22, 2012. http://www.urbanindia.nic.in/programme/uwss/slb/urban_sanitation.pdf.

[5] "Arghyam: Safe, sustainable water for all," December 24,2012. http://arghyam.org. [Accessed December 24, 2012].
"Community ecosan 2008," December 28, 2012. http://indiasanitationportal.org/sites/default/files/community-ecosan-2008-web.pdf. [Accessed December 28, 2012].

Dry (ECOSAN) Systems

All the dry or ecological toilets (ECOSAN) systems that are likely to be feasible in Indian conditions will also be on-site. The advantage of this system is that fecal material is stored for a period of about 12 months before it is removed, giving time for natural processes to break down the material and destroy pathogens and parasites. Urine is separated and should ideally be stored and used as a fertilizer. Ablution is carried out away from the latrine hole to ensure that the vault contents remain dry. In order to prevent smells and nuisance caused by flies, fine ash is kept in a container in the latrine superstructure and sprinkled over the contents of the vault every time the latrine is used. ECOSAN has yet to be implemented on anything other than a pilot scale in India. It is too early to say whether it will prove to be acceptable to users and technically viable, though compost toilets are prevalent in the mountainous regions of India. However, two observations can be made:

- ECOSAN demands more from users (in terms of behavior) than other forms of on-site sanitation.
- There are many things that can go wrong, especially in separating feces and urine.

Therefore, before deciding to use ECOSAN, it would be important to ensure that the intended users understood and accepted what was expected of them; also that potential problems had been identified and systems put into place to deal with them.

Wet on-site systems incorporate some form of water-flushed toilet from which feces and flush water are discharged into a pit or tank. The toilet is normally a pour flush pan. In some designs, the pit or tank is located directly under the toilet, but the normal arrangement is to provide a short length of pipe to connect the toilet to one or more offset pits or tanks. Having the pit(s) or tank offset makes it easier to dislodge them.

Three basic categories of wet on-site system:

1. Pour flush toilet to single leach pit.
2. Pour flush toilet via division chamber to twin leach pits [the model used in integrated low cost sanitation (ILCS)].
3. Pour flush or cistern flush toilet to septic tank.

Of these, the single leach pit option requires the least space, but the [6]contents—including fresh feces—must be removed at intervals, creating the need for a hygienic pit emptying system. Similar systems will be required for septic tanks. The twin-pit system is designed so that (as with double vault dry systems) the pit contents are stored for a minimum period before they are removed, during which time the waste decomposes and pathogens die off. This means that treated wastes can be disposed of or reused without the health risks associated with handling undigested excreta. The main drawback with this system is that it

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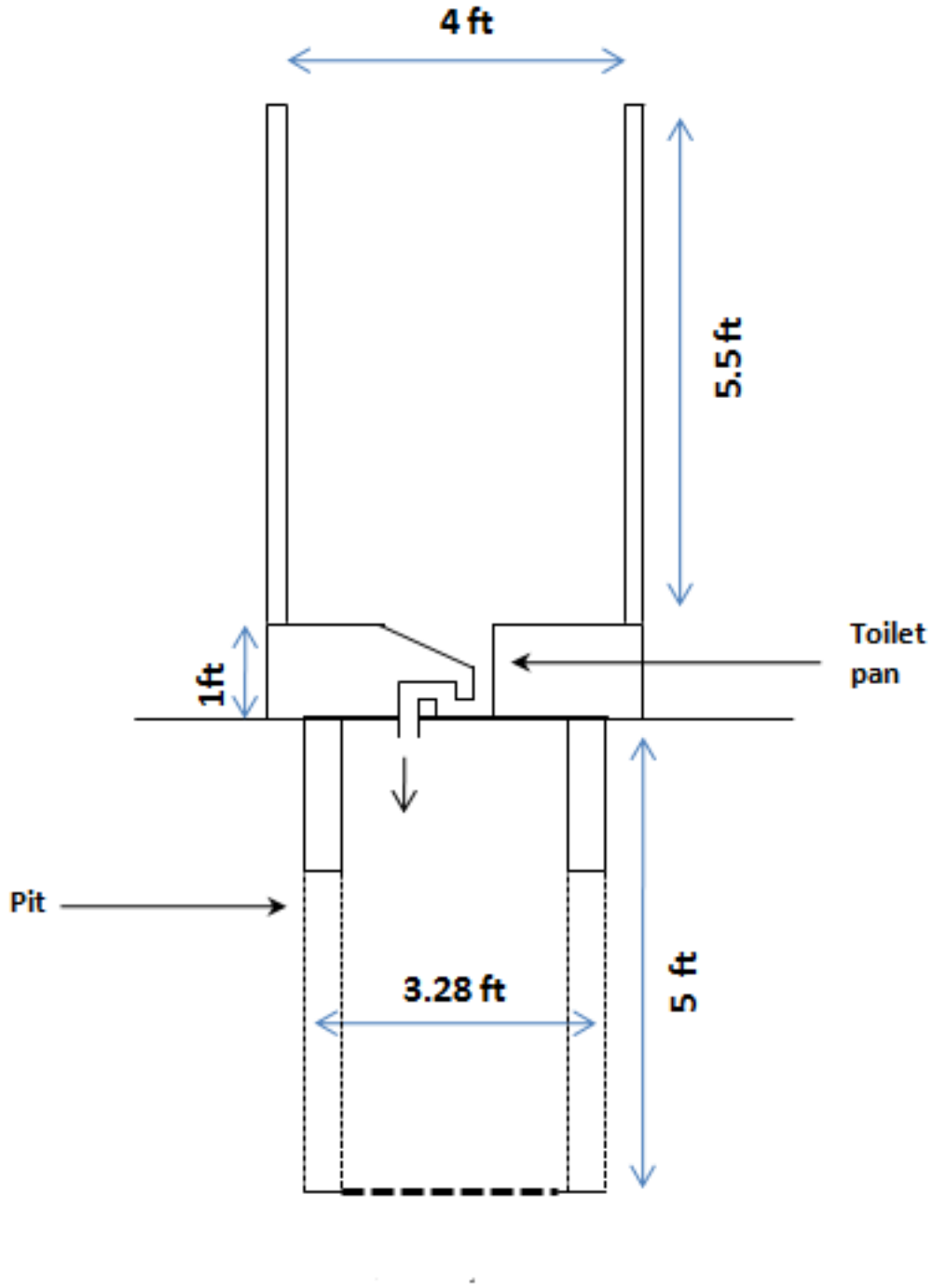
6 "Consortium for Dewats Dissemination Society," January 3, 2013. http://cddindia.org/community-based-sanitation-cbs. [Accessed January 3, 2012].
"Eco Toilets," January 3, 2013. http://www.gramalaya.in/eco_toilets.php. [Accessed January 3, 2013].

will not work properly if users do not understand, or are not interested in, the way in which the system should function. Septic tanks consist of a chamber or series of chambers into which wastewater is discharged and contained. Sediment and solids settle to the bottom of the tank and organic wastes are decomposed by the action of bacteria. The effluent from septic tanks may contain pathogens and should be discharged into a soak away (or drain field). In practice many septic tanks in India discharge effluent to the nearest open drain. Where drain fields do exist, they may not function effectively due to poor design and lack of maintenance. Where ground conditions do not permit infiltration of treated wastewater, additional treatment in the form of a constructed wetland or anaerobic filter could be provided prior to discharge into a drain or watercourse. This option should only be considered if management systems for the treatment facilities can be guaranteed, a condition that very often cannot be met. Where ground conditions do not permit infiltration of treated wastewater, additional treatment in the form of a constructed wetland or anaerobic filter could be provided prior to discharge into a drain or watercourse. This option should only be considered if management systems for the treatment facilities can be guaranteed, a condition that very often cannot be met.

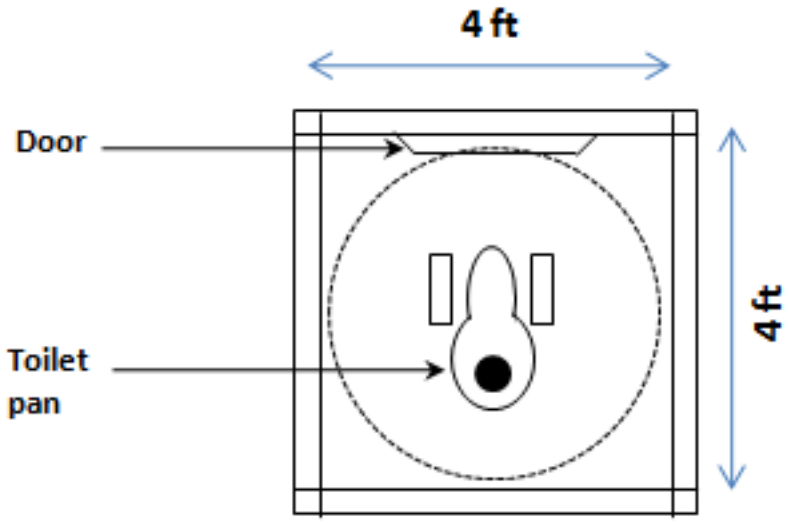
All off-site and hybrid systems incorporate cistern or pour flush toilets connected to sewers. In the case of hybrid systems the toilets are connected via interceptor tanks. Black water and salvage are normally combined on-plot and discharged to the sewer through a single household connection. In nearly all cases, sewage treatment is required before it can be safely discharged to the environment or used for irrigation or aquaculture. Sewerage, the collective name for a system of sewers, consists of a network of buried pipes that convey wastewater from a house to the point of disposal. Sewerage relies upon a sufficient quantity of wastewater flow to convey solids along the pipe to a discharge point.

Common technology options for sanitation[7]

1. Plinth level toilet with temporary superstructure:



[7] "Appropriate Low cost toilet technology." January 4, 2013. http://www.gramalaya.in/pdf/appropriateLowcost_toilet_technology.pdf. [Accessed January 4,2013].

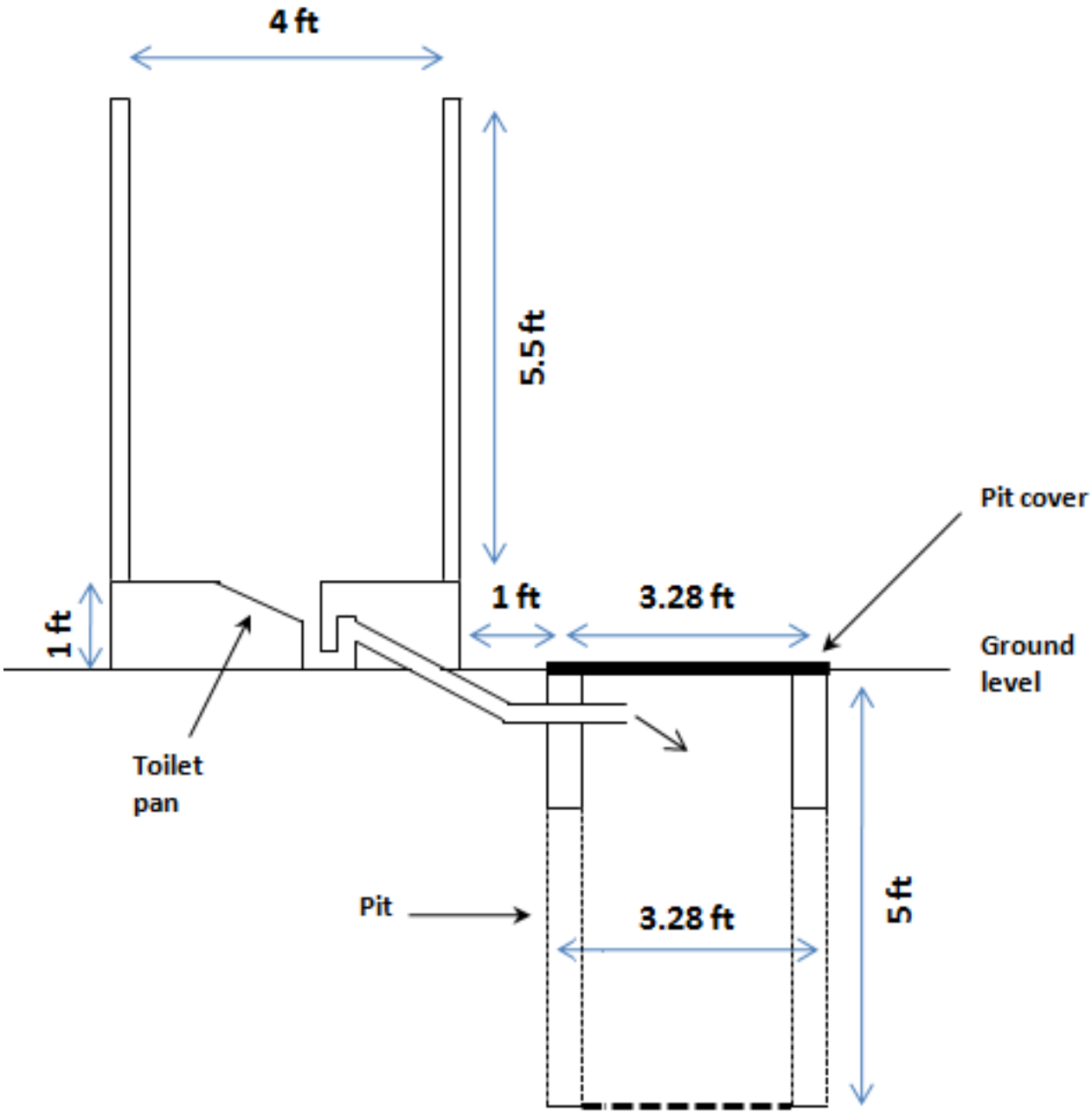


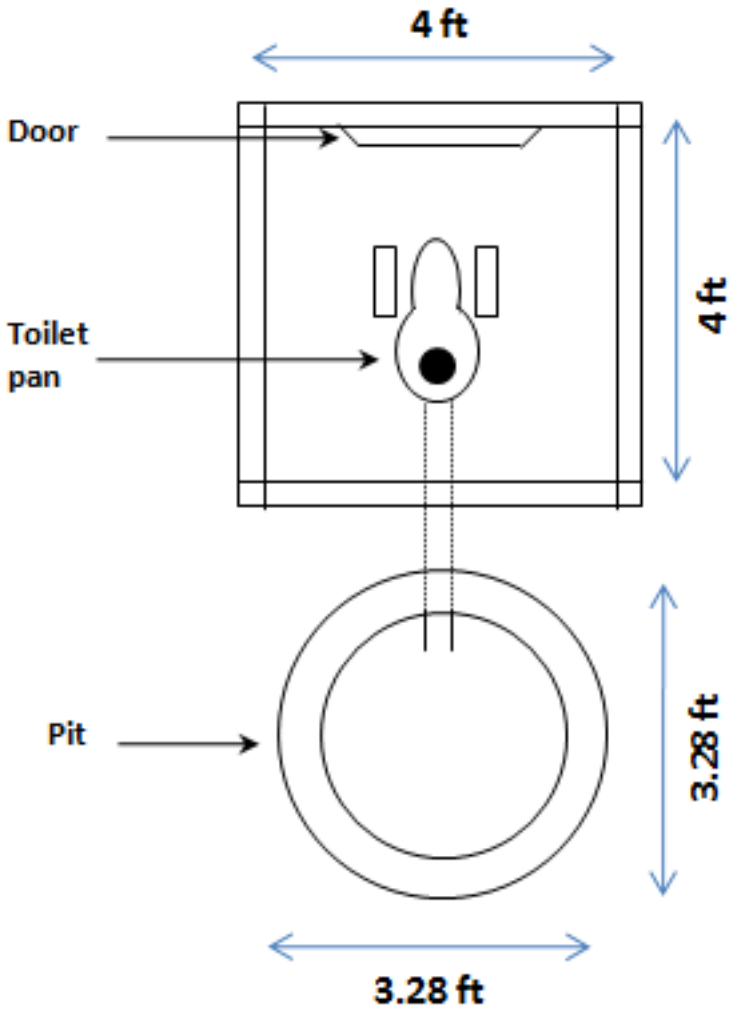
Salient features:

1. Appropriate where space is limited
2. Easier to empty when pit fills
3. Low cost
4. Superstructure made from locally available materials such as banana Leaves, bamboo sticks and gunny bags
5. It is appropriate for festival places and during emergencies
6. It is constructed in one day
7. The plinth level basement may be circle or square shape

Approximate cost = Rs.1515.

2. Toilet only model with superstructure using hollow bricks:



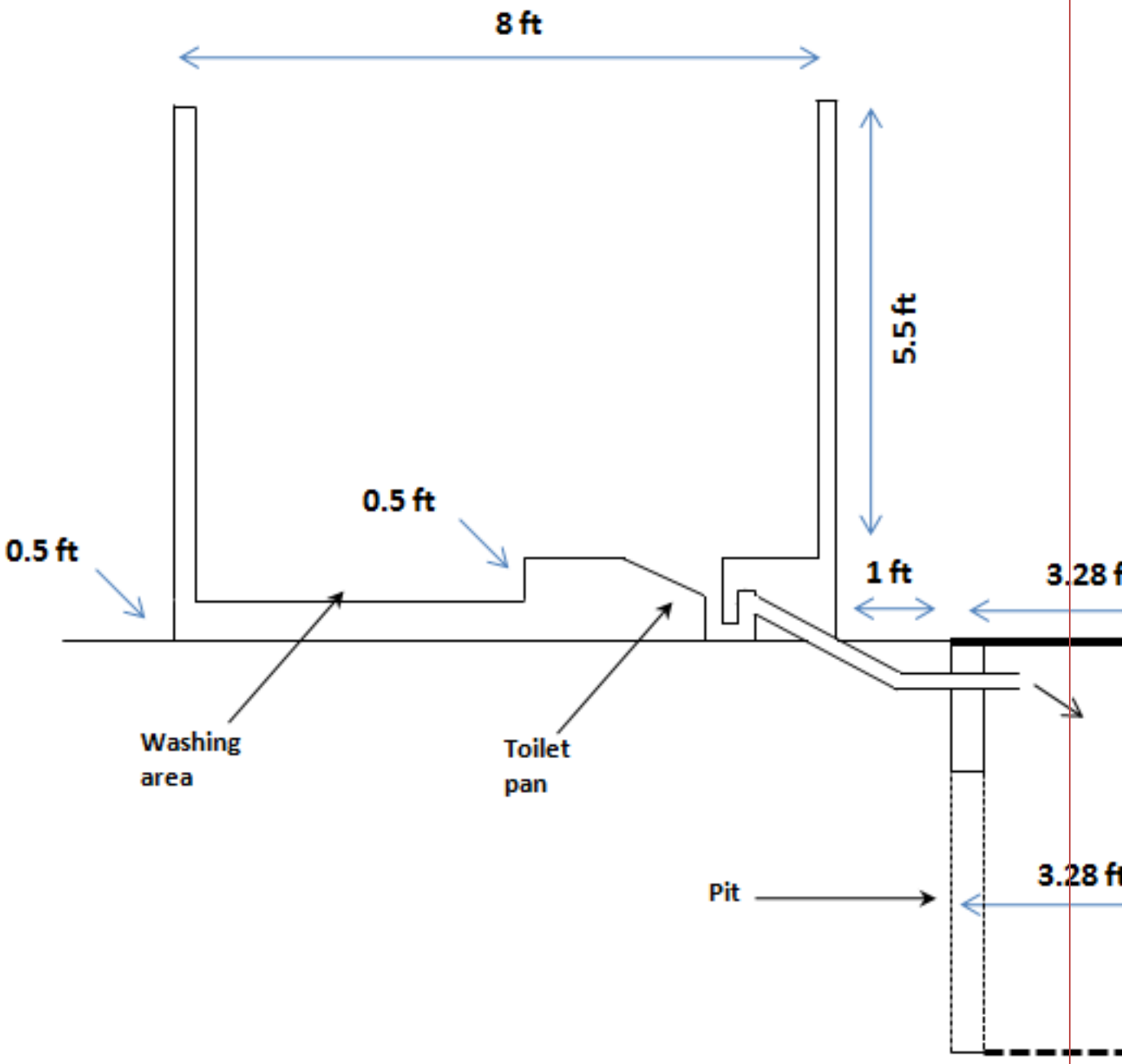


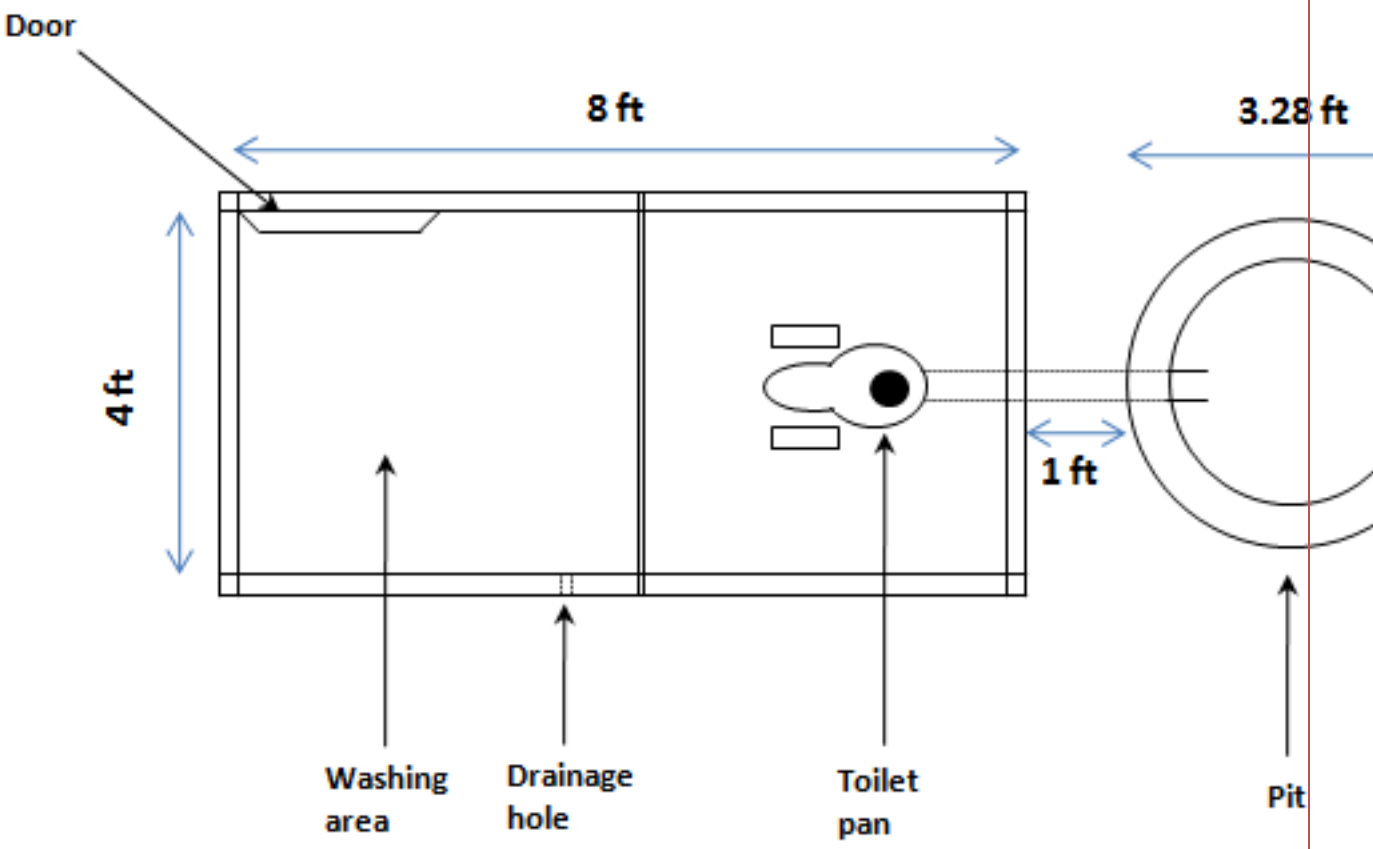
Salient features:

1. It is a suitable model for all
2. Low cost
3. Appropriate where space is limited

Approximate cost = Rs. 5500

3. Toilet attached bathroom using hollow bricks without roof



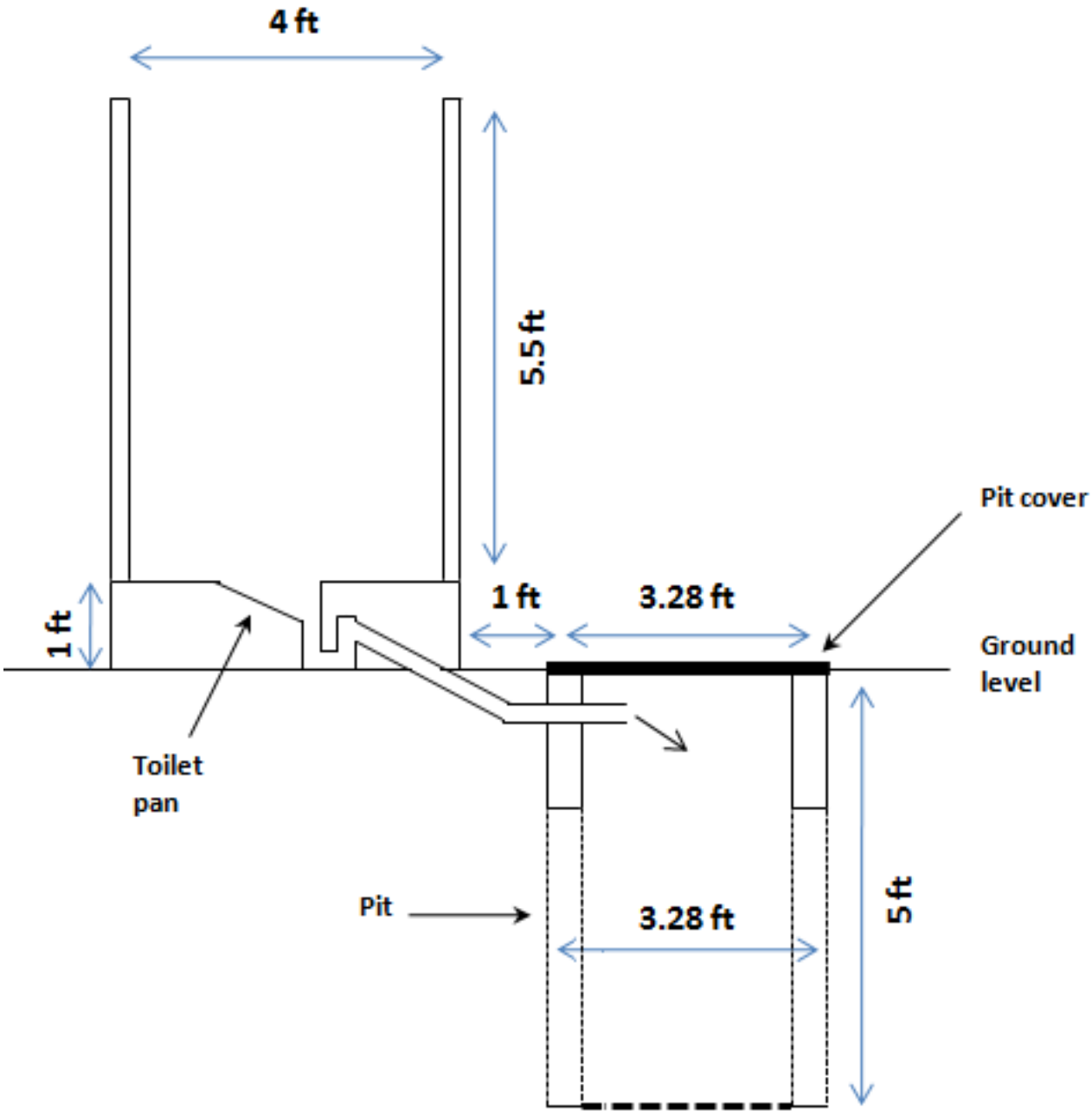


Salient features:

1. Provides privacy for ablution, especially important for women and adolescent girls
2. Provides water storage, bathing and washing facilities inside the toilet
3. Promotes kitchen garden from bathroom waste water
4. Multifunctional structure

Approximate cost = Rs.7257

4. Toilet only model with superstructure using bricks with roof (Concrete rings pit)



Salient features

1. Low cost
2. Appropriate where space is limited
3. Provides privacy
4. Roof provides cover during rainy season

Approximate cost = Rs.6857

5. Single pit – Pour flush latrine

Salient features:

1. Simple and relatively inexpensive form of on-site sanitation that have widespread application in urban areas but are dependent upon the provision of an affordable and hygienic fecal sludge collection and treatment service.

2. Leach pits are appropriate when water use is at least 25 liters per capita per day. However, they may be used to deal with all household wastewater when per capita water use does not exceed about 50 liters per day, depending upon soil characteristics and groundwater level. If wastewater production is higher, leach pits may still be used for disposal of black water with off-site disposal of grey water via a drainage or sewerage system.

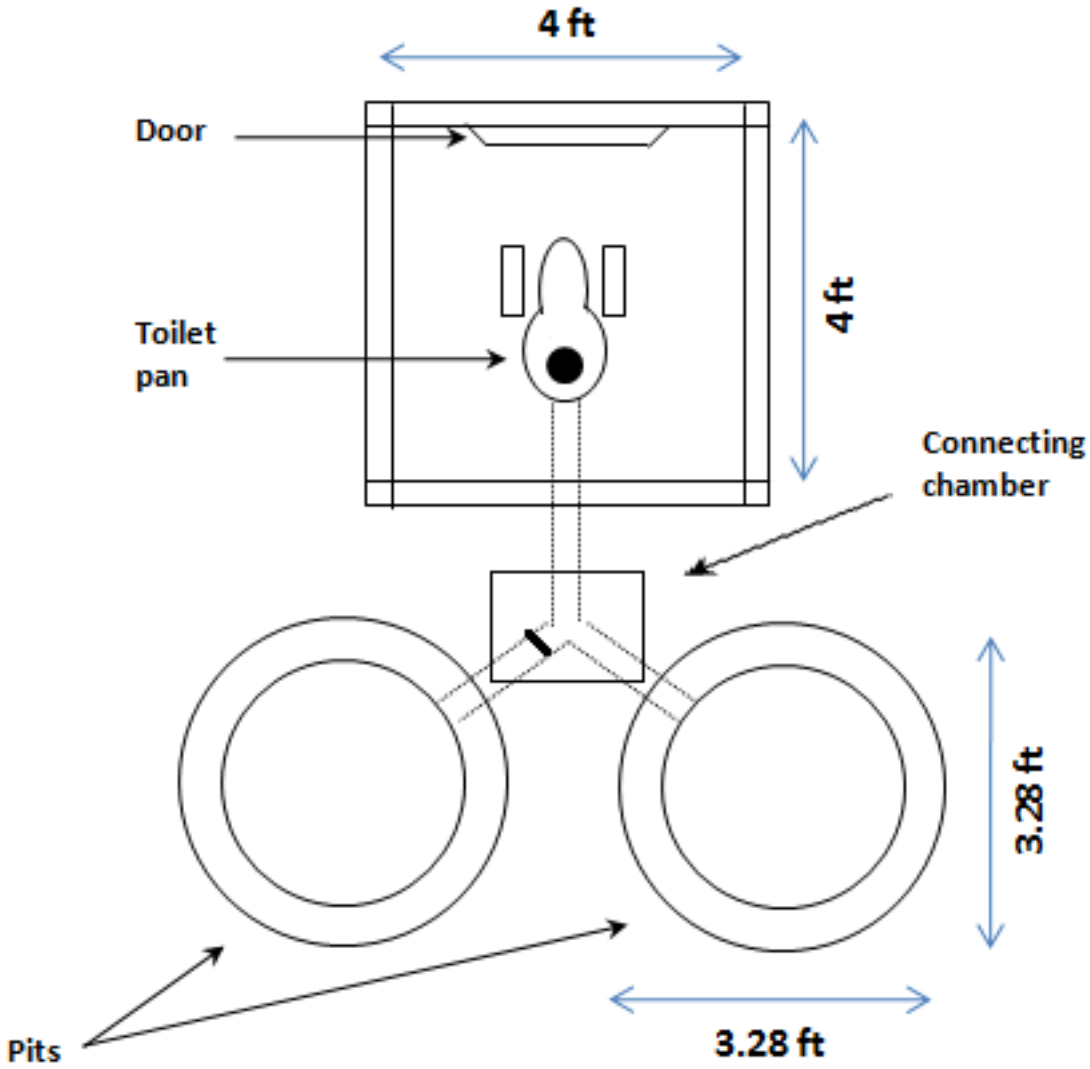
3. Impermeable soils such as clay or rock preclude the use of leach pits. A high water table may also reduce the capacity of the soil to infiltrate wastewater. In these situations, the pits and latrine superstructure should be raised and a layer of sand provided around the pits to promote infiltration of wastewater.

4. Care should be taken when using leach pits in situations where groundwater is used for water supply. A minimum distance of 10 meters should be allowed between a leach pit and a shallow well.

5.Once the pit is full, it must be desludged. The methods used should prevent operators or cleaners from coming into contact with fecal material. The undigested and unstabilized sludge must be treated and disposed of safely.

Approximate cost = Rs. 3500

6. Twin pit – Pour flush latrine



Salient features:

1. When the first pit gets filled up, the flow of excreta has to be diverted to the second pit
2. Two leach pits are connected to one single pour-flush toilet
3. Twin-pit toilets have a high convenience
4. When emptying one pit, people use the another pit
5. This technology has been widely used in the Government of India's Integrated Low Cost Sanitation Scheme (ILCS).
6. It is applicable where:

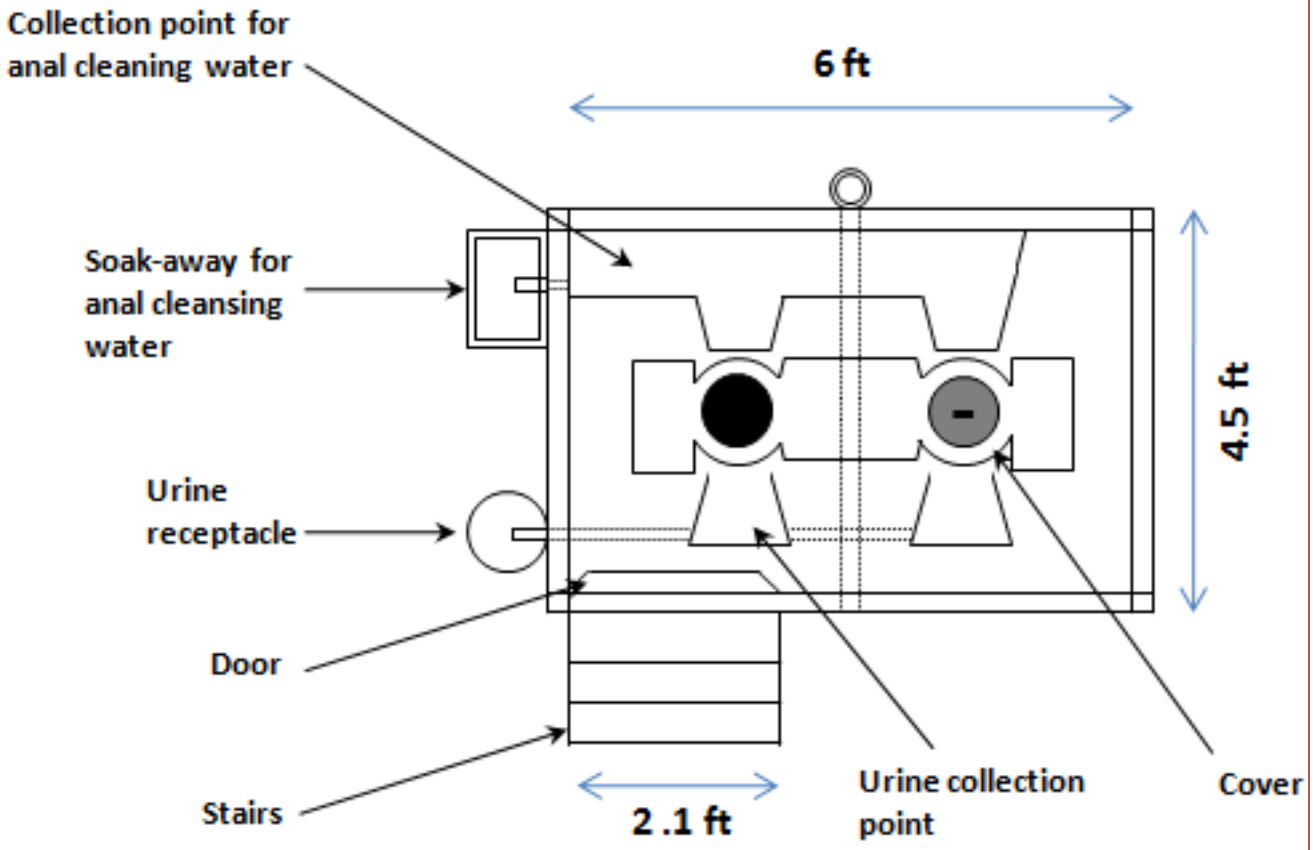
(i) Water use is in the range 30–50 liters per capita per day depending upon the characteristics of the soil or groundwater level.

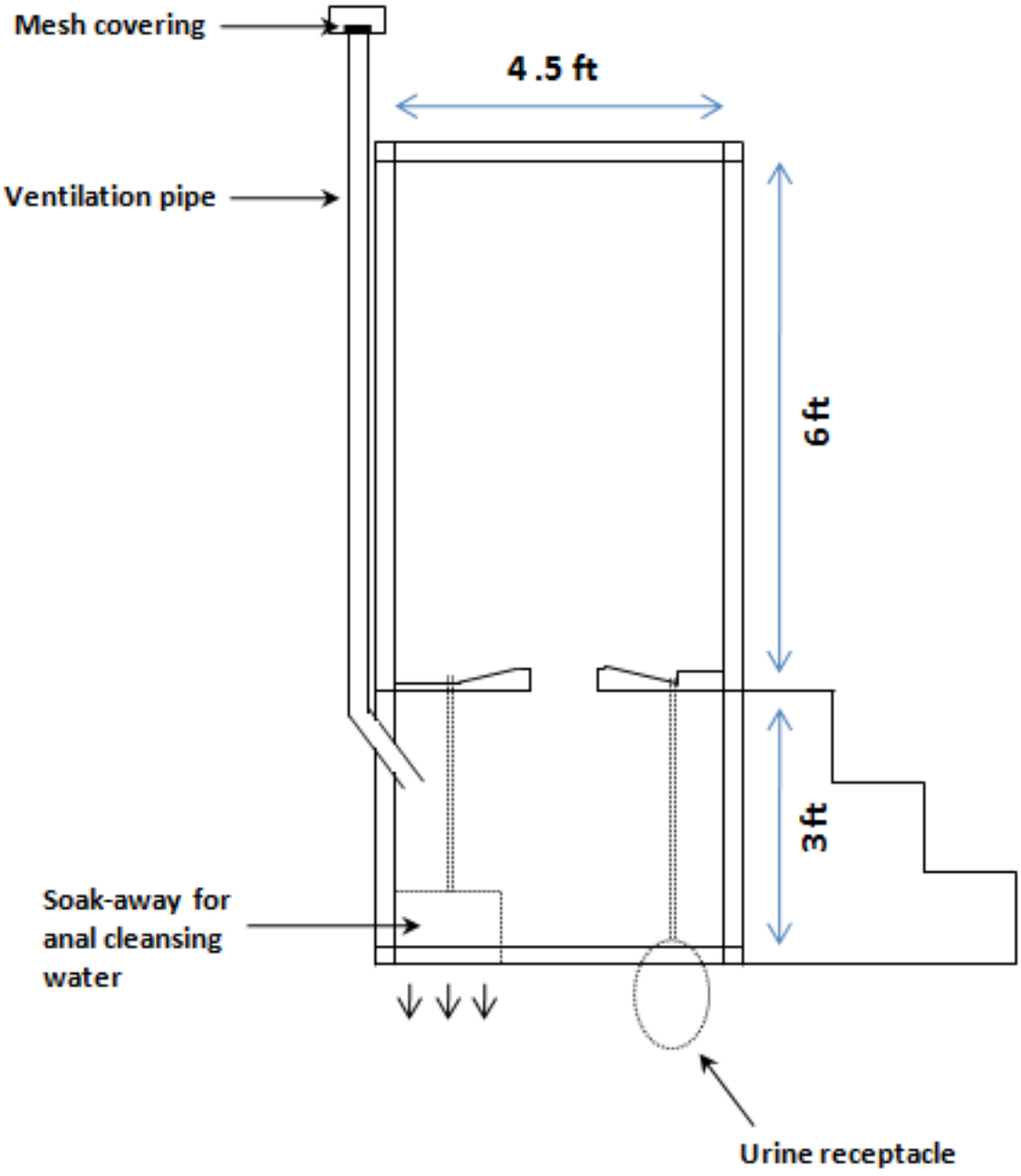
(ii) The depth to the water table is 3 meters or more, allowing a clear 2-meter vertical distance between the bottom of the pit and the water table.

7. Constraints for single leach pits relating to impermeable soils and the proximity of wells and tube wells also apply to double leach pits.
8. The pits must be used alternately and the diversion chamber must be accessible so that flow can be diverted between chambers.
9. Wastewater should never be diverted back to the first chamber before digested sludge has been removed from it.

Approximate cost = Rs. 7257

7. ECO-SAN toilets



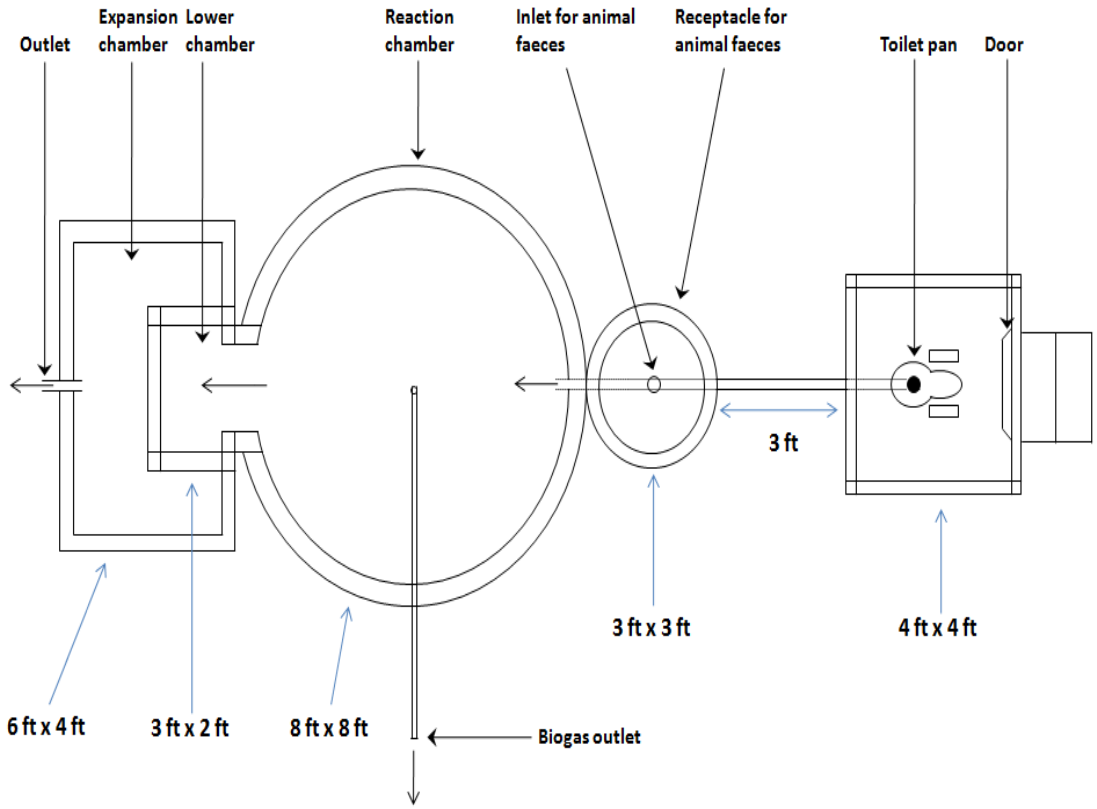


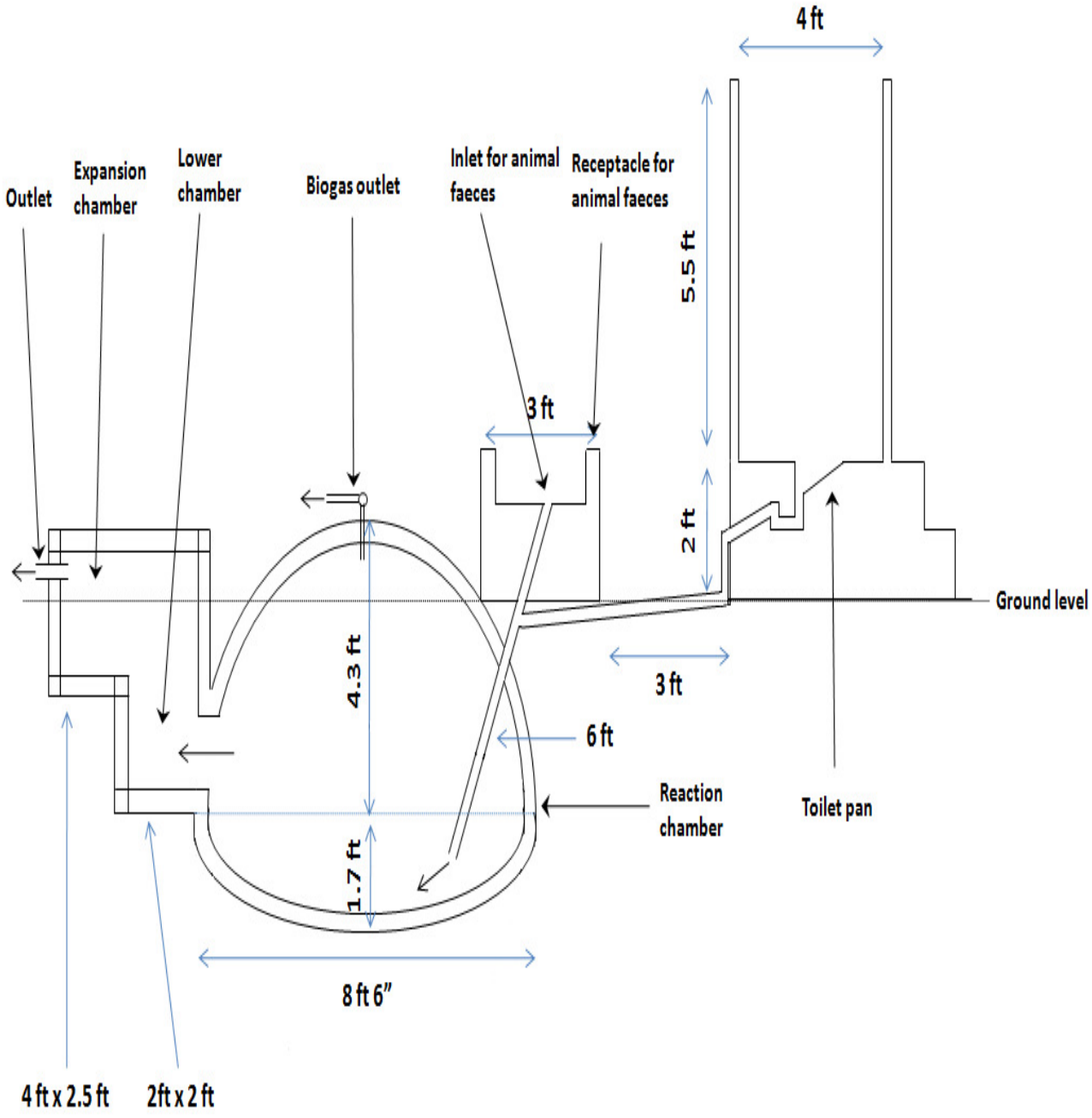
Salient features:

1. Avoids contamination of water sources and soil
2. Composting of human waste for use as a natural fertilizer
3. There is no need of emptying the pits
4. It is applicable for water logged, water scarce, coastal and rocky areas
5. Promotes soil fertility and improved crop production.

Approximate cost = Rs. 10747

8. Bio-gas linked toilets



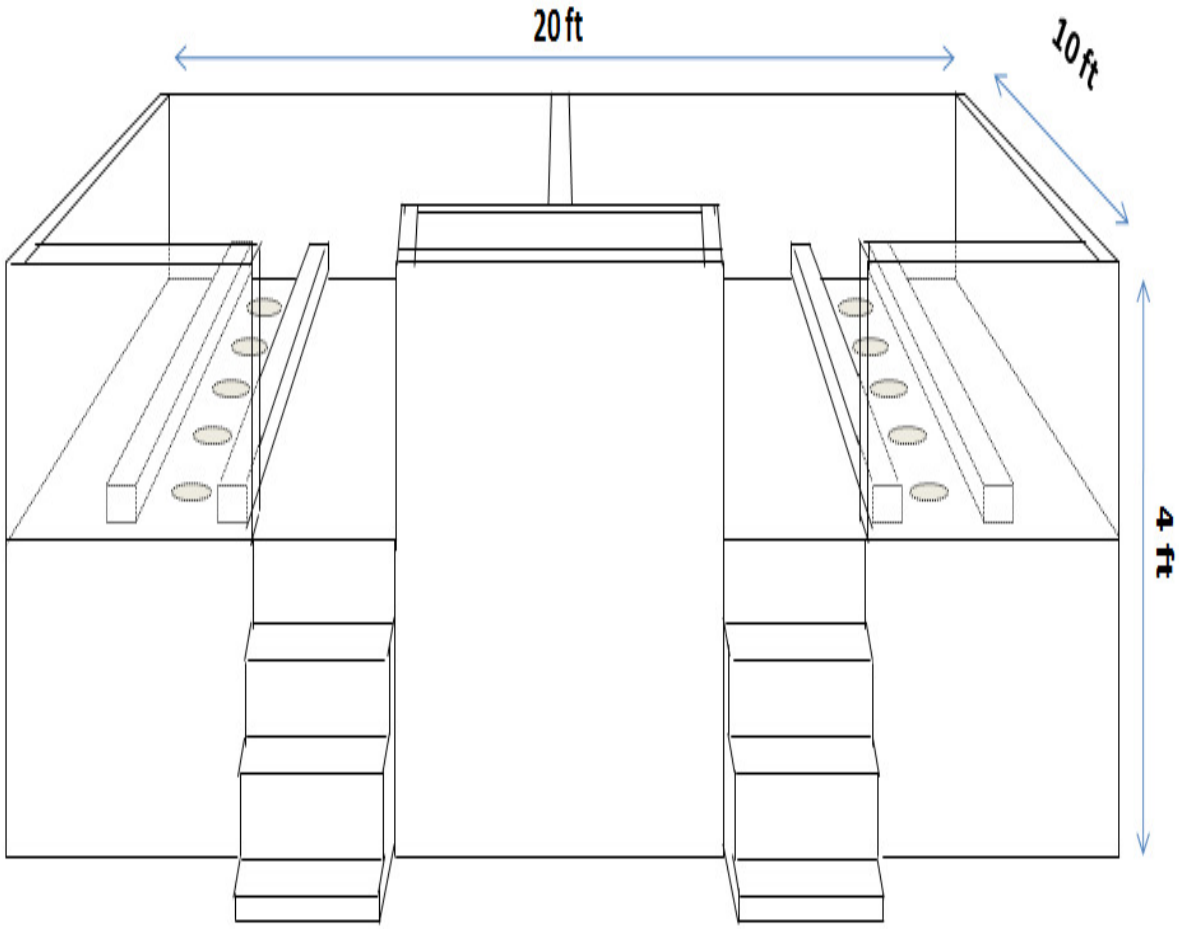


Salient features:

1. Bio-gas is a promising non-conventional energy that converts waste matter
2. Eco-friendly
3. Cost effective
4. Provides a fuel for electricity, heat and light.
5. Bio-manure increases productivity and soil conservation

Approximate cost = Rs. 21167

8. Child friendly toilets - Model – I

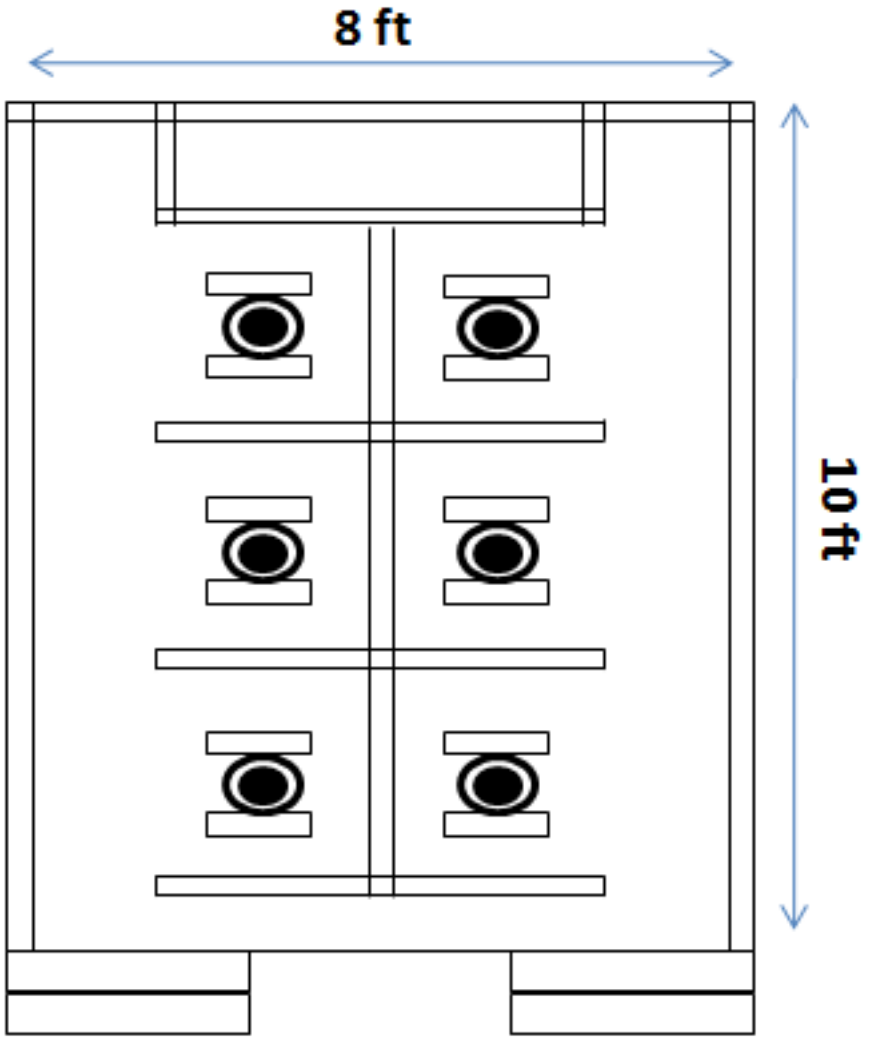


Salient features:

1. Privacy for children
2. Beautiful caricatures of pets and animals on the wall
3. Partition for boys and girls
4. No fear among the children to use the toilet
5. Anal cleaning and hand washing facilities are inside the toilet
6. As the CFTs are constructed adjacent to the community toilets, maintenance is easier
7. Promoting proper hygiene behavior from childhood.

Approximate cost = Rs. 29720

9. Child friendly toilets – Model - 2



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3. Partition for boys and girls
4. No fear among the children to use the toilet
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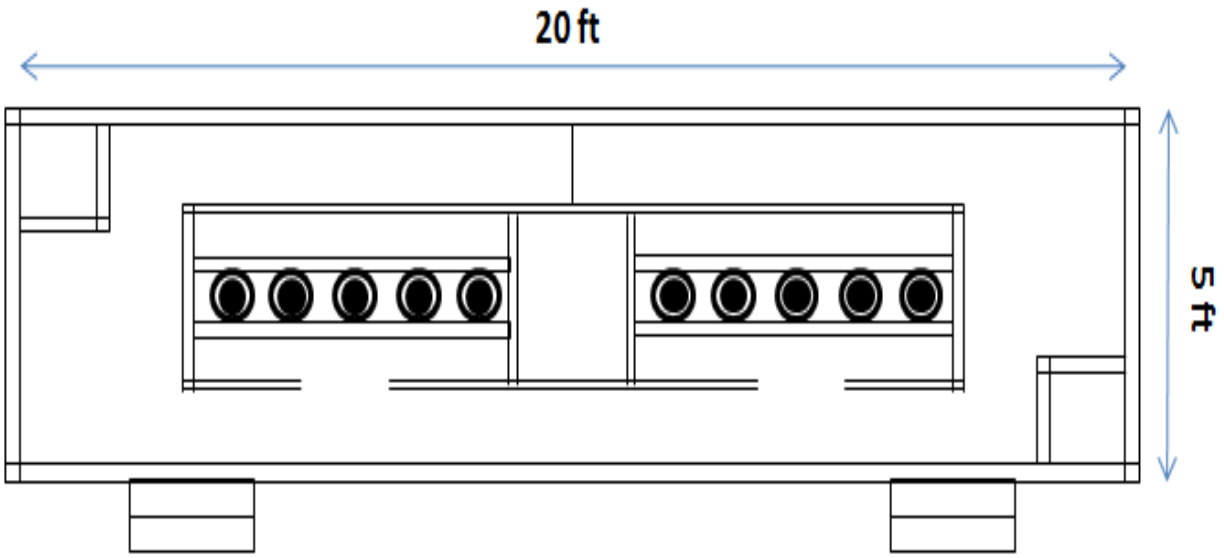
6. As the CFTs are constructed adjacent to the community toilets, maintenance is easier

Approximate cost = Rs.18160

10. Child friendly toilets – Model - 3



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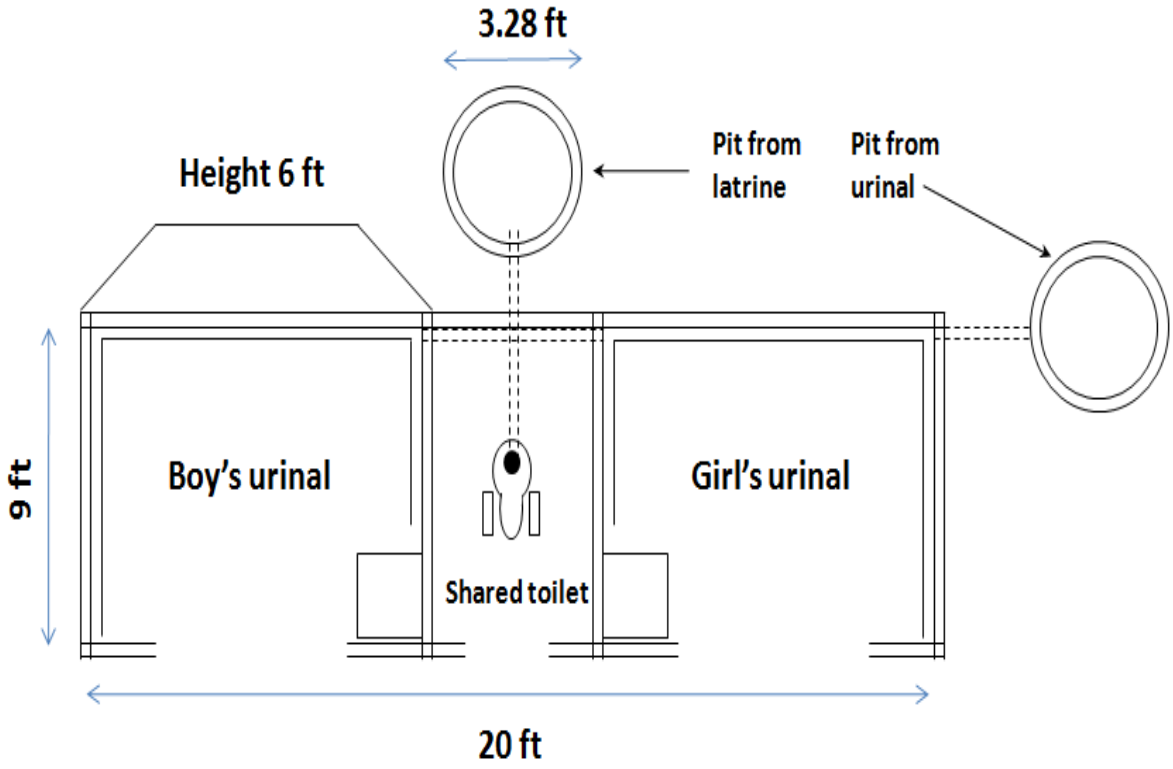
4. No fear among the children to use the toilet
5. Anal cleaning and hand washing facilities are inside the toilet
6. As the CFTs are constructed adjacent to the community toilets, maintenance is easier

Approximate cost = Rs.28130

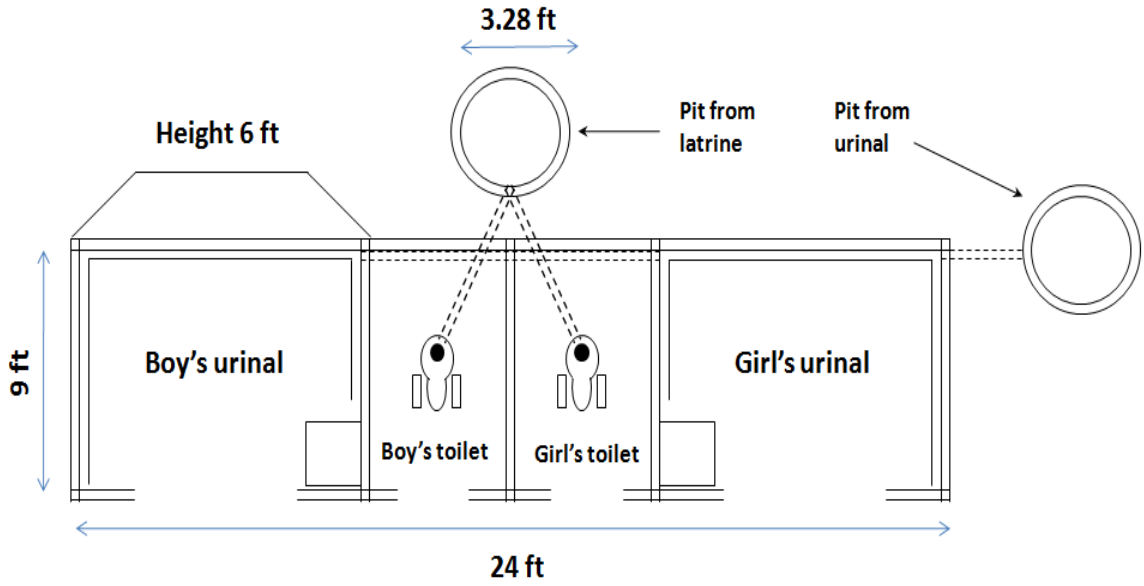
11. School sanitary complex – Model 1



Salient features:

1. School Sanitation is a tool for promoting better sanitation and water management for children
2. Improves the school environment
3. Privacy for school children
4. Promoting proper hygiene behaviors from childhood
5. Operation and maintenance by school children
6. Separate facilities for children for urination and defecation
7. School toilets should be constructed within the school campus
8. Incinerator should be installed in girls toilet for menstrual hygiene management
9. One toilet is enough for primary school children
10. Water facilities and hand washing facilities should be inside of the toilet.

12. School sanitary complex – Model 2

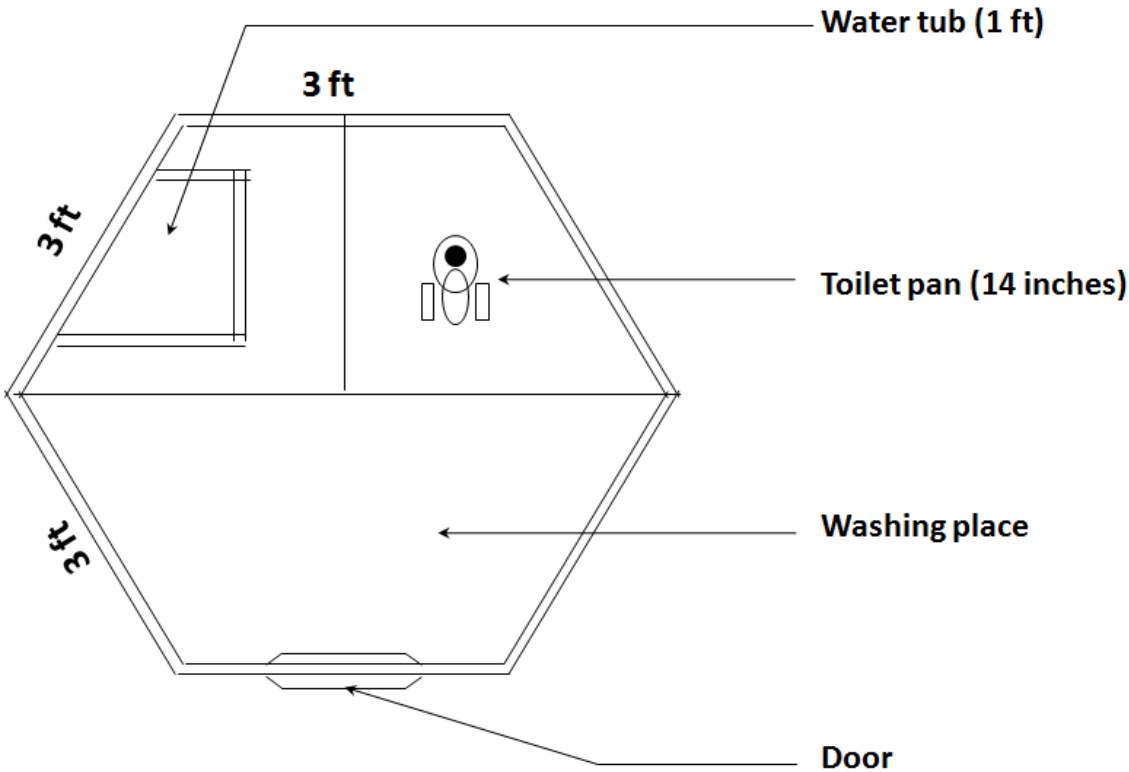


Salient features:

1. School Sanitation is a tool for promoting better sanitation and water management for children
2. To improve the school environment
3. Privacy for school children
4. Following hygiene behaviors from the childhood
5. Operation and maintenance by school children
6. Separate facilities for children for urination and defecation
7. School toilets should construct within the school campus
8. Incinerator should be installed in girl's toilet for menstrual hygiene management
9. One toilet is enough for primary school children
10. Water facilities and hand washing facilities should be inside of the toilet

Approximate cost = Rs.56770

13. Anganwadi toilet



Salient features:

1. It is a platform for behavior change for the children
2. Promoting hygiene behaviors from childhood
3. Child friendly door with a provision for opening from inside and outside of the toilet
4. Displays pet animal pictures inside the wall, providing a friendly environment
5. Smallest toilet pan with 14 inches should be used
6. To maintain one foot height of water storing tub. Water tub should be easy to access for children for cleaning and washing

Approximate cost = Rs. 12660.

Stakeholder's participation

Government Involvement

In accordance with the Millennium Development Goals of United Nations and National Common Minimum Program of Indian Government, the Ministry of Urban Development has launched a massive city modernization scheme named as **Jawaharlal Nehru National Urban Renewal Mission (JNNURM)** with a total investment of Rs.20 billion over seven years. It was officially inaugurated in December, 2005 by the Prime Minister and an evaluation of the experience of implementation of the Mission would be undertaken before the end of 11th five year plan in 2012.

The JNNURM has two submissions:-

(1) **Urban Infrastructure and Governance:** It focuses on clean water supply, adequate sanitation facilities, solid waste management, road network etc. This works under Ministry of Urban Development.

(2) **Basic Services to Urban Poor:** It focuses on integrated development of slums and works under Ministry of Housing and Urban Poverty Alleviation.

Water supply and sanitation is a State responsibility under the Indian Constitution. States may give the responsibility to the Panchayati Raj Institutions (PRI) in rural areas or municipalities in urban areas, called Urban Local Bodies (ULB). At present, states generally plan, design and execute water supply schemes (and often operate them) through their State Departments (of Public Health Engineering or Rural Development Engineering) or State Water Boards.[8]

The responsibility for water supply and sanitation at the central and state level is shared by various Ministries. At the central level three Ministries have responsibilities in the sector: The Ministry of Drinking Water and Sanitation (until 2011 the Department of Drinking Water Supply in the Ministry of Rural Development) is responsible for rural water supply and sanitation; the Ministry of Housing and Urban Poverty alleviation and the Ministry of Urban Development share the responsibility for urban water supply and sanitation. Except for the National Capital Territory of Delhi and other Union Territories, the central Ministries only have an advisory capacity and a limited role in funding. Sector policy thus is a prerogative of state governments.

National Urban Sanitation Policy: In November 2008 the government of India launched a national urban sanitation policy with the goal of creating what it calls "totally sanitized cities" that are open-defecation free, safely collect and treat all their wastewater, eliminate manual scavenging and collect and dispose solid waste safely. Different ratings such as red category" (in need of immediate remedial action), "black category" (needing considerable improvement) and "blue category" (recovering) are given by the Government to mark the progress of the cities in their sanitation plan. The rating serves as a baseline to measure

[8] Anupam Tyagi.2012." India – Government funds for sanitation inadequate, private sector should pool in". *The Economic Times,* February 9, Health Care Section.

improvements in the future and to prioritize actions. The government intends to award a prize called Nirmal Shahar Puraskar to the best sanitation performers.

Nongovernmental Organizations' Involvement

Non-governmental organizations can add value to the sanitation program due to their ability to work closely with the community: in the initial planning and needs assessment; in capacity building; during the installation of new household facilities; and in operation and maintenance. Managing communication between the municipality and local residents may be central to this role. It is, therefore, important for the municipality to treat non-governmental organizations not just as private contractors but as partners, especially where community support is central to the success of the new investment. In some cases, it may be better to work with such organizations under a Memorandum of Understanding rather than a contract, so that the
Organization's independence is not compromised in the eyes of the community. Where a potential role for nongovernmental organizations has been identified, it should not be assumed that any local organization could fulfill the task or legitimately represent the community. It is important to check whether an organization has the right range of skills for the task, proven experience and the capacity to operate at the scale required. Some Non-Governmental Organizations are very effective on a small scale but cannot meet the managerial demands of a service once it expands. It is also important to recognize that, while such organizations have humanitarian objectives, they need to cover their operating costs. They should, therefore, be compensated adequately for any work assigned to them. Continuity is also important; it can be difficult for nongovernmental organizations to continue funding their staff if there are long periods of inactivity between municipal assignments.

Thus, with proper support from the policy makers, the non-governmental organizations can take an effective part in a sustainable sanitation solution. Non-governmental organizations like Arghyam in Bangalore and Gramalaya in Trichy, Tamil Nadu are doing really good work for installing, operating and maintaining low cost sanitation technologies keeping in context the local surroundings.

Private Players Involvement

Phase II of the Jawaharlal Nehru National Urban Renewal Mission (JNNURM), which will be carried out over the next five years, envisages a larger, more proactive role for the private sector in providing basic services to citizen, especially in the field of water supply and sanitation. On the one hand, by seeking help from private players, the urban local bodies can provide improved and more cost effective sanitation services to the citizens, while on the other hand, the private players can reap benefits by filling the gap between demand for improved sanitation and its lack of supply and this opportunity can lead to huge profit and a successful business practice.

India can take example of countries like Kenya and Cambodia where private players are

playing a vital role in providing effective sanitation programs.
Thus with public-private partnership, the delivery of sanitation services in India can be made more efficient, transparent and cost effective.

TECHNOLOGIES EXISTING ACROSS THE BORDER

COUNTRY: KENYA

BACKGROUND AND CONTEXT:
Due to poor management and uneven development, Kenya's economy has remained stagnant with a real GDP growth rate of only 1.5% per annum. The per capita GDP is estimated at US$301.The population of Kenya is projected to increase dramatically over the next two-and-half decades, doubling by 2025. Currently official figures claim that sanitation coverage is lowest in rural areas and in informal settlements in urban areas. There is a pressing need for achieving sustainable and effective sanitation coverage in Kenya.

Factors that hinder sanitation coverage

1. Limited financial ability
2. Lack of awareness of sanitation and hygiene.
3. Lack of knowledge
4. Adverse geo-hydrological conditions
5. Flooding in low lying areas.
6. Nomadic pastoralism.
7. Cultural factors.

Technologies in use

1. **SKYLOO:** raised latrine with urine diversion and separate collection of urine and faeces.
2. **AEBORLOO**: with portable superstructure and no urine diversion, a tree can be planted in the filled pit.
3. **FOSSA ALTERNA:** with dual pits and portable superstructure, digested contents of pit not in use can be emptied after a year.[9]

[9] "Sanitation and hygiene in Kenya," February 7, 2013.

http://www.wsp.org/sites/wsp.org/files/publications/af_kenya_hygiene.pdf. [Accessed February 7, 2013].

COUNTRY: Cambodia

Background and Context

Cambodia's per capita income is rapidly increasing but is low compared to other countries in the region. Its per capita income in PPP is $2,470 and $1,040 in nominal per capita. Population of Cambodia is 14 million approximately, where 85% of them reside in rural areas. Only 23% of rural household has access to improved sanitation. Private sector is playing a very active role in construction, operation and maintenance of latrines there. 80% of households in Cambodia purchased it from local private sector actors and paid with their own money. 95% of households there are aware of the need for safe water, sanitation and hygiene.

Factors that hinder sanitation coverage

1. Price (too high, unclear)
2. No supplier or too far away.
3. No delivery
4. No trust in the supplier.
5. Poor service.
6. Purchase too complicated.
7. Installation requires expertise.

Prevailing Practices

1. Assistance is provided to the mother on the birth of first child with a US$15 toilet voucher (redeemable by local producers) plus a US$5 rebate on construction of second latrine pit. For year 1-5 , a annual reward of US$0-10 each year is given based on following criteria:
    a) • Toilet usage (verified)
    b) • Village toilet coverage (verified)
    c) • Completion of hygiene course
    d) • Presence of hand washing facility.[10]

[10] Sanitation Finance in rural Cambodia," February 8, 2013 http://www.wsp.org/sites/wsp.org/files/publications/WSP-Sanitation-Finance-in-Rural-Cambodia.pdf. [Accessed February 8,2013].

"Water, sanitation and hygiene," February 9,2013. http://www.gatesfoundation.org/watersanitationhygiene/Documents/wsh-strategy-overview.pdf. [Accessed February 9,2013].

2. Demand creation programs (CLTS, mass media) and sanitation marketing programs to increase and improve the supply of low-cost sanitation goods and services.
3. Microfinance programs to enable non poor households to develop improved sanitation facilities.
4. Conditional cash transfers in place of existing facilities and hygienic maintenance.
5. Direct sales by latrine sales agent to consumers at affordable options.

ORGANISATION: BILL AND MELINDA GATES foundation.

Location: Sub-African and Asian Countries

Mission: Guided by the belief that every life has equal value, the Bill and Melinda Gates Foundation works to help all people lead healthy, productive lives. In developing countries, they focus on improving people's health and giving them chance to lift themselves out of hunger and poverty.

Strategy: Providing people with safe and sustainable sanitation services must go beyond simply giving them a latrine or toilet.

Focus on three areas:

1. **Sanitation Science and Technology:** Working on innovative approaches to dealing with human waste that are affordable, safe, sustainable, and centered on the needs of the user. The Reinvent Toilet Challenge (RTTC) is a key part of this effort because it encourages the development of waterless, hygienic toilets that do not require piped water or a sewer connection.

2. **Delivery Models at scale:** Stimulating demand for, and supply of, improved sanitation in rural communities. Understanding what people want, what they will keep using, and the policies and practices needed to support those changes at scale.

3. **Policy and advocacy:** Encouraging and supporting sanitation policies that works for the poor. Informing government about successful sanitation approaches and encourages a policy environment that will accelerate access to sustainable sanitation.

Case Study and Business Model

Taking the slum near the National Games Village in Bangalore as a case study , I have developed a business model of providing low cost latrine facilities to the people of that area by lowering the per usage cost and also making it free for children to solve the problem of open defecation and other unhygienic practices. Further, It will also generate revenue for the private operator with a break- even point of 98 days.

Through this, I have tried to show how local entrepreneurs can take advantage of existing sanitation opportunities and the gap between the demand and the supply of sanitation facilities, in a way that leads to sanitation services being extended to poor people, dramatically increasing coverage without requiring more philanthropy.

Map of the area selected[11]

GREEN RECTANGLES → Existing toilets in usable condition.
RED RECTANGLES → Existing toilets in degradable condition.
BLUE TRAINGLES → Areas identified for setting up new toilets.

[11]"Innovation business model," January 15, 2013. http://www.waterforpeople.org/programs/how-we-work/initiatives/sanitation-as-a-business.html. [Accessed January 15, 2013].

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Business Model Development

After conducting a market research based on semi- structured questionnaire, it is clear that a replicable business models for sustainable sanitation service delivery that benefits the poor, can be adopted by the private sector.

Expected Outcomes of the Business Model

- Develop a business model that can overcome existing economic, technical and social constraints, and make a profit.
- Scaled-up business operations that have the potential to expand sanitation coverage to at least 500,000 people.
- Organizations working on sanitation (governments, development organizations, donors) gain a better understanding of how to support and incorporate sanitation business models into practice
- Identifying a replicable model for other areas as well.

Brief description

Provision of sanitation services is complex and encompasses numerous service providers, technologies and approaches distinguished by the different cultural, institutional and sectorial environments within which they operate. It can be categorized into three main components; available technologies, user demand and policy environment. This approach will focus on all components for the scaling up of sanitation service delivery.

The number of people accessing sanitation services has increased since 1990. Many cities worldwide are also undergoing rapid urbanization and governments are faced with a seemingly unyielding backlog as they try to increase coverage of sanitation services throughout their populations. Estimates show that India will fail to meet the sanitation coverage targets at the current rate of progress and a significant number of this un-served population resides in urban/semi-urban areas and small towns. This group is amongst the worst served in terms of sanitation and hygiene services. Therefore the inability to increase coverage for these populations can potentially give rise to a potential opportunity for private players/local entrepreneurs.

Understanding the Barriers

1. High price (Rs.2/3)
2. No toilets or too far away
3. Poor service
4. Closed for 10 hours a day

Low Cost Technology Options for Sanitation in India as per the Demand of the Local Surrounding

Focus Areas

- Low-cost, location specific, acceptable technologies and designs.

Steps followed

1. Survey of settlements and services.
2. Consultation and needs assessment.
3. Market research through semi-structured questionnaire.
4. Identify appropriate technologies.
5. Choosing the most technically viable and acceptable sanitation option.
6. Cost analysis of the option.
7. Revenue estimate of the model.
8. Analysis of replication of the model.

Questionnaire used in market research

1. Gender : Male ____
   Female ___

2. Age: Below 15_____
   16-30____
   31-45____
   Above 45____

3. Did you have any of the following health issues in the past ?
   - Diarrhoea and dysentery____
   - Typhoid_____
   - Malaria____
   - Cholera____
   - Worms____
   - Eye infection and skin diseases___
   - None____

4. How frequent is the water supply here ?
   - Daily_____
   - Alternate days____
   - Once in a number of days___
   - Never____

5. Are you satisfied with the current latrine facilities ?
   - YES
   - NO
   - DON'T KNOW

6. If unsatisfied, why ?

   _____

7. What do you think of the prevailing price per usage of the latrine ?
   - LOW
   - AFFORDABLE
   - HIGH

8. Do you think there is need for more latrine facilities ?
   - YES
   - NO
   - DON'T KNOW

9. How many times generally in a day you use the paid latrine facility?
   - 0
   - 1
   - 2
   - 3
   - 4
   - More than 4

10. Do you think the operating time for the usage of the current latrine facility should be increased or not?
    - YES
    - NO
    - MAY BE

Results derived from the Questionnaire

I have taken a sample size of 100 people. Following are the inferences drawn from the responses I got:

- There are close to 40 percent children in the area.
- Most of the people have faced water borne disease, specially women and children
- Water is supplied by the Bangalore Water Supply and Sewage Board for two purposes: 1. Drinking 2. Household purposes
- Water comes every alternate day.
- Most of the people are not unsatiesfied with the current latrine facility due to reasons such as : 1.High cost 2. No toilets or too far away 3. Poor service 4. Closed for 10 hours a day 5. Degradable condition of the toilet
- A considerable number of people feel the need a low cost latrine facility in sufficient numbers.
- People face problems due to inability to access the latrine after 7 p.m.

Technology to be used: Pour flush toilet

Description: It is a technology where excreta are flushed into a pit by pouring one or three liters of water. Pour flush toilets have a water seal to reduce odor and insect problems. Fecal matter and wastewater are collected through underground sewage pipe, which is then connected to the main pipe provided by the Bangalore Sewage Board. It uses water of about 25 liters per capita per day, which is suitable for that area as water comes from Bangalore Sewage Board every alternate day.

Salient features:

1. Simple and relatively inexpensive technology.
2. Have widespread application in urban areas.
3. Require minimum amount of water.
4. Widely used by Government in its Integrated Low Cost Sanitation Scheme.
5. Does not depend much upon the behaviour of the people as in case of dry and eco sanitation.

4P's of Marketing:

1. Product: Sanitation Facilities using pour flush technology
2. Price: Re. 1/usage
3. Place: Slum Area near National Games Village

4. Promotion:
    - Wall paintings about the need of hygenic practices
    - Community engagement programmes such as social events to communicate the need to have a proper sanitation and how to operate and manintain them.
    - Include children of the area and reward them with small gifts who have knowledge of good sanitation practices.
    - Divide the area into blocks and engage people of the block to maintain the cleaniness of the latrines in their block and reward the block with the best practices.

Putting practice to numbers:

- Location: Slum Area near National Games Village, Bangalore
- Total Houses: 1000-1200
- Estimated Population: 4200-4750 people
- Total number of working toilets: 10*3=30
- Current Average number of people per toilet: 150
- Targeted average number of people per toilet: 50 people/toilet
- Need for extra toilets: At least 60
- Technology used: Pour flush Toilet:
- Cost Estimates per unit:

Details	No. of units	Unit cost (in Rs.)	Total amount (in Rs.)
Toilet pan with p-trap (ceramic rural pan with deep slope)	1	250	250
Country bricks (locally made)	500	4	2000
Cement	2.5 bags	275	687
Masonry charges	4 Masons	350	1400
Sand	1 cart	500	500
PVC pipe - 10 feet (4 inch dia)	10 feet	22	220
		Total	5057

- Total cost to build 60 units: 60*5057= Rs. 303,420
- Operational Cost:
  1 cleaner/10 units: 6*500*12=36000
  1 care taker/shift: 12*750*12= 108000
  Maintenance cost/year/unit= 250
- Total Maintenance cost/unit= 15000
- Total operational cost= 36000+108000+15000= 159,000
- Total Investment= 303420+159,000= Rs. 462,420

- Estimated Average usage /day: 2.5 times (Urination and defecation)
- Prevailing Price: Rs 2/3 per usage
- Targeted Price: Re 1 per usage
- Market potential: 4500*0.6(60%)= 2700 people (35-40% children)
- Services free for Children
- Current Timings: 6am to 7pm
- New Targeted timings: 5am-1pm, 2pm- 10pm

- Estimated Average number of people using the facility per day as per the research= Approx. 70% of 2700= 1890
- Expected Revenue per day: 1890*1*2.5= Rs. 4725
- Break Even Point: Approx. 98 days.

Implementation and replication potential of the model

The necessary steps to achieve the stated vision of success will form the following activities:

1. Taking stock of existing knowledge, practice and business. What we know, what is on the ground: Identification of knowledge and innovative sanitation models within the sector, its vicinity and across the board. Identification of actors/institutions that can contribute to innovation.
2. Characterize the components and identify gaps and bottlenecks in service delivery in the sanitation value chain
3. Develop business models based on the component business model. While some universal aspects shape the business model exist, it is important to avoid a 'one-size-fits-all' approach as this can predetermine success/failure. Models will be appropriate and tailored to the specific cultural, institutional and regulatory contexts of the selected areas.
4. Adoption/embedding of the business model in national processes: for use in future initiatives aimed at increasing sanitation coverage.

Advantages of implementing suggested model

• Latrines gives social status and privacy for women and children.
• Sanitation brings improvement in environmental conditions.
• Accessible sanitation facilities save time and increases working hours
• Usage of latrines reduce incidence of diarrheal diseases and medical expenses.
• Sanitation improves income status.
• Last but not the least, this can go a long away in solving the open defecation problem in our country.[12]

RECOMMENDATIONS

1. Government and other operators should have thorough understanding of urban water and sanitation deficiencies.
2. Increasing private sector participation in JNNURM PHASE II to solve many failures plaguing public sanitation utilities.
3. Conditional cash transfers through AADHAR linked bank accounts to the beneficiaries on maintaining hygienic practices.
4. There should be shift in the geographical concentration of public private participation in India.
5. Make the urban local bodies viable enough to fund for PPPs sanitation projects.
6. There should be more participation from domestic private operators and local entrepreneurs in making sanitation a profitable business.
7. Support from local stakeholder should be consistent and adequate.
8. Increasing awareness and technical capacity to undertake PPPs.
9. Improving mechanisms to address tariff concerns.
10. Project preparation, structuring, and risk sharing should be clear and not patchy.
11. Well reestablished and accepted principles should be followed well to increase the chance of success of PPPs.
12. Build cities' implementation and monitoring capacity.
13. Introduction of proper long-term sector regulation which should be accompanied by other enablers such as rationalized public funding, tariff frameworks, increased role clarity, and stakeholder participation.
14. Clearly understanding the gap between demand of improved sanitation and lack of supply of it taking into consideration the local surroundings and community's needs.
15. Clear and understandable communication to the people by the operators on proper operation and maintenance of the facilities.

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[12] Radheshyam Jadhav. 2012. "JNNURM II opens doors for private players". *The Times of India*, June 12, City Section. "Trends in Private Sector Participation in the Indian Water Sector," February 10,2013.http://www.wsp.org/sites/wsp.org/files/publications/WSP-Trends Private-Sector-Participation-India-Water.pdf. [Accessed February 10,2013].

CONCLUSION

Though it is a long way to go to make India completely free from open defecation and the hazardous diseases that follow from it, still I hope my research will take at least a step forward towards this journey. I have incorporated in my paper the various legislations and standards governing the sanitation program in India and also the bottlenecks being faced while implementing the program. With the help of various published documents of Ministry of Urban Development, non-profitable organizations like Arghyam and Gramalaya, I have explained the most common available technologies in India. Also, I have explained the role that is already and can be taken by various stakeholders like Government, non-governmental organizations and private players in this field. Then by taking a local registered slum as a case study, I have developed a business model with a detailed cost analysis of a preferred technological option and the revenue estimates of the model. I hope this model serves the purpose of various operators working in the field of providing a sustainable solution of sanitation. Thus, improved sanitation with proper operations and maintenance can make our dream of making India a clean and healthy country, infusing more energy, wealth and happiness among its citizens. In this way, we can make our country a truly civilized and independent and fulfill the vision of our father of nation Gandhiji who strongly believed national sanitation to be an important aspect of independence “Swaraj”.

“ Conservation of national sanitation is Swaraj work and it may not postponed for a single day on any consideration whatsoever.” M.K.Gandhi.

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