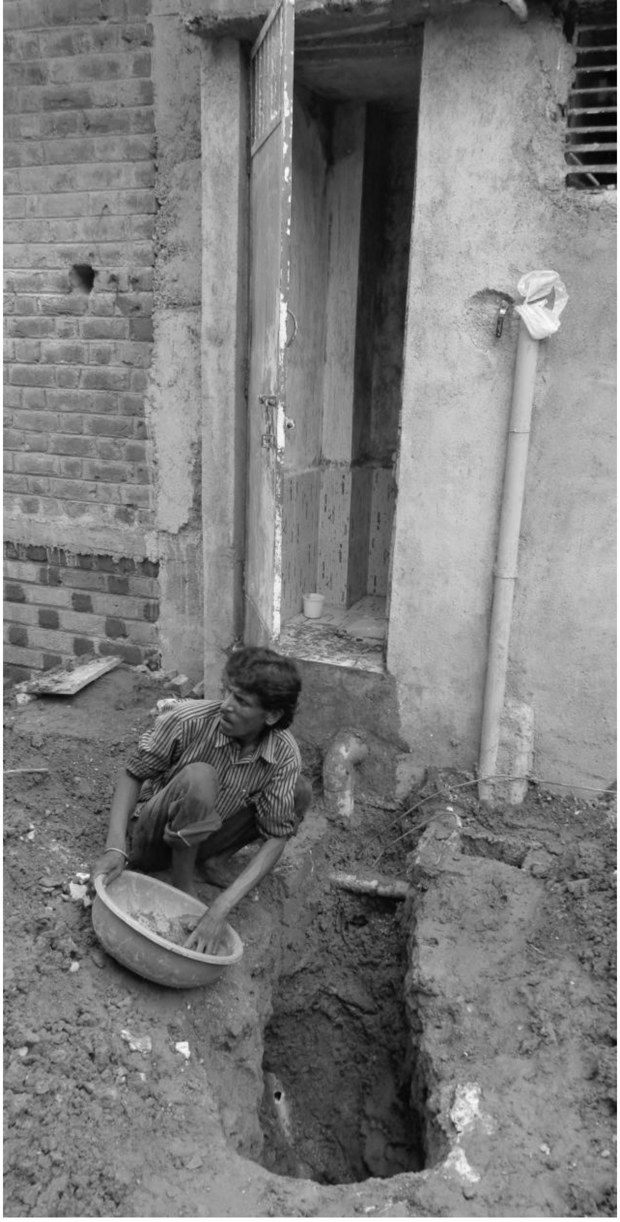

Standard Operating Procedure (SOP) for Fecal Sludge Management for Municipalities in Gujarat

UMC
URBAN MANAGEMENT CENTRE

p a s performance assessment system

Prepared by
Urban Management Centre

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All photographs are by UMC unless otherwise mentioned.

Content from this manual can be used and quoted with due acknowledgement and the program as follows:

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URBAN MANAGEMENT CENTRE

Urban Management Centre (UMC)

The Urban Management Centre (UMC) is a women promoted not-for-profit organization, that works towards professionalizing urban management in India and worldwide. UMC provides technical assistance and support to city governments and facilitates change through peer-to-peer learning processes. It enhances the capacity of city governments by providing expertise and ready access to innovations on good governance implemented in India and abroad. It facilitates city governments to design, implement and evaluate municipal development and management projects. UMC extensively works in the areas of urban water and sanitation, heritage management, urban planning, urban health, municipal finance, urban management, urban transportation and institutional restructuring. More details on www.umcasia.org

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Performance Assessment System (PAS)

PAS, a seven-year action research project, has been initiated by CEPT University with funding from the Bill and Melinda Gates Foundation. PAS aims to develop better information on water and sanitation performance at the local level to be used to improve the financial viability, quality and reliability of services. It uses performance indicators and benchmarks on water and sanitation services in all the 400-plus urban areas of Gujarat and Maharashtra. UMC and the All India Institute of Local Self Governance are CEPT's project partners in Gujarat and Maharashtra, respectively. More details on www.pas.org.in

Standard Operating Procedure (SOP) for

Fecal Sludge Management for Municipalities in Gujarat

This SOP is included in the guidelines for Open Defecation Free Gujarat
issued by the Mahatma Gandhi Swachhta Mission, Urban Development and Urban Housing
Department, Government of Gujarat

Prepared by

Urban Management Centre

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We are pleased to bring this SOP document to improve fecal sludge management practices in cities of Gujarat. Our work with cities over the last two decades has clearly pointed out the need to focus on the entire value chain of sanitation and not only focus on the user interface. City Managers should use this SOP to ensure safe sludge management practices in their cities.

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Manvita Baradi
Director
Urban Management Centre

Contents

List of Tables

List of Figures

List of Boxes

List of Abbreviations

BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health & Environmental Engineering Organization
FSM	Fecal Sludge Management
GPCB	Gujarat Pollution Control Board
GUDC	Gujarat Urban Development Company Ltd.
GUDM	Gujarat Urban Development Mission
GWSSB	Gujarat Water Supply and Sewerage Board
LPCD	Liters Per Capita Per Day
MoUD	Ministry of Urban Development
MPN	Most probable number of coliforms
NUSP	National Urban Sanitation Policy
PAS	Performance Assessment System
O&M	Operation & Maintenance
OSS	On-site Sanitation Systems
pH	Hydrogen ion concentration
RCC	Reinforced cement concrete
SOP	Standard Operating Procedure
SS	Suspended Solids
STP	Sewage Treatment Plant
TSS	Total Suspended Solids
UASB	Up flow Anaerobic Sludge Blanket
ULB	Urban Local Body
UMC	Urban Management Centre
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Agency
WHO	World Health Organization

INR	Indian National Rupees

1. Background

Proper treatment and management of fecal sludge is integral to safe sanitation practices which ensure health and well-being of citizens. According to the Census 2011 data on sanitation, around 30million urban households, or more than one thirds of all urban India depends on on-site sanitation solutions for safe waste water disposal. In Gujarat too, the reliance on on-site sanitation systems is very high. 105 out of the 167 cities in the state do not have any underground drainage system and are dependent on technologies such as single pits, twin pits and septic tanks for waste water disposal.

Also in cities that have underground drainage network, the coverage of the underground network is limited. With rapid development, more and more properties especially in peripheral urban areas are making their own arrangements of waste water disposal. A rapid assessment of septage management in Asia carried out by USAID in 2010 revealed that about 148 million people in urban areas will have septic tanks by the year 2017. Though the National Urban Sanitation Policy (NUSP) emphasizes the need for proper collection, treatment and disposal of sludge from such on-site installations, very limited attention has been paid to the construction, management, maintenance and safe disposal of fecal sludge from these systems.

Most urban local bodies (ULBs) in India are not able to effectively monitor the regular cleaning and maintenance of septic tanks and pits. Some ULBs provide septic tank and pit cleaning as a municipal service but the supply of such desludging services is far from adequate. In many cities private players have filled this gap by providing these services for a fee. The private contractors also sometimes sell the nutrient rich sludge to farmers in the vicinity of cities. However the disposal of waste water is often not regulated. The sludge is dumped in storm water drains and open areas posing considerable health and environmental risks.

Recognizing the growing importance of safe fecal sludge management practices, the Ministry of Urban Development (MoUD) has recently released an advisory to provide guidance to states and cities on policy, technical, regulatory and monitoring aspects of fecal sludge management. The advisory is a useful resource on fecal sludge management for cities in India. In addition to the advisory, the guidelines on design and construction of septic tanks issued by the Bureau of Indian Standards (BIS) and the Central Public Health and Environmental Engineering Organization (CPHEEO) are also a good reference on technical design and maintenance of septic tanks. These standard operating procedures (SOP) borrows from these two resources as well as the team’s extensive experience of working with cities in Gujarat to establish a uniform procedure for fecal sludge management in Gujarat and present the information in a handy, comprehensive and easily accessible format.

1.1. Existing fecal sludge management practices in Gujarat

Like in other cities of India, fecal sludge management has been a neglected area in ULBs of Gujarat as well. The sector has not received any attention because of poor understanding of O&M requirements, lack of guidance, inadequate resources and skills, shortage of manpower and finance. Currently out of the 167 ULBs, only 62 have a partial sewer system. Most cities from the Saurashtra region do not have any underground drainage system and are dependent on on-site sanitation systems. The toilets are connected to septic tanks/ pits and the sullage/effluent is often discharged into road side storm water drains which are covered or open. Fecal sludge generated in small cities often ends up in garbage dumps, storm water drains, water bodies or is used for agriculture. In cities that have sewerage network and functional STPs, sludge is emptied in manholes or transported to STPs and treated along with the sewage conveyed through the underground network.

Prevalent on-site sanitation systems (OSS) in cities in Gujarat

Most existing toilets in urban Gujarat use pour flush latrine interface. Insanitary latrines such as dry latrines and service latrines have been phased out. The pour flush latrines are either connected to single pit, twin pits or septic tanks.

Single pit system: It is observed that single pit system is one of the most widely used systems to dispose wastewater. These single pits are completely lined or partially lined at the top and then left un-lined. Lining materials include brick, concrete or mortar plastered onto the soil. These pits are constructed very deep (6-12m) and hence last for15 or more years without emptying. Because of their depths, the pits cannot be completely cleaned using suction machines. The sludge at the bottom hence hardens and the capacity of these pits to treat waste water keeps reducing over the years. As the pits are not cleaned often, they pose a risk of ground water contamination.

Septic Tanks: Septic tanks are the second most commonly used OSS after single pits. They are designed as watertight chambers which provide primary treatment for blackwater and greywater. The liquid flows through the tank and heavy particles (sludge) sink to the bottom, while scum (mostly oil and grease) floats to the top. The septic tanks should be appropriately sized and the accumulated sludge and scum must be removed every 2-3 years. However in Gujarat, most septic tanks are constructed oversized and are not cleaned for 5-10 years. The effluent of the septic tank must be dispersed by using a soak pit or transported to another treatment technology. Soak pits are common in Gujarat. Many of these soak pits located in dense areas have lost their absorption capacity due to sludge entering into the pits because of lack of cleaning and maintenance of septic tanks. Hence soak pits also need to be emptied and cleaned frequently.

Twin pit system: The Twin pit system consists of a pour flush toilet connected to two alternating pits. Only one of the two pits is used at any time and accommodates waste generated over one or two years. Then the second pit is used. This allows the contents of the first pit to transform into Pit Humus (a sanitized soil-like material) which is safe and can be manually excavated. The twin pit system is not a commonly found system in Gujarat. Where present, the system is often not used appropriately and effectively functions as a latrine connected to two single pits.

Box 1Prevalent on-site sanitation systems in Gujarat

Cities in Gujarat also do not have any reliable data on number of households dependent on each of these above mentioned systems. Anecdotal evidence suggests that cities are moderately aware of the functioning and difference between these systems.

The Prohibition of Employment as Manual Scavengers (and their rehabilitation) Act, 2013, prohibits manual cleaning of pit toilets and septic tanks. Adopting mechanical processes for cleaning of septic tanks such as suction emptiers is seen as the only way to eliminate manual scavenging. Regrettably, part of septic tank / pit cleaning in some cities is carried out manually. Based on PAS-SLB data of 2013, 85cities in the state provide mechanized septic tank/ single pit cleaning as a municipal service. However, currently there is no infrastructure in any of the Municipalities in Gujarat for adequate fecal sludge treatment. GMFB has provided sludge sucking machines to the ULBs but sometimes these are inadequate and not functioning. Septic tank cleaning hence is often addressed by the private sector with little monitoring and regulation from the ULB.

It is feared that the new Act may drive the already secretive business of fecal sludge emptying underground, and drive up the cost of emptying. Hence, it becomes essential that the ULBs recognize and register sludge emptying services as legitimate business, regulate their operations and enforce the use of mechanized suction machines. Simultaneously, ULBs need to augment their infrastructure and resources directly or through contracting out emptying, transport and treatment of sludge.

For improving the coverage of safe sanitation in the State, the Government of Gujarat is providing financial assistance for underground drainage projects and for establishing sewage treatment plants. This assistance is under the Swarnim Jayanti Mukhya Mantri Shaheri Vikas Yojana for all 159 Municipalities. GUDM, GUDC and GWSSB have been identified as implementing agencies. But to achieve well functional sewerage, cities need to reach water supply levels of135 lpcd, which is also going to take efforts and time. Till then fecal sludge management is of prime importance to ensure total sanitation. The septic tank combined with soak pit pro vides good sanitation and can work well with lesser (70-100 lpcd) level of water supply than that needed for conventional sewerage. Therefore it makes both economic and sanitation sense to manage sludge efficiently till sewerage becomes feasible and affordable.

Figure 1 and Figure 2 show the current sanitation value chain in two cities surveyed by the UMC team. The line weight depicts the percentage of connections. Higher the weight, higher is the percentage. The green color denotes safe sanitation while the red ones denote un-safe practices that need to be improved. The dependence of households on on-site sanitation is higher in Himmatnagar and Amreli Municipalities.

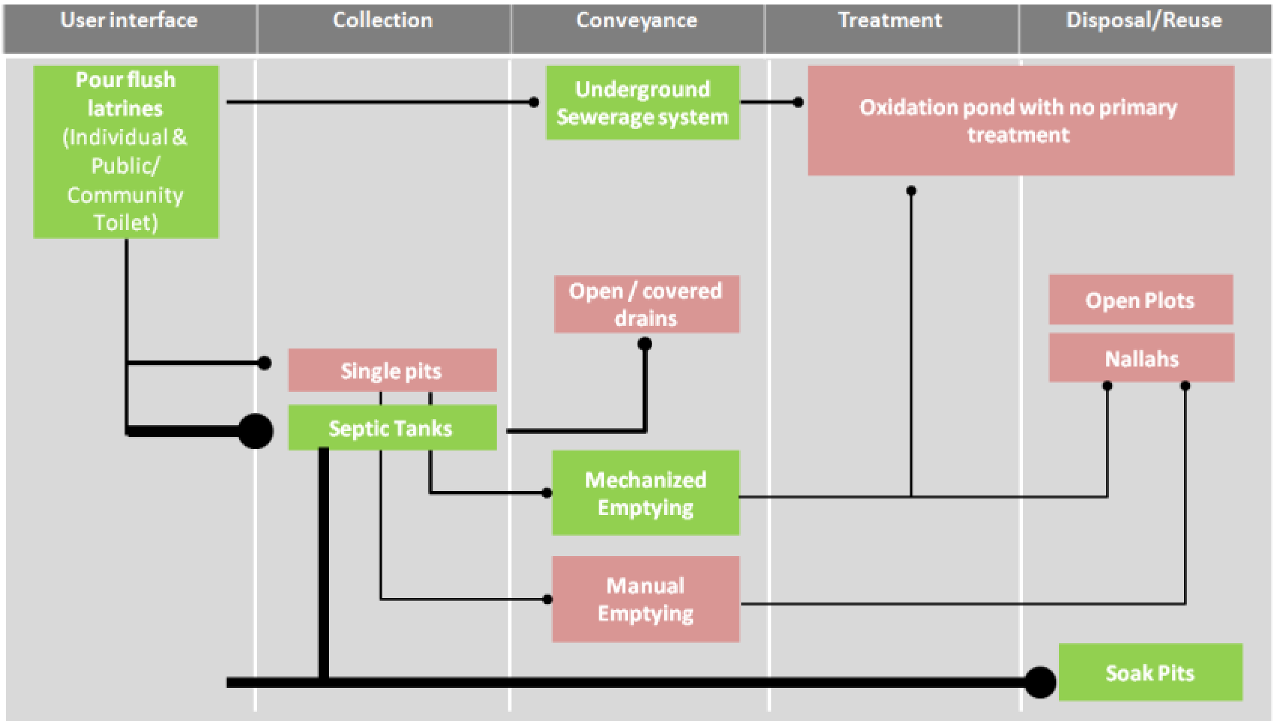

Figure 1 Sanitation value chain of Himmatnagar

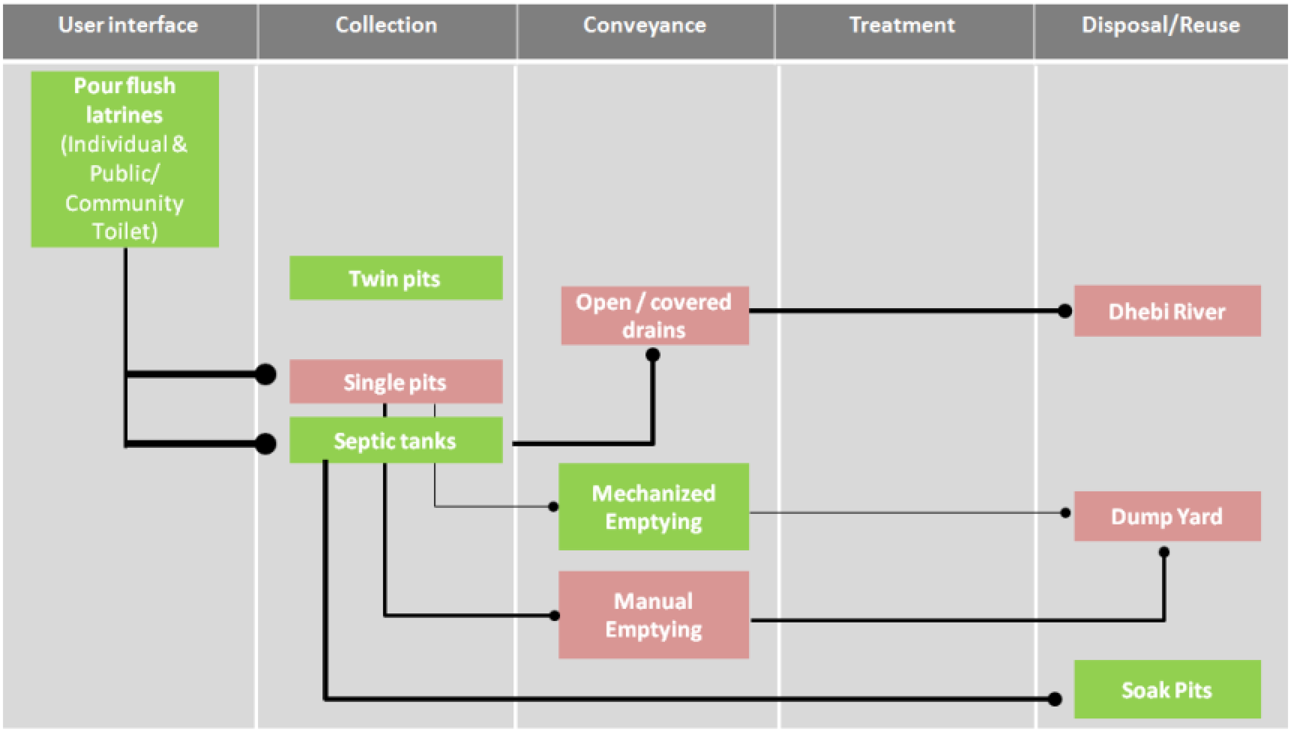

Figure 2 Sanitation value chain of Amreli

2. About the SOP

This SOP is a step-by-step guide for ULBs to institute a framework for on-site sanitation system management. This SOP conforms to the advisory note on septage management released by MoUD and draws from UMC's experience of working with ULBs in Gujarat. It provides a set of written instructions on septic tank construction, cleaning and maintenance and disposal of sludge in a concise format. The SOP also contains a set of recording formats to help ULBs to document the number of septic tanks and frequency of cleaning for better decision making.

2.1. Scope and Applicability

The purpose of these guidelines and SOP is to establish a uniform procedure for construction, routine maintenance and regular cleaning and emptying of on-site waste water disposal systems. The procedures outlined in this SOP are applicable to all ULBs in Gujarat in which households are dependent on single pit, twin pit, septic tank system and other systems. This SOP covers the following areas:

- Design and construction guidelines for twin pits and septic tank system
- Cleaning procedure for pits and septic tanks
- Safe transportation of septage
- Septage treatment and disposal
- Appropriate re-use of treated septage

2.2. Methodology for Preparation of SOP

The SOP is prepared based on the Advisory Note on Septage Management in Urban India (January 2013), and the Guidelines for Swachh Bharat Mission (December 2014) by the Ministry of Urban Development, Government of India along with data and information collected from various cities regarding their current fecal sludge management procedures. The UMC team with guidance from Mr. K. V. Dinesh visited eight cities (Patan, Deesa, Anklav, Dhrangadhra, Khambhat, Himmatnagar, Amreli and Lathi) to understand the existing practices in the ULBs. The team obtained firsthand information through interaction with concerned officers in ULBs regarding existing sanitation systems, infrastructure and facilities, recording and monitoring frameworks and institutional arrangements for fecal sludge management in the city. The team also studied leading practices from other cities and countries in similar context to inform the preparation of the SOP for integrated FSM.

2.3. Target Audience for SOP

This SOP is targeted to the Chief Officers, engineering staff and/ or staff in-charge of sewerage sanitation in ULBs of Gujarat state. This SOP intends to bridge the gap in understanding of O&M requirements of fecal sludge (also called septage) and provide handy guidance to ULBs through a step by step process for fecal sludge management.

3. Standard operating procedure for integrated fecal sludge management

An integrated fecal sludge management plan would cover aspects across the value chain of on-site sanitation including safe collection, conveyance, treatment and disposal/reuse of the treated fecal sludge.

3.1. Conduct an audit of on-site sanitation systems technologies that collect and treat fecal sludge

A ULB should conduct a comprehensive audit of on-site sanitation systems that provides the city officials with a base line of the existing situation in the city. The audit should cover the following areas:

- Number of toilets connected to various types of on-site sanitation systems (single pits, twin pits septic tanks, others)
- Assessment of local construction standards, methods and technology
- Existing issues with on-site sanitation systems
- Routine O&M by property owners
- Cleaning and emptying frequency

3.2. Provide guidance to property owners on construction of accepted OSS

Toilet and septic tank construction are regulated by the National Building Code of India, 1983. The section on drainage and sewerage specifies sizing and design of toilet, septic tank and other sanitation infrastructure.

3.2.1. Conversion of single pit systems into on-site primary treatment system

The ULBs should take proactive steps towards encouraging households to convert their exiting single pit systems to more advanced systems that include collection and primary treatment. The addition of a septic tank or other treatment system before the single pit can enable households to convert the single pits into a soak pit (if the pit adheres to construction standards and has absorption capacity). The ULBs should also ensure that the disposal system of all existing public and community toilets in the city is improved to an on-site treatment system.

3.2.2. Construction of twin pits

Twin pits system consists of two underground chambers (pits) to hold and treat fecal sludge. These are normally offset from the toilet and should be at least 1 meter apart. A single pipe leads from the toilet to a small diversion chamber, from which separate pipes lead to the two underground chambers. The pits should be lined with open-jointed brickwork. Each pit should be designed to hold at least 12 months accumulation of fecal sludge. Wastewater is discharged to one pit until it is full. Discharge is then switched to the second chamber. The filled up pit can be conveniently emptied after 1.5 to 2 years, when most of the pathogens die off. The sludge can safely be used as manure. Thus the two pits can be used alternately and perpetually. Refer Annexure A for details on construction specifications for the system for various soil types and contexts (Ministry of Urban Development & JICA, 2013).

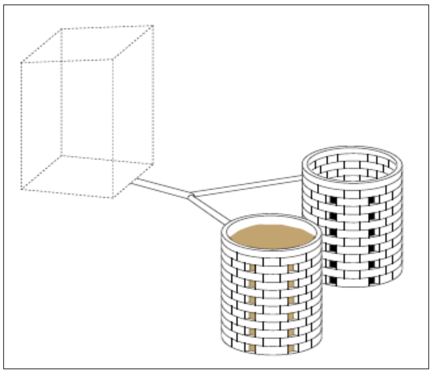

Figure 3 Twin pit system (eawag & IWA) 2014)

3.2.3. Construction of septic tank based systems

CPHEEO prescribes septic tanks as double chambered with specified sizes. Septic tanks need to be watertight and are built of bricks, stones or concrete. The recommended sizes of septic tanks and soak pits (used in Gujarat cities to serve dual function of storage & digestion of solids and infiltration of liquids) are shown in Tables 21.1, 21.2 and 21.6 of CPHEEO manual on Sewerage and Sewage Treatment Systems Part A Engineering and are reproduced in Annexure B. Cities can adopt their own innovative techniques for septic tank construction by using locally available material and skills.

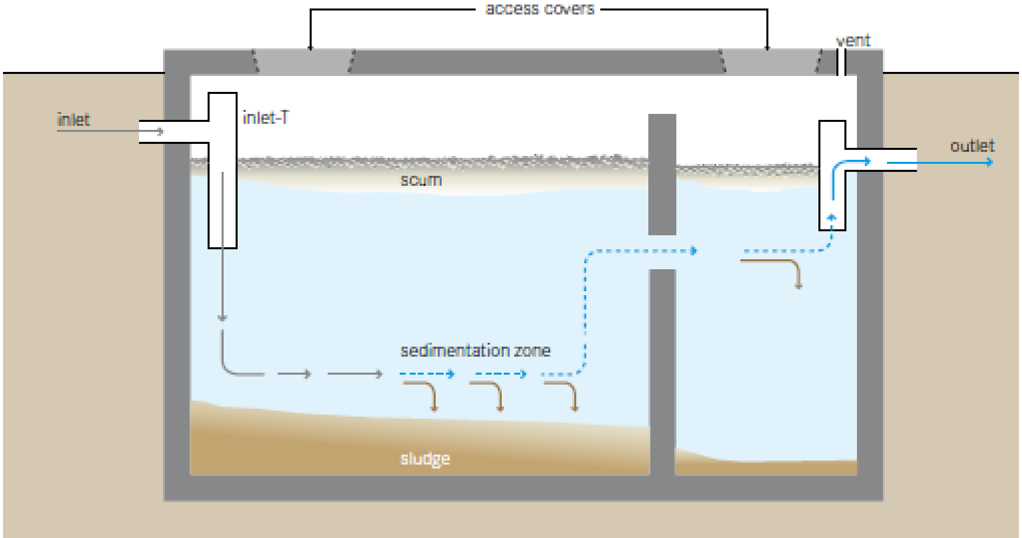

Figure 4 Double chambered septic tank

Image source: Compendium of Sanitation Systems and Technologies - 2nd Revised Edition)(eawag & IWA, 2014, p. 74)

Figure 5Local Innovation- Readymade Septic Tanks of RCC and Plastic used in Maharashtra & Jharkhand

Image source: K.V Dinesh and Sintex (Sintex)

The process of design and construction should be done very carefully; otherwise, problems may occur due to poor design and workmanship of septic tank and soak pit. A possible solution to this can be provision of standard designs of septic tanks to the citizens by the ULB and adoption of a simple process of construction, verification and approval which can be clubbed with the house completion report.

Effluent from the septic tanks should ideally be disposed using soak pits or leach fields which allow the absorption of liquids in the ground or should be conveyed using a solids-free/ settled sewer.

Disposal of effluents using soak pits

A soak pit is a porous-covered chamber that allows effluent from septic tanks to soak into the ground. It is also known as a soak-away or leach pit. The soak pit should be connected to the septic tank by an extension pipe with a T junction to receive the over flow from the tank. The diameter of soak pit is generally 900 mm with depth varying from 2400 to 4000 mm. The soak pit is filled with bricks or broken stones and is covered with stone or RCC slab. A vent pipe should be provided to release the gases produced in the soak pit. For detailed construction guidelines on septic tanks and soak pits, refer the Manual of Sewerage and Sewage Treatment Part A Engineering published by MoUD (Ministry of Urban Development & JICA, 2013, pp. 9-23).

Conveyance of effluent to an off-site treatment facility

In cities where discharging effluent into drains is a common practice, it is recommended that ULBs include alternative solutions in their long-term plans. ULBs can explore systems like settled or solids-free sewer system which is designed as a network of small-diameter pipes that transport pre-treated and solids-free wastewater (such as septic tank effluent). This system is economical than the conventional underground drainage system. It can be installed at a shallow depth and does not require a minimum wastewater flow or slope to function. For the detailed guidelines on settled or solids-free sewer system, refer Compendium of sanitation systems and technologies by Eawag and IWA (eawag & IWA, 2014, p. 92).

3.3. Provide guidance to property owners on routine O&M of OSS

Routine operations and maintenance of the complete on-site sanitation system is critical to ensuring safe and efficient sludge management practices. ULBs should educate and inform property owners about the proper functioning and maintenance requirements of these systems and encourage them to clean them often. The on-site O&M responsibilities of sanitation infrastructure (private) for which property owners are responsible include:

- Repair and maintenance of toilets, septic tank, soak pit and piping
- Clearing pipe blocks
- Getting fecal sludge emptied from private or municipal vacuum emptier at an interval of 2-3 years.

Figure 6 ULBs can distribute flyers and carry out IEC campaigns about proper septic tank/ soak pit usage

Image source: United States Environmental Protection Agency (USEPA)

3.4. Prepare a service plan for scheduled emptying of septic tanks

All ULBs should ensure safe emptying of on-site treatment units at regular intervals. Currently most households get their septic tanks cleaned once in 8-10 years. It is evident that there is not enough awareness among households to get their septic tanks cleaned at regular intervals of maximum 2-3 years. The ULB should initiate scheduled septic tank desludging services and carry out extensive awareness campaigns to ensure that the septic tanks are cleaned at least once in three years.

The scheduled emptying services should be provided on a rotating, two to three year cycle. In order to comply with The Prohibition of Employment as Manual Scavengers (and their rehabilitation) Act, 2013, ULBs need to ensure that all septic tanks and pit systems in the city are cleaned mechanically. The ULBs should either provide the emptying services themselves or enter into service contracts with private agencies. The contracts could also include construction and operation of treatment options like sludge drying beds. If the private players are providing the service, ULB should monitor their services. Suggestive criteria for selecting private emptiers should include:

- Provision of safety and protective gear to the cleaners
- Availability of mechanical cleaning equipment (Vacuum emptiers)
- Availability of a doctor on call
- Adequate number of trained staff
- Agreement to follow procedures listed in SOP

Since the households will be unlikely to pay for the scheduled services, the ULBs can consider raising their local taxes or charge a fixed amount as user charges for sanitation every year. The private service providers could then be compensated by the ULB.

Scheduled emptying of septic tank, Experience from Marikina city, Philippines

Source: A Rapid Assessment of Septage Management in Asia, Policies and Practices in India, Indonesia, Malaysia, the Philippines, Sri Lanka, Thailand, and Vietnam, January 2010, USAID

To achieve its goal of desludging all septic tanks in the city by 2011, Marikina City is implementing the "OplanTodoSipsip" program with Manila Water Company, Inc. (MWCI). Developed with support from the ECO Asia program, the initiative mobilizes local barangay leaders to educate communities about desludging septic tanks. As a result, Marikina City has increased the percentage of households using desludging services from 40 to 55 percent. Cooperative actions include the following:

- Community meetings are held to explain the program in advance of the desludging;
- A sound truck and fliers advertise desludging in a community the day before it is done;
- Local barangay staff accompany MWCI desludging crews to encourage homeowners to cooperate and open inaccessible septic tanks;
- MWCI places stickers on houses that have been desludged, so a second visit can be made later to the homes without stickers; and
- Promotion campaigns are conducted that include distributing informative calendars, art contests, and hand washing events.

The project aims to desludge all 90,000 septic tanks in Marikina City on a rotating five-year cycle. At the time of writing, however, MWCI had only desludged 5,400 septic tanks.

Box 2Scheduled emptying of septic tank, experience from Marikina city, Philippines

3.5. Invest in capital infrastructure

3.5.1. Procure cleaning equipment.

Septic tank needs emptying in regular intervals of depending on its design capacity. The ULBs need enough vacuum emptiers to effectively service all septic tanks in a city. The ULB can buy these emptiers or can ensure adequate equipment through signing service contracts with private contractors. Indicative capacities and other details of sludge emptying equipment available in India are listed in the table below:

Table 1 Indicative details of fecal sludge emptying equipment

Tank capacity (litres)	Gross Vehicle Weight (Tonnes)	Vacuum (%)	Displacement (litres per minute)	Positive pressure (bar)
1000 & 1500	5	80	1500 – 4500	2.0
3000	10	80	1500 -4500	1.5
6000	16	90	3200 – 9000	1.5
9000	25	90	4500 – 12000	2.5

ULBs can also procure dedicated small footprint (1500 – 3000 liter capacity) vacuum emptiers to service slums and other areas where access is narrow. For areas with wide roads (>9m), vacuum emptiers of capacity 5000-9000 liters can be deployed. The following box shows indicative requirement of cleaning equipment for cities of Patan and Lathi (Ministry of Urban Development, 2013, p. 40).

Patan

Number of septic tanks in the ULB (Census 2011)	8692
Existing number of emptiers	1
If septic tank needs to be cleaned once in three years ,then number of septic tanks need to be cleaned in a day	(8692/305*3) = 9.5 (Appx. 10)
Assuming that present emptier cleans 5-6 septic tanks /day ,then additional number of septic tank emptiers needed	1
Cost of emptier @ Rs. 1,500,000 (incl. prime mover)	Rs. 15 lakh
Annual O&M cost per emptier	Rs. 2 lakh
Annual Salary of staff involved in septic tank emptying process	Rs. 2.5 lakh
Income earned per emptier per annum by emptying 500 septic tanks @service fee of Rs. 500-Rs 1500 / tank	Rs. 2.5 Lakh-Rs. 7.5 lakh

Lathi

Number of septic tanks in the ULB (Census 2011)	2563
Existing number of emptiers	1
If septic tank needs to be cleaned once in three years ,then number of septic tanks need to be cleaned in a day	(2563/305*3) = 2.8 (Appx.)
Assuming that present emptier cleans 3 septic tanks /day ,then number of septic tank emptiers needed	1
Cost of emptier @ Rs. 700000 (incl. prime mover)	Rs. 7 lakh
Annual O&M cost per emptier	Rs. 1 lakh
Annual Salary of staff involved in septic tank emptying process	Rs. 2.5 lakh

Income earned per emptier per annum by emptying 915 septic tanks @service fee of Rs. 500-Rs 1500 / tank	Rs. 4.5 lakh - 13.7 lakh

Box 3Calculating requirement for vacuum emptiers for Patan and Lathi

3.5.2. Construction of sludge drying beds

The ULB needs to construct sludge drying beds to appropriately treat the fecal sludge. As the sludge is partially treated in the septic tank, it requires appropriate treatment before the usage. Drying of the sludge in the drying beds is considered as one of the septage treatment system. The following table presents the area requirement for sludge drying beds if the quantum of sludge generated is 100 cum/day:

Table 2 Calculation of Sludge drying beds and area required

	Sludge drying Beds	
1	Quantum of sludge to be treated (cum/day) – HHs level	100
2	Single Drying Bed area (12m x 12 m)	144
3	Max. Sludge depth (m)	0.3
4	Capacity per bed (cum)	43
5	Sludge drying cycle (days)	10
6	Total No. of sludge drying beds required (SDB)	30
7	Total site area (SD Bed area + 10% SD bed area + area of office and dried storage + area of ancillary units) (sqm)	13,250

Source:(Ministry of Urban Development, 2013, p. 36)

3.6. Establish customer service protocols

Once the ULB has procured the vacuum emptiers or made required arrangements with private contractors, the ULB should establish customer service protocols and convey it to the citizens by publishing in the local newspaper, holding meetings and displaying the information at citizen service centers. The ULB should also establish a helpline number and publicize it widely.

3.7. Follow operating procedure for cleaning septic tank/ soak pit

3.7.1. Daily Preparation for the ULB / emptying and transport service

- Receive work orders for the day
- Check the functioning of vacuum emptier and equipment
- Check personal protective equipment – All employees should be responsible for maintaining their own personal protective equipment (such as gloves, boots, hat, face mask, Davy's lamp) in good condition
- Check Disinfecting and spill control equipment – Operators should be trained on identifying spills and proper methods of disinfecting. Sprinkle lime over spilled area, wait 15 minutes, then wash with water
- Check Hoses – inspect hoses for cracks and wear– discard or repair worn and broken hoses. Connecting the Hose in the correct manner using the clamp style fitting ensures a tight and leak proof

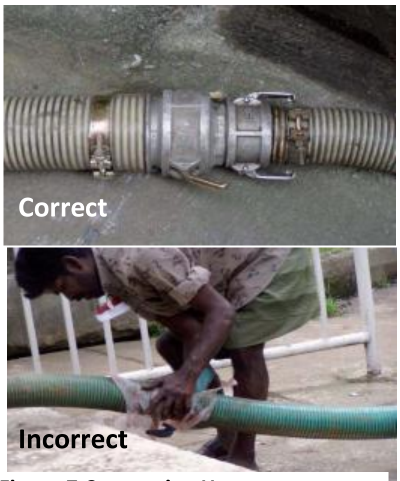

Figure 7 Connecting Hoses
Image source: K.V Dinesh

connection. Use of twine and plastic for making connections causes leaks and require cleanup.

Figure 8 Protective Gear and Vacuum Emptier

3.7.2. Operating the vacuum emptier

Operators should become familiar with the proper operation of the equipment in use for each operation. This includes the physical operation of the truck, and all valves, piping, power take-offs and ancillary equipment for the vacuum emptier (including the tank, valves, hoses, and fittings). The following steps can be followed for operating the vacuum emptier:

Figure 9Operating the vacuum emptier
Image source: (Robbins, 2007)

- Reach the first site and meet the building owner.
- Before pumping, check the tank to look for obvious damage to the structure and to verify proper piping is in place.
- Check the water level to get clues as to tank condition: high levels (above outlet level) indicate a clogged outlet; low levels (below outlet level) indicate a leaking tank (or tank not in use).
- Check for back flow into tank during pumping and when pumping is complete. Flow back may indicate a problem with plumbing in the house or clogged disposal.
- Open the access covers, inspect the interior and exterior of the tank. If more than one, locate and remove lids (for at least 2 hours) from all compartments.
- Each compartment will require pumping after ventilating. Probe the tank with the last length of hose. This will provide an indication on the volume of sludge to pump.
- Start the pump or vacuum equipment. The operator will make sure there is suction and that the pump is operating.
- Volume in the tank should start decreasing rapidly. Use hose to break up sludge and scum to the extent possible.

After pumping is complete, check the tank for remaining sludge. If there are accumulated solids remaining, initiate the pump-back procedure, which is to send the pumped fecal sludge under pressure back into the tank and direct this flow toward the sludge mass. This will break up the mass, making it possible to pump out. When pump-back is complete, pump out the tank again (suction). When pumping is complete, wash the hoses and replace the tank lids. Clean up any spills and disinfect with lime or bleach solution.

3.7.3. Cleaning and desludging on site systems

Septic tank/Single pit emptying: The process of septic tank emptying can be broken down into the following three simple steps:

From septic tanks firstly a small quantity of scum in the vicinity of the suction pipe is withdrawn.

Liquid septage is extracted until sludge at the bottom is reached.

Sludge comes off last and is fully sucked out only if there is bottom slope in the septic tank towards outlet. It is important to empty the tank completely including sludge.

Figure 10 Septic tank emptying procedure

If tanks are emptied partially, they become more and more filled with hardened sludge, washout of solids occurs and quality of effluent deteriorates. Septic tanks must be emptied once in 2-3 years or even earlier intervals when they are overloaded. If the single pits are not dug very deep and cleaned regularly at an interval of 2 to 3 years, the sludge from the pits can be emptied mechanically. If the hardened sludge is to be mechanically removed, the pit should be back washed and the sludge should be diluted and then emptied.

Soak pit cleaning

In most cities septic tanks are not cleaned regularly due to which sludge enters soak pits and gets accumulated resulting in diminishing the capacity of soil. In high water table or in stony, gravely soils where percolation capacity of soil is limited, the soak pits get filled and hence need to be cleaned. It is essential that ULBs and State do not permit soak pits deeper than 3m. Image 4 shows a typical example of soak pit emptying in Anklav city. For emptying typical soak pits in Gujarat cities the following steps can be followed:

Remove the Soil Cover (1-1.5m) and puncture the concrete cap to make a hole to insert the suction pipe

Pump water into the pit to make the pit contents dilute to enable smoother flow

Figure 11 Soak pit cleaning procedure

However in the long term, it is recommend that in areas where the percolation capacity has reduced ULBs should consider alternate systems like settled sewerage system or connect to open drain system as an intermediate solution

Cleaning twin pits

Once a pit is full, in a twin pit system, it should be closed and the wastewater should be channelized to the second pit. The full pit should be emptied only after one to two years after the contents of the pit have transformed into a partially sanitized, soil-like material called pit humus. Pit humus can be manually excavated.

3.8. Safely transport fecal sludge to sludge treatment site

Figure 12Septage emptying vehicle

Image source: Urban Management Centre

If cities have an oxidation pond or a sewage treatment plant, the emptier should dispose fecal sludge into STP inlet chamber or into the manhole on the outfall sewer or in the sludge drying beds. In case of partial sewerage, it is not advisable to dispose these in the sewers since it will end up as sludge in open drains and make the situation worse.

If the ULB do not have any provision of the treatment system, ULB can select the suitable treatment and the following actions at fecal sludge receiving site are summarized below.

- Plan the trip so as to arrive at the disposal site within the specified disposal site operating hours
- Report equipment malfunctions or required repairs immediately to supervisors.
- At the Disposal Facility position the truck so that the fecal sludge may be directed to the receiving chamber with only one length of hose
- Open the valve and allow the sludge to flow via gravity into the receiving chamber
- When the tank is empty, disconnect hose and clean tank and hose with water
- Use all safety precautions at disposal site and keep site clean

3.9. Treat and dispose fecal sludge

Sludge is the black water from toilets mixed with grey water from bathrooms whereas septic tank effluent is the liquid part which flows out from septic tank (since solids are trapped in septic tank). Sludge has a much higher concentration of pollutants than the septic tank effluent. Biological Oxygen Demand (BOD) and Total Suspended Solids (TSS) are two common measurements of the strength of wastewater. Sludge may have BOD concentrations between 440to78, 600 mg/l and TSS values in excess of 90,000 mg/l, where septic tank effluent has values averaging 200 mg/l BOD and 300 mg/l TSS. As septic tanks fill with sludge, the effluent begins to resemble fecal sludge with higher pollution values. Therefore, regular desludging provides dramatic improvements in effluent quality. Detailed sludge characterization (BOD, TSS &other microbial characteristics) as well as its dewatering characteristics (specific resistance etc.) should be done prior to the design of any fecal sludge management facility. Treatment of sludge can be of two types, treatment at sewage treatment plants and at independent septage treatment plants. The details of these two types of treatment are given in the section below:

3.9.1. Treatment of fecal sludge at Sewage Treatment Plants

Co-treatment of fecal sludge along with municipal sewage at a STP if available in the city is the most desirable option. Though sludge is more concentrated in its strength than domestic sewage, its constituents are similar to municipal wastewater. The sewage treatment plants should have adequate capacity to accept the sludge without hampering the functioning of the sewage treatment plant. Another possible way (needs checking for STP shock load or overload) is to dispose fecal sludge into easily accessible manholes at steep gradient sections on outfall sewers.

Sludge could be added to sewage immediately upstream of the screening and grit removal processes. Fecal sludge could be processed with the sludge processing units of STP. If fecal sludge is to be co-treated with sewage, it will be necessary to construct a fecal sludge receiving chamber. Chemicals such as lime or chlorine can also be added to the fecal sludge in the storage tank to neutralize it, to render it more treatable, or to reduce odors.

Figure 13 Sludge disposal into inlet chamber of STP

Image Source: septage management guide for local governments, 2007, David M. Robbins

3.9.2. Treatment at independent Fecal Sludge Treatment Plants

When a city does not have a sewage treatment plant, a treatment plant specially meant for sludge treatment becomes the option to consider. These include:

a) Lime stabilization – odor control, conditioning and stabilization of the sludge.
b) Dewatering – sludge drying beds or mechanical dewatering.
c) Anaerobic / aerobic wastewater treatment – liquid from the sludge drying beds and mechanical dewatering systems.
d) Co-composting with organic solid waste.

Lime stabilization

Lime stabilization is practiced to stabilize, control odor, vector and pathogen destruction. Lime stabilization involves adding and thoroughly mixing lime (lime powder slaked with water in 1:3 proportions, 15 litres of slaked lime for 4000 litres of septage) with each load of septage to ensure that the pH is raised to at least 12.

Lime addition could be done at any of these three points:

- In the septage emptier
- In a septage receiving tank where septage is discharged
- Spread septage in a pit and apply lime every time septage is dumped.

Figure 14 Lime stabilization

Sludge drying bed

An unplanted drying bed is a simple, permeable bed that, when loaded with sludge, collects percolated leachate and allows the sludge to dry by evaporation. Approximately 50% to 80% of the sludge volume drains off as liquid or evaporates. The sludge, however, is not effectively stabilized or sanitized.

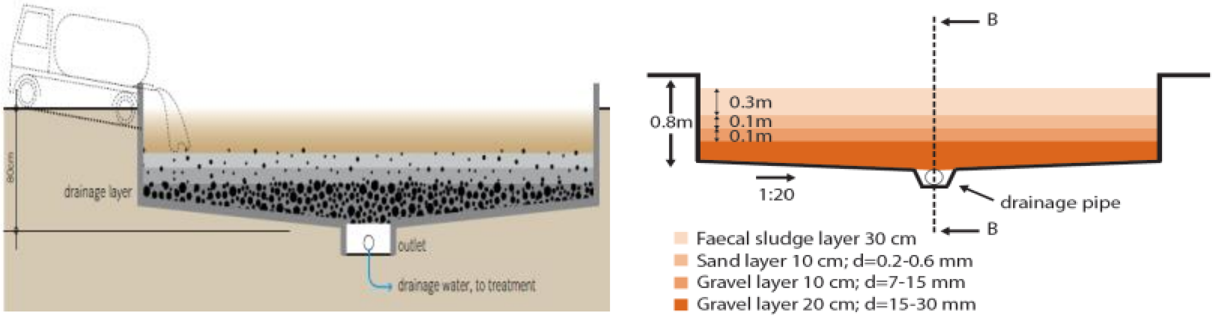

Figure 15 Sludge drying beds

Image source: Compendium of Sanitation Systems and Technologies - 2nd Revised Edition and Advisory on septage management

Planted Sludge drying bed

A planted drying bed is similar to an Unplanted Drying Bed, but has the added benefit of transpiration and enhanced sludge treatment due to the plants. The key improvement of the planted bed over the unplanted bed is that the filters do not need to be desludged after each feeding/drying cycle. Fresh sludge can be directly applied onto the previous layer; the plants and their root systems maintain the porosity of the filter.

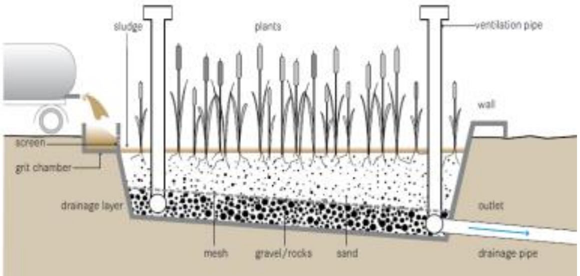

Figure 16Planted Sludge drying bed

Image source: Compendium of Sanitation Systems and Technologies - 2nd Revised Edition

Septage dewatering

The septage after lime dosing is pumped to screw press or any other mechanical dewatering machine. Polyelectrolyte (a chemical commercially available for use as a coagulant in water supply and sewage treatment) is added to improve the dewatering efficiency. The liquid residual/ filtrate from dewatering machine needs to be further treated before disposal. The dewatered sludge needs to be dried or composted prior to reuse as soil conditioner / organic fertilizer. Instead of Screw Press the other options could be to use centrifuge or belt press or a filter press. Many companies in India manufacture these.

Figure 17Septage dewatering

Composting of Septage

Composting is a popular method of treating septage. During the composting process organic material undergoes biological degradation to a stable end product. Approximately 20 percent to 30 percent of the organic solids are converted to carbon dioxide and water.

Figure 18Septage composting

Image Source: Cao Dzien co composting plant in Hanoi, Vietnam. Business Analysis of Fecal Sludge Management, Sept 2012, Gates Foundation

As the organic material in the septage decomposes, the compost heats temperatures in the range of 50 to 70 degrees Centigrade and harmful pathogens are destroyed. The resulting humus-like material is suitable as a soil conditioner and source of nitrogen and phosphorus. The basic procedure for composting is as follows:

- Septage is mixed with a bulking agent (e.g. agricultural residue, cow dung, organic part of municipal solid waste) to decrease moisture content of the mixture, increase porosity, and assure aerobic conditions during composting.
- The mixture is aerated by mechanical turning ("agitated") for about 28 days. The most common "agitated" method is windrow composting: the mixture of septage or wastewater solids and bulking agent is pushed into long parallel rows called "windrows", about 1 to 2 meters high and about 2 to 4.5 meters at the base. The cross-section is either trapezoidal or triangular. Several times a week the mixture is turned over using a front-end loader to move, push, and turn the mixture. Factors affecting the composting process (USEPA 1984) include moisture content (40 percent to 60 percent); oxygen (5 percent to 15 percent); temperature (must reach 55 to 65^{0} C); pH (6 to 9); and carbon-to-nitrogen ratio (30:1).
- Pit composting is simple, does not need any equipment and has been practiced in Gujarat before. The process involves digging many pits (1.2m wide, 1.5m deep and 4m long) and covering with soil (2-3 inches) every time septage is dumped until it gets filled. Contents of the pit are emptied and can be used for soil enrichment after 6 months, by this time most pathogens die off and composting is complete. Treated septage is safe for agricultural use.

Innovative Approach for Septage Management

Source: Business Analysis of Fecal Sludge Management, Sept 2012, Gates Foundation

Recent innovative method of using a geo tube for septage storage and transfer has been introduced in Malaysia. The geo-tube material is made of a porous membrane with the sludge received through a hose from a truck. Discharge can be achieved by using a pump or gravity. Sludge in the geo-tube is gradually dewatered by leaching through a porous membrane and the leach ate is treated in the nearby STP while the solids are retained inside. Exposure to the outdoor heat further dries the sludge and the geo-tube is eventually transported to a landfill or recovery facility. Geo-tube before and after use in Malaysia

Box 4Innovative Approaches of Septage Management

Dewatered septage/sludge can be used as a fertilizer in agriculture application

- A fecal coli form density of less than 1000 MPN/g total dry solids
- Salmonella species density of less than 3 MPN per 4 g of total dry solids.
- WHO (2006) suggests helminth egg concentration of < 1/g total solids and E-coli of 1000/g total solids in treated septage for use in agriculture.

Properly treated sludge can be reused to reclaim parched land by application as soil conditioner, or as a fertilizer in agriculture. Deteriorated land areas, which cannot support the plant vegetation due to lack of nutrients, soil organic matter, low pH and low water holding capacity, can be reclaimed and improved by the application of treated septage.

Septage sludge, as a result of lime stabilization has pH buffering capacity that is beneficial for the reclamation of acidic soils. Treated septage is applied with agricultural manure spreaders. Liquid sludge, typically with solid content less than 6 percent are managed and handled by normal hydraulic equipment. Treated septage contains nutrients in considerable amounts, which supports the growth of a number of plants.

Drip irrigation is the preferred irrigation method for settled septage effluent when irrigation is feasible. Crops which could be safely grown are corn, fodder, cotton, trees including fruit trees, eucalyptus and poplar.

Aquaculture can be practiced for settled septage effluent when freshwater is available to achieve dilution to ensure dissolved oxygen is above 4 mg / l. Fish species of tilapia and carp are preferred since they tolerate low dissolved oxygen. Both drip irrigation and aquaculture need land and are feasible at city outskirts.

3.9.3. Full cost recovery

To be sustainable, the septage management programs should be funded from the users in the form of user fees. This fee can be added to either the property tax or it can also be used as a pay and use system. This fee should include cost of staff, transportation, treatment, disposal and operation and maintenance.
An example of cost recovery is Marikina City, Philippines. Manila Water Company, the service provider, will purchase eight new septage pumping trucks and fund a mechanized treatment facility in exchange for a 10% surcharge added to the monthly water bill. The program will fund septage pumping of 55,547 septic tanks every 5.25 years (Robbins, 2007).

3.9.4. Social marketing

This includes initiating programs for educating the citizens at large. Dedicated Information, Education and Communication (IEC) programs need to be undertaken to inculcate education on sanitation for school children, youth and women in the city.

The social marketing system has different steps, these can include surveying the existing perceptions, conducting meetings with stakeholders, developing technical committees and outreach tools for media outlets, pre testing the tools, performing final surveys and deploying the messages to gauge results.

In Muntinlupa, the city and the technical team developed a campaign plan with target audiences and messages and then developed a mascot, fliers, posters, newspaper ads and a video about the market treatment facility that was aired on a local cable TV station (Robbins, 2007).

3.10. Recording and Reporting

Keeping accurate records regarding tanks and volume pumped is important for billing and compliance. Recordkeeping is an integral part of a comprehensive septage management program.

The “manifest system” is a tracking and compliance tool. It helps ensure that all of the septage pumped arrives at the disposal site and minimizes the opportunity for illegal discharge. It is also a record that some septage programs may choose to use for paying septage hauling subcontractors.

Manifest forms are simple receipts that specify:

- the location or address of the pumped septic tank
- septage characteristics (residential or commercial)
- the name and address of the property owner or occupier
- the volume of septage pumped
- any notes regarding tank deficiencies, missing pipes or fittings, improper manholes or access ports, cracks or damage observed

All ULBs should keep a manifest form record for each septic tank / soak pit emptied (A sample manifest form is shown in **Annexure D**). Once completed, a copy of the manifest is given to the property owner as a receipt. When the septage load is delivered to the disposal site, the disposal site operator:

- accepts the load
- verifies the volume
- takes a sample if needed
- signs the manifest proving receipt of the volume of septage disposed of

It may be advantageous for the operator (ULB or private) to pump out multiple tanks before going to the disposal site. In this case, a multiple-load manifest form should be completed as well as in addition to individual manifest/receipt forms. The completed document or documents should be given to the ULB for their records. Cities with more than one lakh population should maintain the records at ward level for on-site sanitation system cleaning.

3.11. Ensure safe practices

Never enter a septic tank / soak pit which has not been well ventilated. Check for gas levels before entering septic tanks, manholes and closed chambers. Following steps should be followed as safety measures for septage management:

- Always keep first aid kit, gas detection lamp and fire extinguisher in the septage emptier vehicle
- Provide training to workers handling septage on safety and hygiene practices
- Provide fencing or compound around septage treatment facility premises
- Train staff and compel them to wear helmets, gum boots and gloves while on work.
- Ventilate covered tanks/pits by keeping them open for sufficient period before entering
- Paste list of emergency numbers on septage emptier and at a prominent place in septage treatment / disposal unit

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Annexure

Annexure A

Specifications of twin pit system (From CPHEEO manual)

In water logged area: The pit top should be raised by 300 mm above the likely level of water above ground level at the time of water logging. Earth should then be filled well compacted all-round the pits up to 1.0 m distance from the pit and up to its top. The raising of the pit will necessitate rising of latrine floor also. A typical pour flush latrine in water logged areas is shown in Figure 19

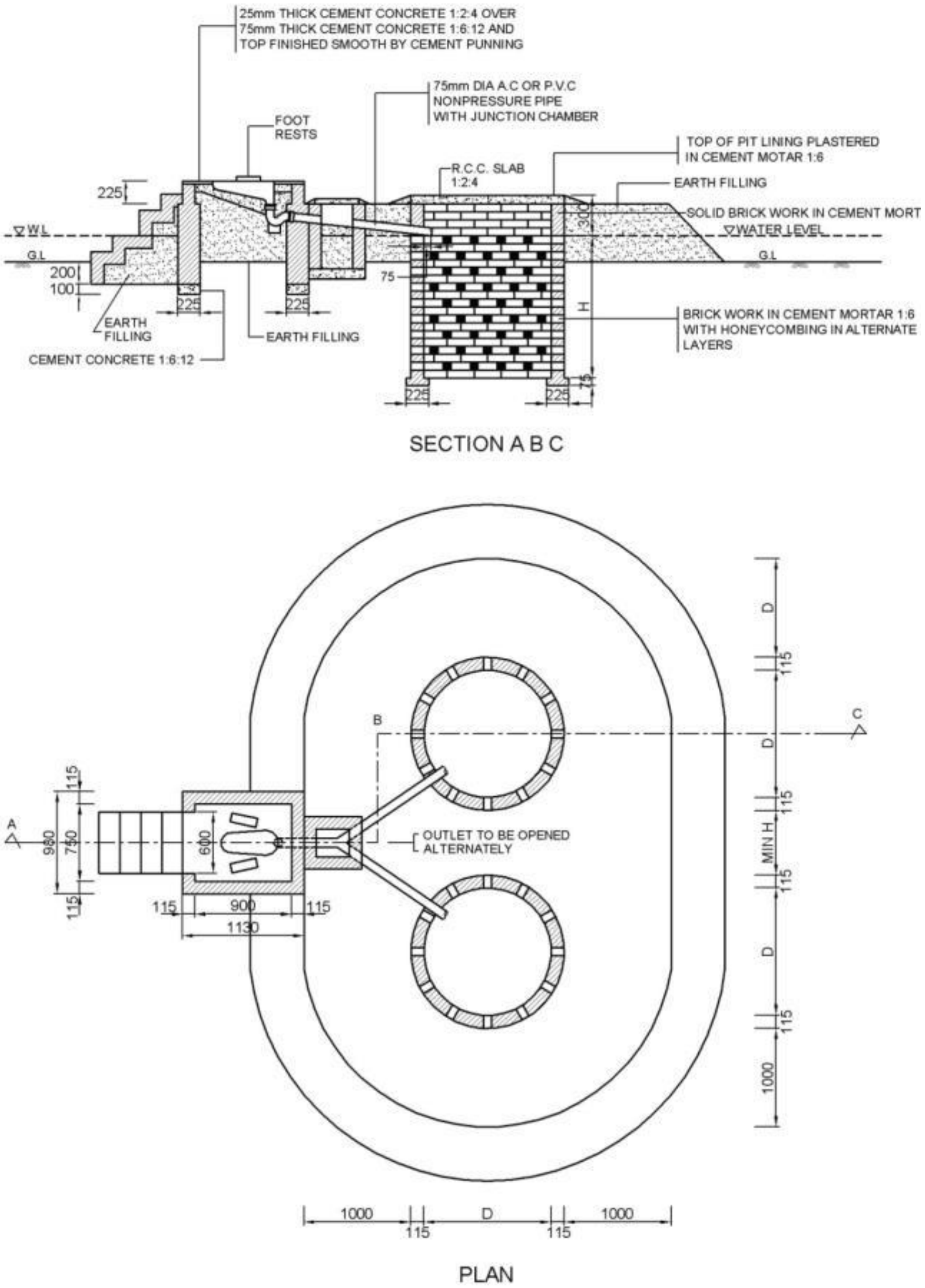


Figure 19 Twin pit for water logged area

In high subsoil water level: Where the subsoil water level rises to less than 300 mm below ground level, the top of the pits should be raised by 300 mm above the likely subsoil water level and earth should be filled all around the pits and latrine floor raised as stated above. A typical pour flush latrine with leach pits in high subsoil water level is shown in Figure 20

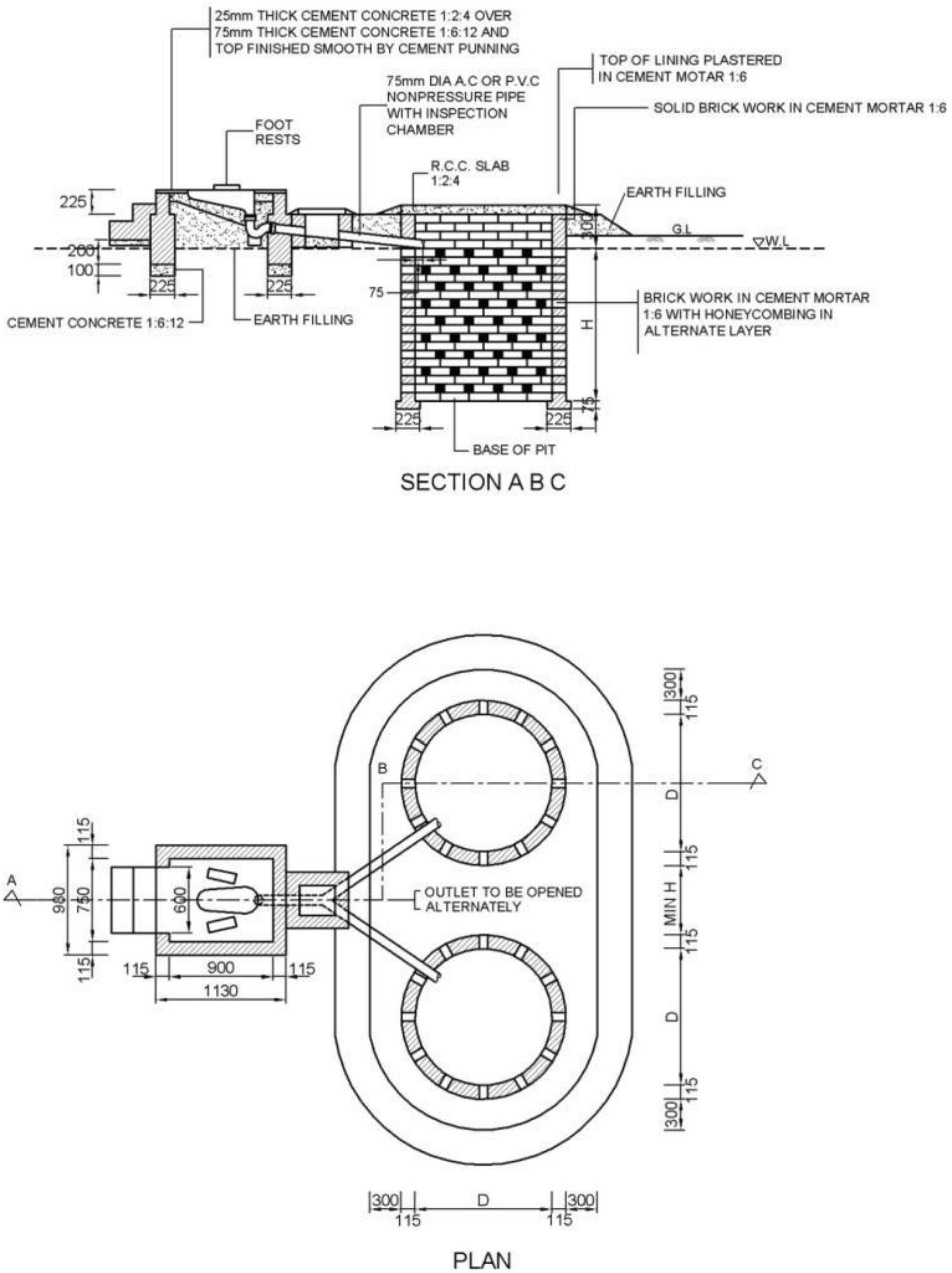


Figure 20 Twin pit in high subsoil water level

In rocky strata: In rocky strata with soil layer in between, the leach pits can be designed on the same principle as those for low subsoil water level and taking the long term infiltrative capacity as 20 l/m2/d. However, in rocks with fissures, chalk formations, old root channels, pollution can flow to very long distances; hence these conditions demand careful investigation and adoption of pollution safeguards as stated in paragraph below.

In black cotton soil: Pits in black cotton soil should be designed taking infiltrative rate of 10 l/m2/d. However a vertical fill (envelope) 300 mm in width with sand, gravel or ballast of small sizes should be provided all round the pit outside the pit lining.

Where space is a constraint: Where circular pits of standard sizes cannot be constructed due to space constraints, deeper pit with small diameter (not less than 750 mm), or combined oval, square or rectangular pits divided into two equal compartments by a partition wall may be provided. In case of combined pits and the partition wall should not have holes. The partition wall should go 225 mm deeper than the pit lining and plastered on both sides with cement mortar. A typical pour flush latrine with combined pits is shown in Figure 21

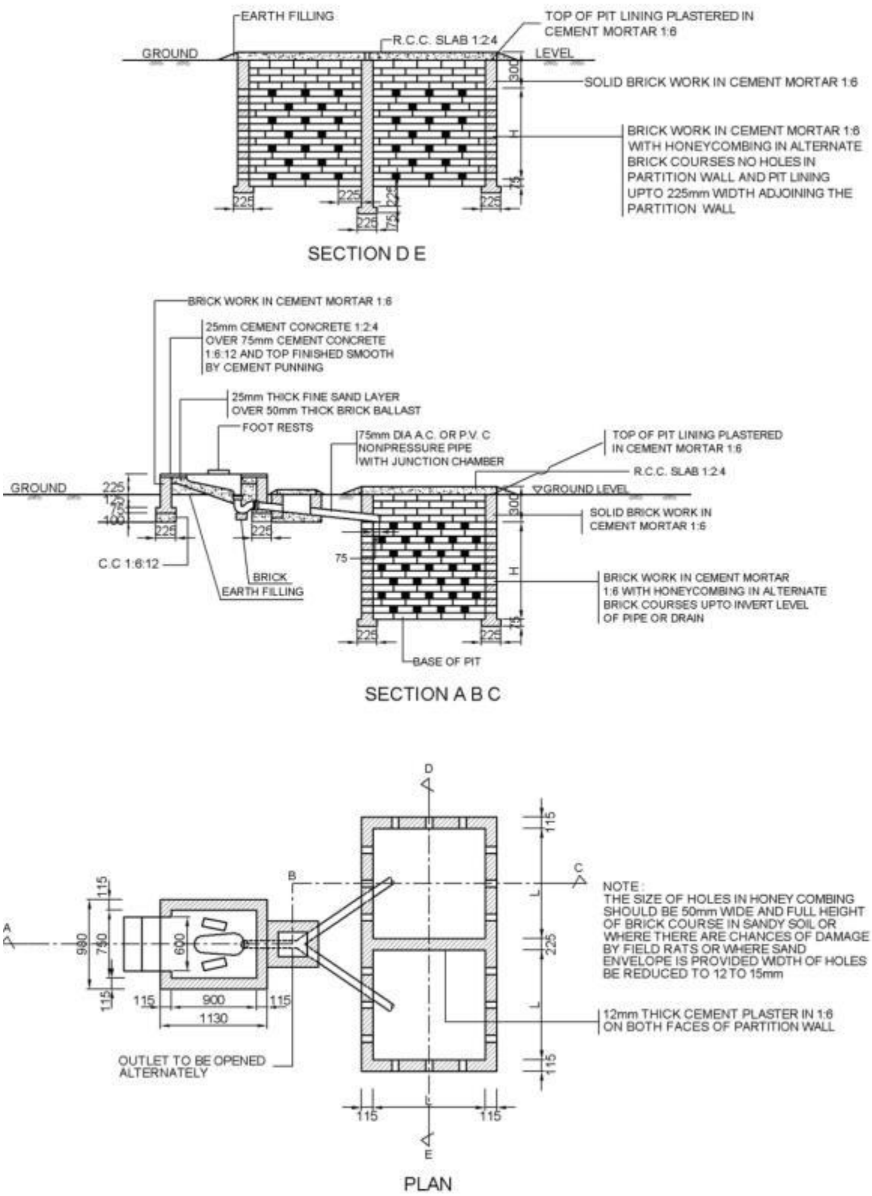


Figure 21 Twin pits in Space constrain location

Annexure B

Recommended sizes of septic tanks (From CPHEEO manual)

Sl. No.	Number of Users	Length (m)	Breadth (m)	Liquid depth for Cleaning once/2 years	Liquid depth for Cleaning once/3 years
1	5	1.5	0.75	1.0	1.05
2	10	2.0	0.9	1.0	1.40
3	15	2.0	0.9	1.3	2.0
4	20	2.3	1.1	1.3	1.8
5	50	5.0	2.0	1.0	1.24
6	100	7.5	2.65	1.0	1.24
7	150	10	3.0	1.0	1.24
8	200	12	3.3	1.0	1.24
9	300	15	4.0	1.0	1.24

Recommended sizes of twin pits

Pit type	5 users		10 users		15 users	
	Diameter	depth in m	diameter	depth in m	diameter	depth in m
Dry pits	0.9	1.0	1.1	1.3	1.3	1.4
Wet pits	1.0	1.3	1.4	1.4	1.6	1.5

Notes:

1. Depth from bottom of pit to invert level of incoming pipe or drain
2. When groundwater table is below the pit bottom it is a dry pit, when groundwater table is above the pit bottom it is a wet pit

Annexure C

MODEL CHECKLIST

The following checklist provides a ready reference of major considerations that apply for work in a confined space such us sewer, septic tank or soak pit.

PRE-ENTRY

The pre-entry considerations should be at least as follows:

a. **Employee selection**, including evaluation of an employee's aptitude and fitness for task and confined space entry.

b. **Employee training should include the following:**
   - Emergency entry and exit procedures.
   - Use of respiratory protective devices.
   - First aid including cardio-pulmonary resuscitation (CPR).
   - Safety equipment use.
   - Rescue drills.
   - Fire protection.
   - Communications.

c. **Actions required before execution are as follows:**
   - Coordinate planning of work.
   - Coordinate supervising of work.
   - Implement emergency rescue plan.
   - Initiate safe work practices.
   - Signpost work area.
   - Isolate confined space.
   - Evaluate confined space environment.
   - Comparison of initial test results with existing standards to determine
   - Ventilation and/or personal protection requirements.
   - Ventilate and/or provide personal protection.
   - Provide for monitoring of confined space during work.
   - Ensure that standby staff is available for rescue of workers and operation of essential equipment.
   - Ensure rescue equipment is readily available and in order.
   - Authorize entry by permit.
   - Suspend work/evacuate space if conditions change to present real/
   - Potential danger.

DURING ENTRY AND RE-ENTRY

The minimum considerations prior to the entry and re-entry should be as below

- A comparison of initial test results with an existing standard to determine whether ventilation or personal protective equipment will be used.
- Continuous or periodic monitoring of confined space atmosphere.
- Ensure safe work practices followed.
- Reissue permit if conditions change.
- Confirmation that all persons and equipment are accounted for.

AFTER EXIT

The consideration after exit should include the following:

- Ensure safe work practices followed.
- Review of operation - comment on any unsatisfactory aspects.
- Acceptance of completed job.
- Secure the entry point
- Clean the equipment and store it in safe place.

Annexure D

Sample Septage Manifest Form (ULBs should modify this to fit their needs)

Name of the City__________________

Date ____________________________ Time ____________________ am/pm

1. Basic Information (Must be completed by the septage emptier (person)

a. What is the Volume of septage emptied (liters) ______
b. What is the type of container emptied? (Tick the correct option)
   ___ Holding Tank ___ Septic Tank ___ Soak Pit___ Other (specify) _________
c. Source: ___ Residential ___ Restaurant ___ Office/commercial ___ Industrial ___ other(__specify___)

2. Generator of septage (Not to be filled in case of Oxidation Pond)

a. Complete name: ____
b. Phone number: ____
c. Complete address with landmarks:
____
____

The undersigned being duly authorized hereby certifies to the accuracy of the source and type of collected septage identified above and subject to this manifest.

Date: ______________ Signature: _________________________________

3. Information about the wastewater emptier (vehicle):

a. Company Name: _______________________________
b. Type of Vehicle: _____________
c. Vehicle Number: ____________

d. Where was the waste taken for treatment?
____
e. Where was the waste dumped?
____
f. Was the treated septage used for any other purpose?
____

4. Acceptance by ________Municipal Council

FORM AT COMPOSTING SITE or SEWAGE TREATMENT PLANT
Emptier (Name) __________________________
Vehicle Number: ______________________________
The above emptier delivered the described septage to this disposal facility and it was accepted.
Disposal date: _________________________________
Signature of authorized official and title: ___________________________

Glossary

Sewer: An underground conduit or pipe for carrying off human excreta, besides other waste matter and drainage wastes.
Source: Manual on Sewerage and Sewage Treatment Systems Part A Engineering, CPHEEO

On-site sanitation: It is underground waste collection system which is used in the absence of piped sewer system. When the wastes are collected, treated and disposed of at the point of generation, it is called an on-site system like pit latrines and septic tank systems.
Source: Manual on Sewerage and Sewage Treatment Systems Part A Engineering, CPHEEO

Fecal sludge: It is a mixture of solids and liquids, containing mostly Excreta and water, in combination with sand, grit, metals, trash and/or various chemical compounds.
Source: Compendium of Sanitation Systems and Technologies, by The International Water Association.

Septage: A historical term to define sludge removed from septic tanks.
Source: Compendium of Sanitation Systems and Technologies, by The International Water Association.

Septic tank: A water-tight settling tank or chamber, normally located underground, which is used to receive and hold human excreta, besides other waste matter and drainage waste.
Source: Manual on Sewerage and Sewage Treatment Systems Part A Engineering, CPHEEO

Soak Pit: Porous-covered chamber that allows wastewater to soak into the ground. It is also known as a soak-away or leach pit.
Source: Septage management in Urban India, Water and sanitation Program, National Urban Sanitation Policy

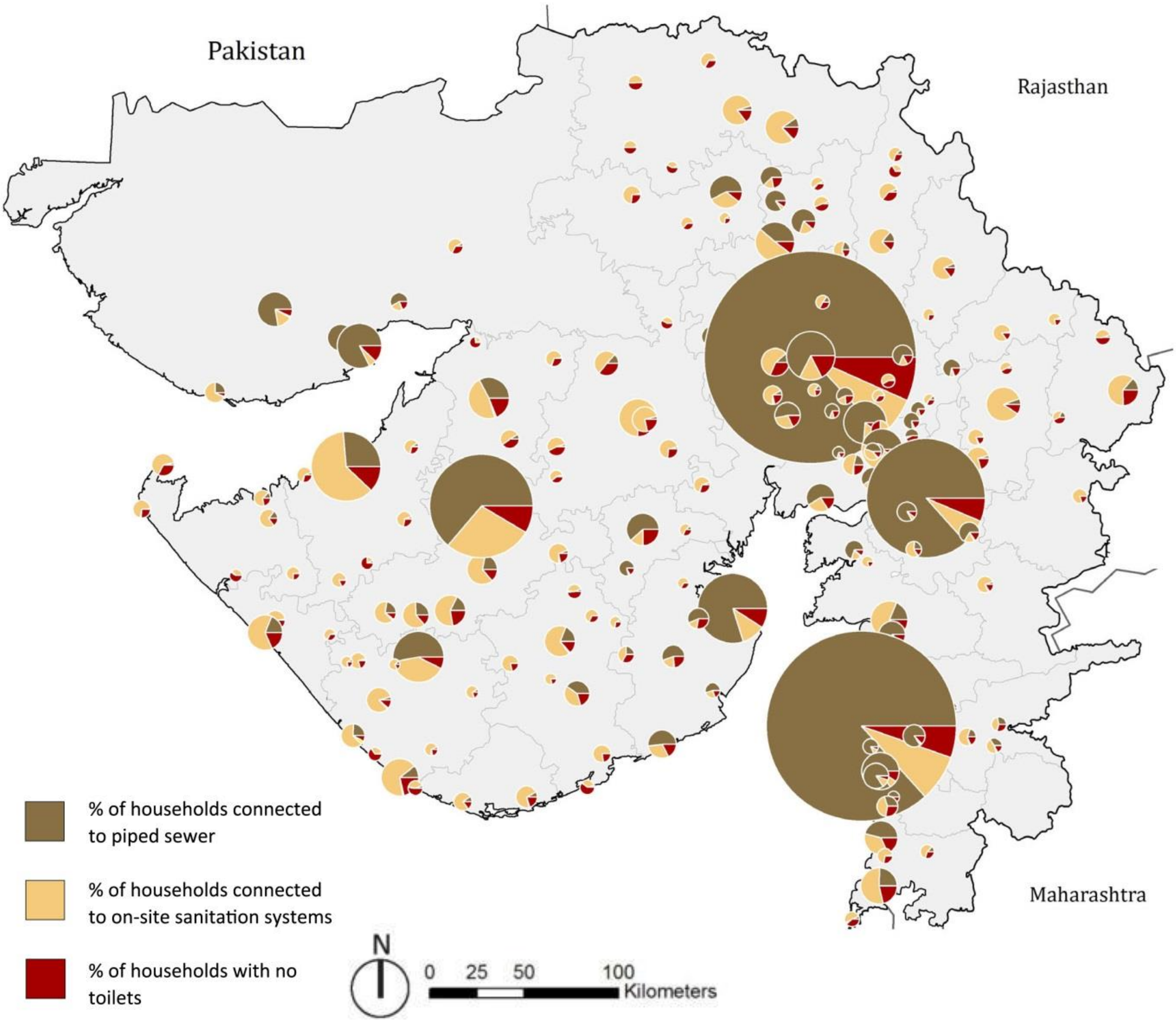
Single-pit system: It is a sanitation technology. Excreta, along with anal cleansing materials (water or solids) are deposited into a pit. Lining the pit prevents it from collapsing and provides support to the superstructure. A single pit latrine consists of a toilet superstructures and a single pit to be filled up, emptied and filled up again. To improve pit latrines, aeration or an additional pit can be added (see single VIP, double VIP or double pit latrine).
Source: Compendium of Sanitation Systems and Technologies. 2nd Revised Edition

Twin-pits: A *sanitation technology* consisting of two alternating pits connected to a *pour flush toilet*. The *black water* (and in some cases *grey water*) is collected in the pits and allowed to slowly infiltrate into the surrounding soil. Over time, the solids are sufficiently dewatered and can be manually removed with a shovel.
Source: Compendium of Sanitation Systems and Technologies. 2nd Revised Edition

Solids-Free Sewer: A solids-free sewer is a network of small-diameter pipes that transports pre-treated and solids-free wastewater (such as Septic Tank effluent). It can be installed at a shallow depth and does not require a minimum wastewater flow or slope to function. Solids-free sewers are also referred to as settled, small bore, variable-grade gravity, or septic tank effluent gravity sewers.
Source: Compendium of Sanitation Systems and Technologies. 2nd Revised Edition

Households with access to waste water disposal system (Census data 2011)

This map visualizes the Census data on access of urban households with waste water disposal system in the state city-wise



(Size of the dot represents the population of the ULB)

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