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Guidelines for Septage Management in Maharashtra

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Swachh Maharashtra Mission (Urban)

Urban Development Department, Government of Maharashtra

Disclaimer

This report is compiled from various government reports and guidelines. It draws from the Ministry of Urban Development, Government of India's Advisory Note on Septage Management in Urban India-2013, manuals of Central Public Health Engineering and Environmental Organization, and Operative guidelines for septage management for urban and rural local bodies in Tamil Nadu.

The report is to be used solely as a reference guide by various stakeholders. Urban local bodies are advised to seek guidance and technical approval from appropriate authorities before implementation. The Urban Development Department, Government of Maharashtra and CEPT University are not responsible for the content or the consequences of any action taken on the basis of the information provided in this report.

Guidelines for Septage Management in Maharashtra

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1 Septage Management and its importance

1.1 Introduction:

"Septage" is the liquid and solid material that is pumped from a septic tank, cesspool, or other treatment facility after it has accumulated over a period of time. A septic tank will usually retain 60 to 70% of the solids, oil, and grease that enter it. The scum accumulates on top and the sludge settles at the bottom, comprising 20 to 50% of the total septic tank volume when pumped. Septage has an offensive odor and appearance and contains significant levels of grease, grit, hair, and debris. It is a host for many disease-causing organisms.

Septage management Plan covers the entire service chain starting from design of septic tank, collection, conveyance, safe treatment and reuse or safe disposal of septage.

Proper treatment and management of faecal sludge is integral to safe sanitation practices. According to the Census 2011 around 30 million urban households, are not connected to any sewer system. Even if the cities create more underground sewerage infrastructure, the septic tank often remains an integral component of the sewerage scheme. A rapid assessment of septage management in Asia carried out by USAID in 2010 revealed that in India about 148 million people in urban areas depend on septic tanks. This was recognized by the National Urban Sanitation Policy (NUSP), 2008, which emphasizes the need for proper collection, treatment and disposal of sludge from on-site installations. In this context, more attention needs to be paid to proper construction of toilets and septic tanks, their maintenance and safe collection, conveyance and disposal of faecal sludge from these systems.

In addition to this, most urban local bodies (ULBs) in India do not effectively monitor the regular cleaning and maintenance of septic tanks. Some ULBs provide septic tank cleaning as a municipal service. This is generally treated as a complaint redressal activity. So when the septic tank/pit overflows a complaint is registered with the ULB. However, many ULBs do not have adequate number of emptying trucks and are unable to provide prompt service. In many cities private players have filled this gap by providing these services. However, their fees are quite high and their services are not regulated. Disposal of collected septage/faecal sludge is not regulated, and sludge is dumped in open drains or in water bodies, or near garbage dumps. Such practices pose considerable health and environmental risks.

1.2 Current septage management practices and its need in Maharashtra

Septage management has been neglected in cities in Maharashtra, as in most Indian cities. The sector has not received any attention because of poor understanding of septage, lack of proper technical guidance, inadequate resources and skills, shortage of manpower and lack of finance.

In Maharashtra, only 32 cities have at least a partial conventional underground sewerage system. Hence, the reliance on on-site sanitation systems is very high in state of Maharashtra However, most cities in the state depend on on-site technologies such as single pit, and twin-pit or septic tank based toilets. As per Census 2011, In Maharashtra, around 70% of households have individual toilets of which 53 % are connected to sewer network, 40 % to septic tanks and around 7% to pits and other systems. The toilets that are connected to septic tanks/ pits often discharge the effluent into road side open drains. As per CPHEEO norms septic tanks need to be cleaned periodically at an interval of 2-3 years (see for example Annexure 1. However surveys conducted in a few cities Maharashtra suggest that septic tanks/pits are emptied only once in 8 to 10 years and only when they overflow.

As per the Prohibition of Employment as Manual Scavengers (and their rehabilitation) Act, 2013, manual cleaning/emptying of pit toilets and septic tanks is prohibited. All ULBs are required to adopt mechanical processes for cleaning of pits/septic tank. Most ULBs in Maharashtra provide mechanised cleaning. However, since the tanks are emptied only once in 8 to 10 years, the sludge that is solidified at the bottom of the pit/septic tank is hard to remove with the small powered emptier that is typically used. As a result, the pits/tanks are not emptied properly.

On the whole, sludge treatment the situation in Maharashtra is quite grim. Currently there is a lack of adequate infrastructure for adequate faecal sludge treatment in most Municipal councils. Even in cities that have sewerage network and functional sewage treatment plants (STPs), only 6 ULBs treat the septage/faecal sludge at the STPs.

The benefits of septage management over the conventional sewerage systems are as follows:

	CONVENTIONAL SEWERAGE		SEPTAGE MANAGEMENT	
Water Requirement	High (>135lpcd)		Low	
Capital Costs	High		Low	
O & M Costs	High		Low	
Technical Expertise	High- *Conveyanc*	High - *Treatment*	Low – *Conveyance*	Low – *Treatment*
Maintenance requirement	High – on *Service*	Low – on *Households*	Low – on *Service*	High – on *Households*
Required capacity to	High		Low	
Implementation challenges	High		Low	

Recognizing the growing importance of safe faecal sludge management practices, there is an emerging need for framing an operative guideline for Septage management for ULBs

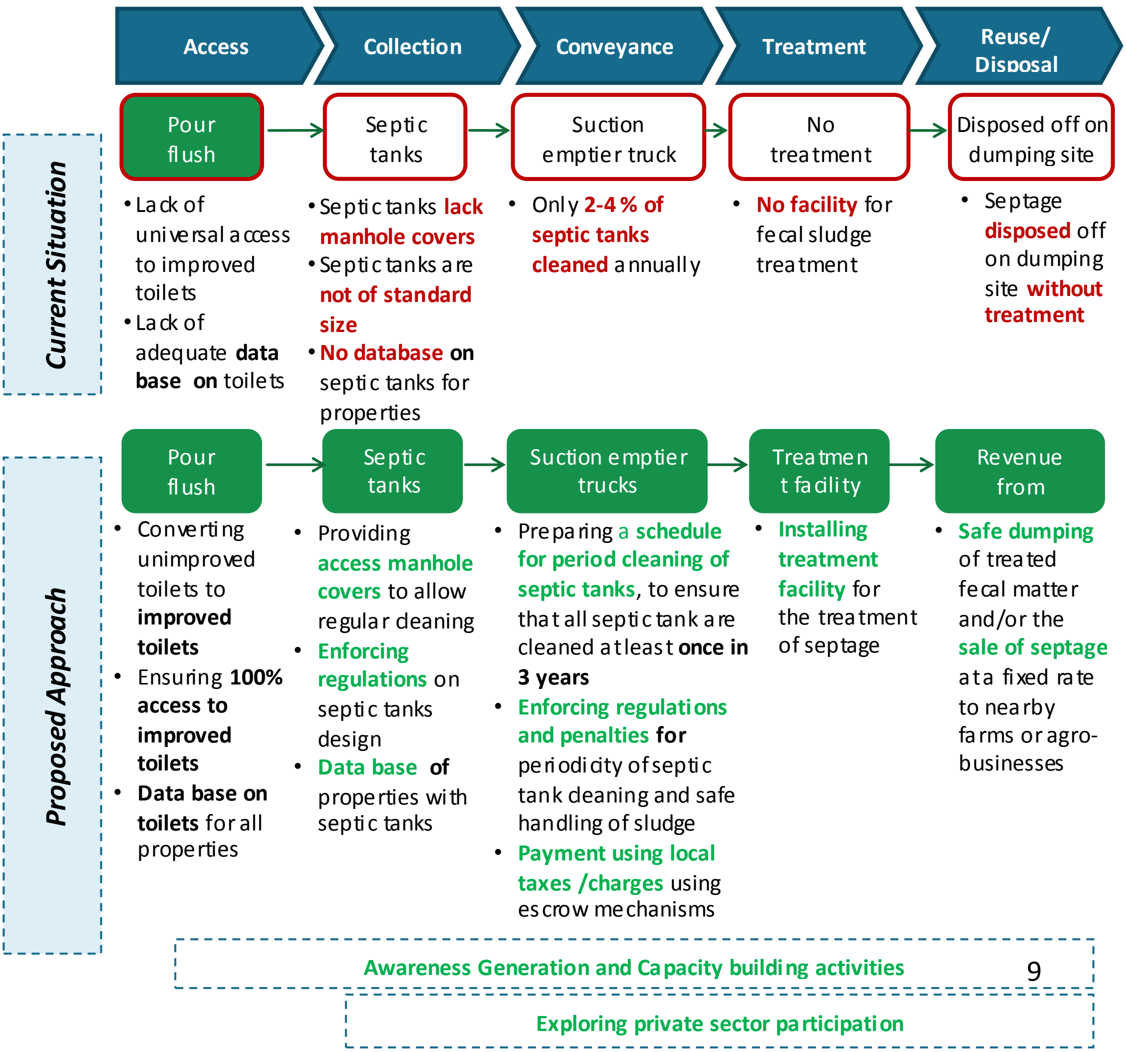
2 Objectives

The objective of this guideline is to facilitate all ULBs in Maharashtra to prepare an integrated faecal sludge management plan and implement a full septage management service in their cities. This would cover aspects across the service chain of on-site sanitation including safe collection, conveyance, treatment and disposal/reuse of the treated faecal sludge for all type of residential and non-residential properties (except industrial properties). These guidelines for seek to provide urban local bodies with knowledge and procedures of preparing a septage management plan. These guidelines also discuss other aspects related to regulation, monitoring and awareness generation that are needed in sustainable implementation of septage management in their cities. The septage management plan would help ULBs improve overall sanitation in their towns.

3 Guideline for ULBs for effective implementation of Septage Management Plan

Septage management Plan covers the entire service chain starting from design of septic tank, collection, conveyance, safe treatment and reuse or safe disposal of septage. The objective of these guidelines is to help city achieve improved sanitation situation in the city through implementation of septage management plan

The following figure depicts the existing situation assessment of on-site sanitation status across service chain in majority urban local bodies of Maharashtra and proposed framework for action to achieve improved sanitation through Septage management.



3.1 Step by step approach: Operationalize of septage management plan

The following is the step by step guide for effective implementation of septage management plan:

A. Preparation of plan for Septage management

1. Existing situation assessment across sanitation service chain
    - Steps for assessment of existing toilets and septic tanks and creation of database
    - Steps for Scheduled septic tank empting services
    - Steps for Planning of septage treatment facility
2. Explore private sector participation for septage management activities
3. Awareness generation and capacity building activities
4. Record-keeping , reporting (MIS), monitoring and feedback systems

B. Financial Resource Mobilization Plan

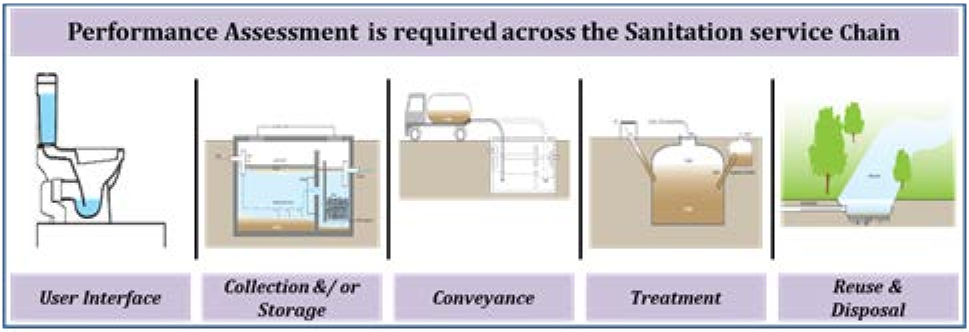
- Sources of revenues for septage management
- Mobilize financial resources to implement septage management plan

A. Preparation of plan for Septage management

1. Existing situation assessment across sanitation service chain

Assessing service performance across the service chain through a city level assessment is the first step in planning process. It is an important exercise, which provides an initial sense of the state of septage facility in the city, help in understanding the context and identifying gaps in key services.

The sanitation service chain considers the following 5 stages:



Detailed assessment of services will need to be done across each link in the chain through appropriate field assessments:

a) **Access & Collection:**
   - **Access** describes the type of toilet and captures if the HH uses individual, shared or community facility. The choice of User Interface will depend on the availability of water. At city level it also measures the availability of public toilets. For sullage disposal, it captures access to bathroom facilities and drainage outlets.
   - **Collection** and Storage/Treatment describes the ways of collecting, storing, and sometimes treating the excreta, grey water generated at the User Interface. The toilet may be connected to sewerage system; onsite systems like septic tank with soak pits, pits or may be functioning as Ecosan / composting toilets. Similarly for grey water disposal, the HHs may be connected to sewerage system or drains of any kind (Open/covered).

Steps for assessment of existing toilets and septic tanks and creation of database

a. City level assessment of coverage of toilet and on-site sanitation facility using the existing database (like property tax module, Census 2011 etc.) or based on recent survey carried out under SBM.
b. If the ULB do not have database, then ULB shall create database of toilets and septic tanks based on questionnare given in ***Annexure 2.*** All

ULB shall link the key result related to toilet availability, type of toilet and its connection with waste water outlet with property tax database on e-governance platform.

c. ULB shall keep updated database related to toilet availability and on-site sanitation through property tax assessment survey carried out at every four years of interval

d. Evaluate existing septic tank designs and other storage/treatment systems and modify (in case of variation) based on design mentioned in ***Annexure 1***.

e. Notices should be issued to all property owners whose septic tanks do not meet the standard septic tank design.

f. Identify insanitary toilets[1] and convert them to sanitary latrines for safe collection and disposal of waste as per norms set out in ***Annexure 1.***

g. All existing septic tanks should have access covers for each chamber, so that they can be easily opened during emptying process. Where such covers are not available, it should be made compulsory for all property owners to provide proper covers.

h. The new septic tanks need to be designed and constructed as per the norms suggested in National Building Code, 2005 and CPHEEO Manual, 2013 which takes reference of design norms from IS: 2470 on Code of practice for installation of septic tanks - Part 1: Design and Construction and Part 2: Secondary treatment and disposal of septic tank effluent 1985 (Reaffirmed 1996). The design norms CPHEEO Manual, 2013 is compiled in ***Annexure 1.***

b) Conveyance

Conveyance describes the transport of products across the service chain. ULB should plan for scheduled septic tank emptying services for effective implementation of septage management plan. Prior to plan for the same,

[1] Insanitary toilet / latrines in households are those where night soil is removed by human, serviced by animals or/and night soil is disposed into open drain or pit into which the excreta is discharged or flushed out, before the excreta fully decomposes. As mentioned in Swachh Bharat mission guidelines, single pit toilets will also be considered as an insanitary toilet/latrine.

ULB shall first assess its role and capacity for implementation of septage management plan. ULB should assess various aspects of septic tank empting like how many septic tanks required to be emptied annually as per CPHEEO norm versus how many are emptied in a year, how many vaccum emptying trucks/ capacity of trucks are required if number of septic tank emptied as per CPHEEO norm versus how many trucks are available/working with capacities of emptier trucks, assessing the cost per emptying visit, method of maintaining the register for septic tank emptying services database etc.

If private player is involved in septic tank emptying business in the city, then, ULB shall also review the role of private septic tank emptier and assess their capacity in lines with the number of septic tank empting annually, charges/fees for empting services, location of disposal, registration/licensing with ULB or not etc.

Steps for Scheduled septic tank empting services

a. ULBs should initiate pre-determined scheduled septic tank empting services and develop a route plan for the same.
b. Mobilize or procure adequate number of suction emptier trucks to maintain a three year rotating cycle. Number and type of vehicles to be purchased based on the sizes of septic tanks or septage generation rate[2] for the city, distance from the location of septic tanks to the septage treatment facility, cleaning frequency of septic tanks and available road width for the suction truck operations.
c. ULBs should either provide the emptying services themselves or enter into appropriate management contracts with private agencies. In case of private sector contract, ULBs should certify and license private septage transporters to de-sludge and transport waste to the

[2] Septage generation rates vary widely from place to place depending on practices of septic tank use, number of users, water used for flushing, and the frequency of cleaning the septage. Adopting the (U.S. EPA, 1984) estimate of septage generation of 230 litres/year and an average household size of four, the septage generation/ household would be 920 litres/year. So for a three year cycle the septage generation rate would be 2760 litres or 2.76 cum. Alternatively, assuming an average septic tank volume of 3 m3 and emptying of septage when one-third of the septic tank is filled with settled solids, the volume of septage emptied would be 1 m3.

designated treatment facility. The license/septage transporter permit is detailed out in ***Annexure 3.1***.

d. All septage transporters need to maintain a collection and transport receipt such as the one detailed out in ***Annexure 3.2***. This needs to be filled duly by the private / ULB service provider and submitted to ULB office.

Measures to be taken during Desludging of septic tanks

a. While desludging the following norms should be followed:
    - The septic tanks should not be fully emptied; small amount of sludge of around 1 to 2 inches should be left in the septic tank to facilitate decomposing of incoming faecal waste.
    - No fire or flame should be used near the septic tanks as there may be inflammable gases inside septic tanks
    - Proper safety gears should be used by the operator while desludging / emptying the septic tanks

b. Septage transportation vehicle operators (whether from ULB or private sector) should be well trained and equipped with protective safety gears, uniforms, tools and proper vacuum trucks, to ensure safe handling of sewage/septage. The rules under the Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013 provide for a comprehensive list of safety gear that should be used while providing these services. The operating procedure for cleaning of septic tanks is detailed out in ***Annexure 3.3.***

c) Treatment and disposal

Treatment: ULB must not dispose the septage collected from septic tank without any treatment and ULB must comply with CPCB and MPCB norms before disposal of septage. ULB should assess the load of septage and assess the requirement of capacity for treatment plant. ULB should first try and assess the possibility of setting up septage treatment facility at the solid waste treatment/disposal site and at the STPs within the city or in nearby city.

Reuse/disposal refers to the methods in which products are ultimately returned to the environment, as either useful resources or reduced-risk materials. The treated septage can be used as a soil enricher or as filling material at construction sites. ULB should carry out primary assessment for availability of market and demand for reuse.

Steps for Planning of septage treatment facility

a. Septage collected from the septic tanks or pits should not be disposed without any treatment.

b. ULB should first assess the possibility of septage treatment at existing STP in the city or STP of nearby city through appropriate agreements with STP operators and receiving ULBs. A list of cities that have STPs in Maharashtra is given in ***Annexure 4.***

c. If STP is not available in the city or nearby that can receive the sludge, then ULB should plan for new septage treatment facility. Various treatment options are given in ***Annexure 5.*** Such a new septage treatment facility should be designed to cater to expected volumes of septage generated in urban local body and if faecal waste is expected from nearby urban local bodies.

d. Input quality of the collected septage should be tested at the treatment facility for checking presence of any metal or traces of industrial waste.

e. The faecal sludge treatment plant should be operational during working hours only and a responsible person should be appointed in the facility to ensure that no commercial or industrial waste is unloaded in these facilities.

f. Septage should be reused / safely disposed only after it meets the parameters mentioned in **Annexure 6**. Various possible reuse options are outlined in ***Annexure 6.***

Measures to be taken while planning for Septage treatment facility

Identification of septage treatment site [3] is crucial for effective implementation of septage management plan. Following parameters to be taken into consideration before finalization of treatment sites:

[3] Referred to: Faecal Sludge Management: Systems Approach for Implementation and Operation, Linda Strande, Mariska Ronteltap, Damir Brdjanovic, IWA 2014

Distance of treatment site: Distance from emptying to delivering and accessibility of the treatment site are major issues. The transport of relatively small fecal sludge volumes (5-10m^3 per truck) on congested roads over long distances in large urban areas is financially unfeasible. A site that is too far away implies fewer trips per day, less revenue and more fuel costs to private operators.

Reliability of electricity: It is also important to assess the availability and reliability of electricity if treatment technology has mechanical operated parts; as in case of fluctuations it will increase treatment time and will affect optimal utilization of treatment capacity.

Neighborhood: A treatment site may generate nuisance, especially bad odors. For this reason it should be located at an appropriate distance from the residential areas.

Land availability: Projects are often delayed because of non-availability or high price of land. ULB should identify the land bank for treatment facility. ULB should also explore the possibility of developing septage treatment facility at solid waste dumping or treatment site.

Geological Parameters: Assessment of existing geological conditions on site like groundwater table, type of soil, prone to flooding is always recommended as it may directly affect selection of technology option.

Indicative Decision making framework for Evaluation of Septage treatment site

Sr. No.	Particulars	Unit	Treatment location 1	Treatment location 2	Treatment location 3	Treatment location 4
Identification of treatment sites						
1	Distance of existing septage disposal site	km				
2	Distance of SWM treatment or disposal facility	Km				
3	Type of SWM treatment facility					
4	Average distance and duration of emptying trip	Km & mins.				
5	Electricity availability					
6	Neighborhood (Residential/ institutional/commercial/ irrigation/farming areas)					
Land availability						
7	Government or private land					
8	Available/ Non-available for developing site					
Geological parameters						
9	Water table	**mt**				
10	Type of soil					
11	Prone to flooding	**Yes/No**				

2. Explore private sector participation for septage management activities

For effective operationalize of scheduled septic tank emptying service and treatment facilities, ULB may also explore the option for private sector participation. Following points to be taken into consideration by ULB:

a. Explore private sector participation for various activities like procurement, operations and maintenance of the suction emptier trucks, construction and operations of septage treatment facility and possible re-users of treated septage within the city as well as in nearby cities.

b. Develop performance based contracts such that payment is linked to the performance of private sector for providing the services.

3. Awareness generation and capacity building activities

Awareness generation activities need to be taken up for successful implementation of faecal sludge management plan and community acceptance and adherence to regulations and service plan set up by the ULBs. Associated training and capacity building of municipal staff as well as private sector contractors also needs to be taken up.

a. **Awareness generation for residents**: Members of Resident Welfare Associations, community organizers, self-help groups and the general public should be made sensitized periodically regarding the need for a sound faecal sludge management system including a 3-year cycle. The health hazards associated with improper collection and treatment of waste, and the ill-effects of sewage discharge into fresh water/storm water drains should be explained to the residents. Sample material for awareness generation is in ***Annexure 7.*** Awareness generation activities should be carried out at the beginning of introducing a scheduled service in all wards and then repeated periodically over the three year cycle.

b. **Capacity building for municipal staff**: Municipal Commissioners/ Chief Officers, Engineers, Sanitary Inspectors, Health Officers, and Sanitary Workers should be well trained in safe septage management and its best practices. This involves regular training sessions on safe collection, treatment and disposal. Information regarding standard septic tank design, the need for periodic inspection and desludging of septage, design of a treatment facility, tender details for engaging licensed transporters, etc. should be disseminated widely to achieve a safe faecal sludge management system. Training should also be provided on safety standards.

c. **Capacity building for septage transporters / private vendors**: Local Bodies should ensure all safety norms are clearly explained to the septage transporters. Private Operators and Transporters should be well trained in safe collection and transportation of sewage including vehicle design, process of desludging, safety gears and safe disposal at the nearest treatment facility.

4. *Record-keeping, reporting (MIS), monitoring and feedback systems*

a. **Recordkeeping and manifest forms** should be an integral part of a comprehensive septage management program. Recordkeeping requirements should be codified into the law governing the program. A sample manifest form is detailed out in ***Annexure 3.2***

b. The completed document or documents with signatures of the household/property, suction truck operator and treatment plant operator should be submitted to the local government for their records. Payment to the suction truck operator should only be made if there are signatures of all the stakeholders. A possible monitoring framework for septic tank emptying services is detailed out in ***Annexure 8***

c. An **MIS system** such as the one discussed in access and collection will need to be developed and maintained.

d. Where possible, **GIS** should be used to be plan the route of suction emptier trucks and tracking these for regular record keeping.

e. **Consumer grievance redressal system** for faecal sludge management should also be set up as a part of urban local body record keeping systems and helpline numbers to be shared with residents as a part of monitoring and record keeping systems for faecal sludge management.

B. Financial resource mobilization

1. Sources of revenues for septage management

a. **Sanitation tax/ charge** should be levied on all the properties for sustaining the septage management activities. The tax/ charge can be added either as surcharge on property tax or a new sanitation tax/ charge can be levied under the Maharashtra Municipal Councils, Nagar Panchayats and Industrial Townships Act, 1965, Chapter IX: Municipal taxation, Section 108.

b. If ULB explore the possibility of Private sector involvement in septage management, then an **escrow account** can be set up where revenues from the sanitation tax/ charge are transferred. The contractual amount for FSM services to the private party can be paid from this escrow account to avoid delays.

c. **Periodic revisions for the taxes/ charges** to be effected based on revisions in costs involved

d. To the extent possible, revenues should be generated from **sale of treated septage** for agriculture or other purposes.

2. Mobilize financial resources to implement septage management plan

a. ULB may utilize the funds from 14th FC to implement the various components related to septage management plan. Creation of database for toilets and septic tanks, procurement of suction emptier trucks and construction of septage treatment facilities are the permissible components to utilize the 14th FC funds. The funds would also be provided as preparatory activity like preparing detailed project report and prefeasibility report for septage management.

b. **IEC & Capacity building funds:** IEC funds under SBM shall be utilized for various awareness generation activities undertaken for implementing septage management plan includes capacity building activities for ULB staff, septage transporters, treatment plant operators and residents of city.

c. Convergence with existing schemes/activity: If any ULB is going to undertake the water audit survey under MSNA or survey under SBM or property tax assessment etc, then ULB should integrate the sanitation survey with the respective activity.

Annexures

1. Conventional septic tank design as per CPHEEO, 2013[4]

1.1 Conventional septic tank

A septic tank is a combined sedimentation and digestion tank where the sewage is held for one to two days. During this period, the suspended solids settle down to the bottom. This is accompanied by anaerobic digestion of settled solids (sludge) and liquid, resulting in reasonable reduction in the volume of sludge, reduction in biodegradable organic matter and release of gases like carbon dioxide, methane and hydrogen sulphide. The effluent although clarified to a large extent, will still contain appreciable amount of dissolved and suspended putrescible organic solids and pathogens.

Therefore, the septic tank effluent disposal merits careful consideration. Due to unsatisfactory quality of the effluent and also the difficulty in providing a proper effluent disposal system, septic tanks are recommended only for individual homes and small communities and institutions, whose contributory population does not exceed 300. For larger communities, septic tanks may be adopted with appropriate effluent treatment and disposal facilities. However, in both cases the sewage from the septic tank should be discharged into a lined channel constructed along with storm water drain as an interim measure till a proper sewerage system is laid. The outfall from such drains should be connected to a decentralised or centralised sewage collection system.

1.2 Design

Several experiments and performance evaluation studies have established that only about 30% of the settled solids are anaerobically digested in a septic tank. In case of frequent desludging, which is necessary for satisfactory effluent quality, still lower digestion rates have been reported. All these studies have proved that when the septic tank is not desludged for a longer period i.e., more

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[4] Source: Central Public Health and Environmental Engineering Organization (CPHEEO) and Japan International Cooperation Agency. (2013). Manual on Sewerage and Sewage Treatment Systems, Part A – Engineering, Chapter 9 – Onsite Sanitation, Page no: 9-15 to 9-21.

than the design period, substantial portion of solids escape with the effluent. Therefore, for the septic tank to be an efficient suspended solids remover, it should be of sufficient capacity with proper inlet and outlet arrangements. It should be designed in such a way that the sludge can settle at the bottom and scum accumulates at the surface, while enough space is left in between, for the sewage to flow through without dislocating either the scum or the settled sludge. Normally, sufficient capacity is provided to the extent that the accumulated sludge and scum occupy only half or maximum two-thirds the tank capacity, at the end of the design storage period. Experience has shown that in order to provide sufficiently quiescent conditions for effective sedimentation of the suspended solids, the minimum liquid retention time should be 24 hours. Therefore, considering the volume required for sludge and scum accumulation, the septic tank may be designed for 1 to 2 days of sewage retention.

The septic tanks are normally rectangular in shape and can either be a single tank or a double tank. In case of double tank, the effluent solids concentration is considerably lower and the first compartment is usually twice the size of the second. The liquid depth is 1-2 m and the length to breadth ratio is 2-3 to 1. Recommended sizes of septic tanks for individual households (up to 20 users) and for housing colonies (up to 300 users) are given below in table below

Table 1: Recommended size of septic tank up to 300 users ***(Source CPHEEO, 1993)***

No. of Users	Length(M)	Breadth(M)	Liquid Depth (Cleaning interval of)	
			2 Years	3 Years
Recommended size of septic tank up to 20 users				
5	1.50	0.75	1.00	1.05
10	2.00	0.90	1.00	1.40
15	2.00	0.90	1.30	2.00
20	2.30	1.10	1.30	1.80
Recommended size of septic tank for housing colony upto 300 users				
50	5.00	2.00	1.00	1.2
100	7.50	2.65	1.00	1.2
150	10.00	3.00	1.00	1.2

No. of Users	Length(M)	Breadth(M)	Liquid Depth (Cleaning interval of)	
			2 Years	3 Years
200	12.00	3.30	1.00	1.24
300	15.00	4.00	1.00	1.24

Note 1: The capacities are recommended on the assumption that discharge from only WC will be treated in the septic tank
Note 2: A provision of 300 mm should be made for free broad.
Note 3: For population over 100, the tank may be divided into independent parallel chambers of maintenance and cleaning.
Note 4: The sizes of septic tank are based on certain assumption on peak discharges, as estimated in IS: 2470 (part 1) and while choosing the size of septic tank exact calculations shall be made

1.3 Construction details

The inlet and outlet should not be located at such levels where the sludge or scum is formed as otherwise; the force of water entering or leaving the tank will unduly disturb the sludge or scum. Further, to avoid short-circuiting, the inlet and outlet should be located as far away as possible from each other and at different levels. Baffles are generally provided at both inlet and outlet and should dip 25 cm to 30 cm into and project 15 cm above the liquid. The baffles should be placed at a distance of one-fifth of the tank length from the mouth of the straight inlet pipe. The invert of the outlet pipe should be placed at a level 5 to 7 cm below the invert level of inlet pipe. Baffled inlet will distribute the flow more evenly along the width of the tank and similarly a baffled outlet pipe will serve better than a tee-pipe.

For larger capacities, a two-compartment tank constructed with the partition wall at a distance of about two-thirds the length from the inlet gives a better performance than a single compartment tank. The two compartments should be interconnected above the sludge storage level by means of pipes or square openings of diameter or side length respectively of not less than 75 mm. Every septic tank should be provided with ventilation pipes, the top being covered with a suitable mosquito proof wire mesh. The height of the pipe should extend at least 2 m above the top of the highest building within a radius of 20 m. Septic tanks may either be constructed in brick work, stone masonry or concrete cast in situ or pre-cast materials. Pre-cast household tank made of materials such as asbestos cement / HDPE could also be used, provided they are watertight and possess adequate strength in handling and installing and bear the static earth and superimposed loads. All septic tanks shall be provided with watertight covers of adequate strength. Access manholes/covers (minimum two numbers one on opposite ends in the longer direction) of adequate size shall also be provided for purposes of inspection and desludging of tanks. The floor of the tank should be of cement concrete and sloped towards the sludge outlet. Both the floor and side wall shall be plastered with cement mortar to render the surfaces smooth and to make them water tight. A typical two compartment septic tank is shown in figure below

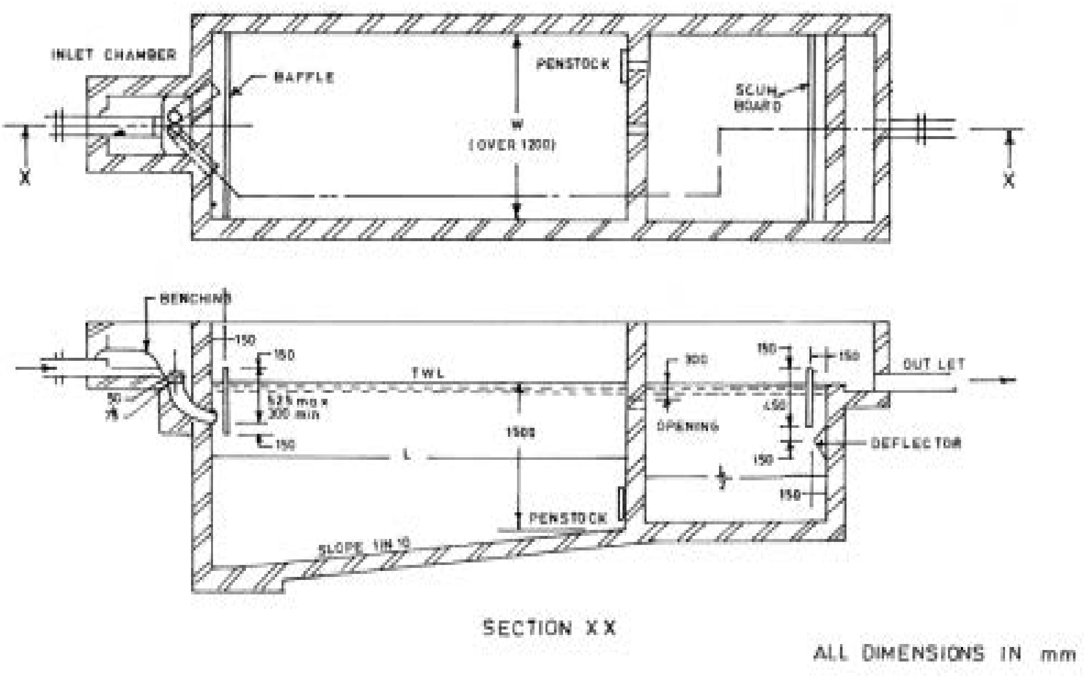


Figure 1: Typical sketch of 2 compartment septic tank for population over 50 (Source: CPHEEO, 1993)

Annexure 2. Questionnaire for septage management database creation[5]

Q No	Question		Options
1	Form id		
2	Locality type	1	Slum
		2	Non-Slum
3	What is the name of the locality?		Locality Name ______
4	Ward no:	1	Number ____
5	Property number as per Council property tax records:	1	Number ____
6	Status of property during the survey	1	Open
		2	Locked
		3	Vacant
7	Type of Property	1	Residential
		2	Institutional
		3	Commercial
		4	Mixed
8	Mark the house typology (only if 7 = Residential)	1	Bungalow
		2	Apartment
		3	Row House
		4	Wada
		5	Chawl
		6	Hut
		7	Others, specify _________
9	Select the type of Institution (only if 7 = Institutional)	1	Hospital
		2	Dispensary
		3	School/College
		4	Religious Institutions
		5	Government Office
		6	Others, specify _________
10	Select the type of commercial	1	Industry

[5] Source: Questionnaire developed by CEPT University / AIILSG

Q No	Question		Options
	(only if 7 = Commercial)	2	Shop
		3	Hotel / Lodge
		4	Others, specify ________
11	Name of Apartment/Building:		
12	Number of Blocks		Number
13	Name of the respondent/ building secretary:	1	First name _____ Middle name _____ Last name _____
14	Contact no. of building secretary:	1	Number ____
15	How many flats are there in this apartment?	1	Number ___
		2	Don't know
16	How many toilets are there in this property?	1	Number ____
		2	Don't Know
17	Number of flats that are occupied	1	
18	How many households are there on this property?		Number ___
19	Name of the respondent/Head of the Household	1	First name _____ Middle name _____ Last name _____
20	Pl provide a mobile Contact no. of head of the household	1	Number ____
21	What is the tenure status of this property?	1	Owner occupied
		2	Tenant occupied
22	Pl provide the name of the owner of this property:	1	Name _________
	-	2	Don't Know
23	Pl provide a mobile contact no. of owner	1	Number ____
		2	Don't Know
24	How many persons are there in this household? (for Commercial, approx numbers of toilet users)		children (less than 6 year):___, Other Male: ___ Other female: ___
25	Do you have your own toilet on your premises?	1	Yes
		2	No
26	What is your own toilet	1	Sewer Network

Q No	Question		Options
	connected to for disposal?	2	Septic tank with soak pit
		3	Septic tank connected to open/closed drain
		4	Single Pit
		5	Double pit
		6	Directly to open/closed drains
		7	Others, specify ________
27	No. of septic tanks in the property	1	1
		2	2
		3	3
		4	Don't Know
28	Type of septic tank: 1. Individual 2. Shared	1	Individual
		2	Shared
29	This property shares septic tank with: ___________		
30	What is the shape of your septic tank	1	Rectangular
		2	Circular
		3	Don't Know
31	Provide dimensions:	1	Don't know
	("L" relevant only if rectangular)	2	Length (ft.) _____
	-	3	Breadth/Diameter (ft.) _____
	-	4	Depth (ft.) _____
32	Septic tank outfall is connected to	1	Soak pit
		2	Open drain
		3	Covered drain
		4	Open land
		5	Others, specify
		6	Don't Know
33	When was the septic tank emptied the last time?	1	Last 6 months
		2	From 6 to 12 months
		3	12-24 months
		4	24-36 months
		5	More than 36 months
		6	Never emptied

Q No	Question		Options
		7	Don't know/Remember
34	Why was the septic tank emptied?	1	Blocked toilet
		2	Overflow from access hole/manhole
		3	Smell
		4	Others, specify
		5	Don't know/remember
35	Were there any problems during emptying of septic tanks?	1	Access or distance for suction truck to house
		2	Break floor tiles to access septic tank
		3	Break concrete manhole to access septic tank
		4	Difficult to locate the septic tank
		5	Smell during emptying
		6	Made a mess
		7	No problem found
		8	Others, specify
		9	Don't know
36	Is the septic tank accessible from road for cleaning by using a suction emptier truck?	1	Yes
		2	No
37	Is there proper access with manholes/covers for any of the chamber of septic tank which can be easily opened	1	Yes
		2	No
B	GPS Location ID		
C	Photographs		

Annexure 3. Scheduled septic tank emptying services

3.1 Septage transporter permit (License)[6]

Septage Transporter Permit for __________ Municipality

In accordance with all the terms and conditions of the current _______ Municipality's Rates, Rules and Regulations, the special permit conditions accompanying this permit, and all applicable rules, laws or regulations of Government of Maharashtra, permission is hereby granted to:

NAME OF PERMITTEE: ____

ADDRESS:____
____

For the disposal of septage from domestic septic tank or commercial holding tank at the___________________ treatment facility.

This Permit is based on information provided in the Septage Transporter Permit application which constitutes the Septage Management Hauled Permit.

This Permit is effective for the period set forth below, may be suspended or revoked for Permit Condition Non Compliance and is not transferable. The original permit shall be kept on file in the Permittee's office. A copy of this Permit shall be carried in every registered vehicle used by the permittee.

EFFECTIVE DATE:

EXPIRATION DATE:

____ CHECK IF RENEWED PERMIT

Permit is liable to be cancelled in case of violations of any Acts, Rules and Regulations relating to the operation of Septage System or in cases of safety protocols not being adhered to or in case of non-permitted disposal.

[6] Source: Operative guidelines for septage management for urban and rural local bodies in Tamil Nadu.(2014)

3.2 Collection and transport records form / manifest forms[7]

Sample Form to be filled by Operator / Transporter of Septage

i. Identification of Waste:

a) Volume ___________
b) b) Type: ____ Septic Tank ____ Others
c) c) Source: ____ Residential ____ Commercial ____ Restaurant ____ Portable Toilet ____Others

ii. Details of Waste Generator

a) Name:
b) Phone Number:
c) Address:
d) Pin:
e) Property tax no.:
f) Any kind of deficiencies, missing pipes or fittings, improper manholes or access covers, any other cracks or damage observed: ____

The undersigned being duly authorized does hereby certify to the accuracy of the source and type of wastewater collected and transported.

Date: ______________ Signature: _______________

iii. Details of Transporter / Operator

a) Company Name:
b) Permit:
c) Vehicle License:
d) Pump out date:

The above described wastewater was picked up and hauled by me to the disposal facility name below and was discharged. I certify that the foregoing is true and correct:

e) Signature of authorized agent and title: ___________________________

iv. Acceptance by __________________Municipality's authorized STP

The above transporter delivered the described wastewater to this disposal facility and it was accepted.

Disposal date: ________________ Amount Collected from Transporter (if any):_______________

Signature of authorized signatory and title: ___________________________

[7] Adapted from operative guidelines for septage management for urban and rural local bodies in Tamil Nadu.(2014)

3.3 Operating procedure for cleaning of septic tanks[8]

3.3.1 Daily Preparation for the ULB / private 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 connection. Use of twine and plastic for making connections causes leaks and require cleanup.

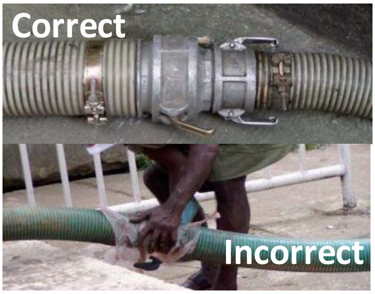


Figure 2: Connecting Hoses

3.3.2 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:

- Reach the first site and meet the building owner.

[8] Source: Guidelines for 'Open defecation Free Towns' under Mahatma Gandhi Swachhata Mission, Government of Gujarat.(2015)

- 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 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 faecal 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. Leave back small amount of sludge of around 1 to 2 inches in the tank so that it microorganisms can act upon the new incoming faecal waste. Clean up any spills and disinfect with lime or bleach solution. Chemicals such as lime can also be added into the suction trucks to neutralize the septage, to render the septage more treatable and to reduce odours.

Annexure 4. ULB Wise Capacity of STPs, present flow and utilization[9]

Sr. No	Class of ULB	Name of the ULB	Capacity* (MLD)	Technology	Present flow (MLD)	% Utilization	Data source year
1	M. Corp	Aurangabad	216	SBR-ASP	100	46	2014-
2	M. Corp	Bhiwandi	17	UASB	17	100	2014-
3	M. Corp	Greater	ND	Aerated Lagoon	ND	ND	2014-
4	M. Corp	Kalyan Dombivli	153	SBR, Soil based technology (IIT)	153	100	2014-15
5	M. Corp	Kolhapur	120	SBR	68	57	2014-
6	M. Corp	Mira	30	MBBR	30	100	2013-
7	M. Corp	Nagpur	200	UASB	150	75	2014-
8	M. Corp	Nanded	174	Extended Aerator with	25	14	2013-14
9	M. Corp	Nashik	271	UASB	239	88	2014-
10	M. Corp	Navi	848	C-TECH	420	50	2014-
11	M. Corp	Pimpri	564	ASP, SBR	432	77	2014-
12	M. Corp	Pune	1134	ASP, SBR, Biotech with extended	1134	100	2014-15
13	M. Corp	Sangli	22	Oxidation pond	22	100	2013-
14	M. Corp	Thane	304	SBR	180	59	2014-
15	Class A	Ambernath	56	UASB	49	87	2013-
16	Class A	Ichalkaranji	40	UASB	30	75	2013-
17	Class A	Panvel	28	C-TECH	8	29	2014-
18	Class B	Karad	8	Aerobic, anaerobic,	8	100	2014-15
18	Class B	Lonavala	8	Aeration tank, clari- floculator,	8	100	2014-15
19	Class B	Pandharpur	31	UASB	8	26	2013-

[9] Source: www.pas.org.in

20	Class C	Mahabalesh	3	Multimedia Bio	2	67	2013-
21	Class C	Pachgani	2	UASB	2	100	2014-
22	Class C	Shirur	6	Aeration type	6	100	2013-
23	NP	Shirdi	26	Sludge bed	12	46	2013-

Note: * - Capacity = Installed capacity of primary treatment plant + Installed capacity of secondary treatment plant

Annexure 5. Faecal sludge / septage treatment options

Septage is the settled solid matter in semi-solid condition usually a mixture of solids and water settled at the bottom of septic tank. It has an offensive odour, appearance and is high in organics and pathogenic microorganisms, whereas septic tank effluent is the liquid part which flows out from septic tank (since solids are trapped in septic tank). Septage 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 septage. As per U.S. EPA, 1984 septage in tropical countries may have BOD concentrations between 440 to 78,600 mg/l and TSS values in range of 310 to 93,378 mg/l, where septic tank effluent has values averaging around 200 mg/l BOD and 300 mg/l TSS. As septic tanks fill with septage, the effluent begins to resemble faecal sludge with higher pollution values. Therefore, regular desludging provides dramatic improvements in effluent quality. Detailed septage characterization (BOD, TSS &other microbial characteristics) as well as its dewatering characteristics (specific resistance etc.) should be done prior to the design of any faecal sludge management facility. Treatment of septage / faecal 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:

5.1 Treatment of septage/faecal sludge at sewage treatment plants:

Co-treatment of septage along with domestic sewage at a sewage treatment plant (STP), if available, is the most desirable option. Though septage is more concentrated in its strength than domestic sewage, its constituents are similar to municipal wastewater. But care should be taken that the STP should have adequate capacity to accept the septage without hampering the functioning of the sewage treatment plant. The municipality should monitor the incoming wastewater load to the STP and accept the septage, if the design norms are not violated with the increased load (on account of the septage). *Annexure 4* provides a list of ULBs with their capacity of the STPs and the present flow received at STPs. The treatment plants that are under-utilized can serve as treatment plants for septage from nearby ULBs and if the STPs are working close to the design capacity, additional loads due to disposal of septage will necessitate expansion or up-gradation of the STP capacity.

The septage could be added at various locations for treating it along with STP wastewater:

1. **Septage addition at the nearest sewer manhole**: Septage could be added to a sewer upstream of the STP, and substantial dilution of septage occurs prior to it reaching the STP, depending on the volume of sewage flowing in the sewer
2. **Septage addition at the STP:** Septage could be added to sewage immediately upstream of the screening and grit removal processes
3. **Septage addition to sludge digesters/sludge drying beds:** Septage could be processed with the sludge processing units of STP.

If septage / faecal sludge are to be co-treated with sewage, it will be necessary to construct a septage /faecal sludge receiving chamber. Chemicals such as lime or chlorine can also be added to the faecal sludge in the storage tank to neutralize it, to render it more treatable, or to reduce odors.

Treatment of septage/faecal sludge at independent septage treatment plants

When an STP does not exist for a city, or the distance or the capacity of the available plant becomes a limiting factor, it is not a feasible option to transport and treat the septage at the sewage treatment facilities. Hence, a treatment plant especially meant for septage treatment becomes the option to consider. Independent septage treatment plants are designed specifically for septage treatment and usually have separate unit processes to handle both the liquid and solid portions of septage. These include:

- Lime stabilization – odor control, conditioning and stabilization of the sludge.
- Dewatering – sludge drying beds or mechanical dewatering.
- Anaerobic / aerobic wastewater treatment – liquid from the sludge drying beds and mechanical dewatering systems.

- Co-composting with organic solid waste

The choice of mechanical dewatering or sludge drying beds would be dependent on the land availability, with mechanical dewatering systems being preferred where land is scarce and sludge drying beds being adopted where land availability is not a constraint. The benefit of using these treatment plants is that they could provide a regional solution to septage management. Many septage

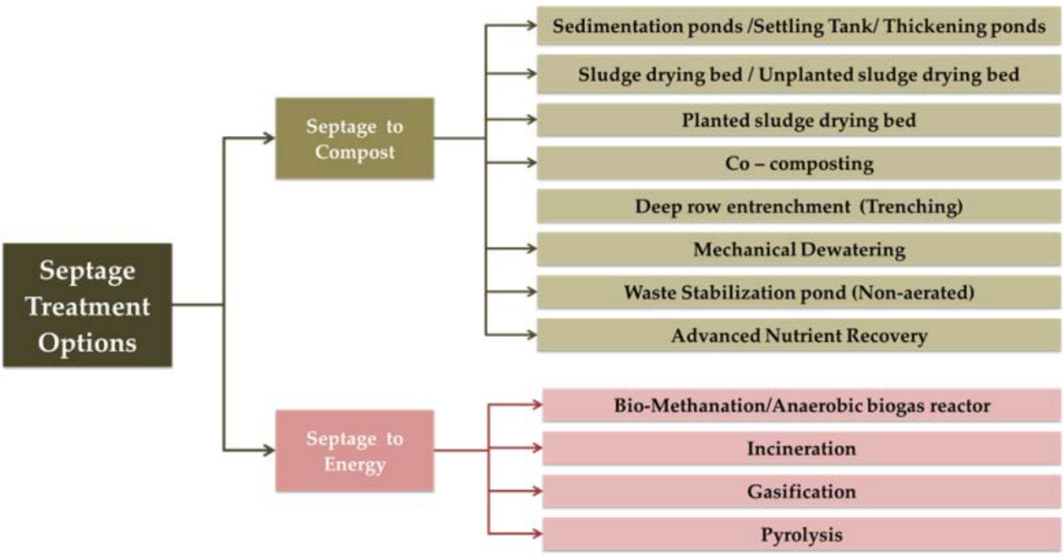


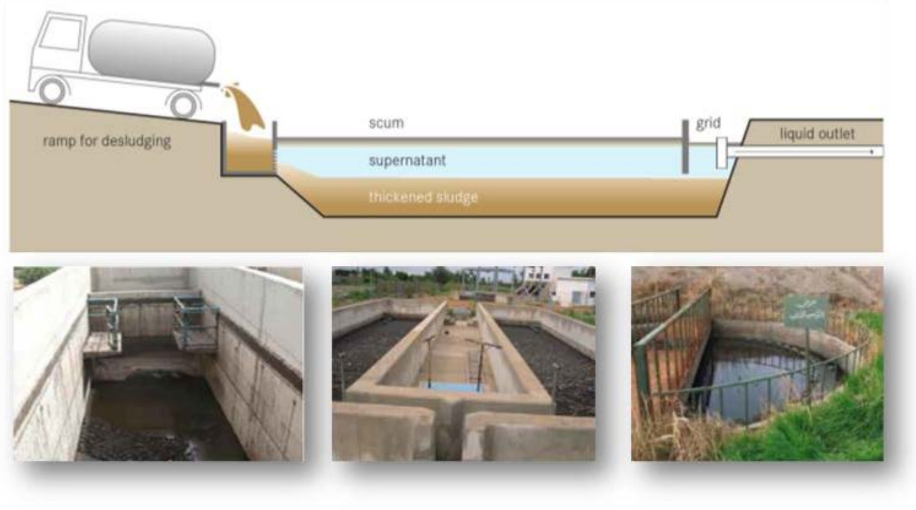
Figure 3: Septage treatment

treatment plants use lime to provide both conditioning and stabilization before the septage is dewatered, and this dewatered sludge can be used as organic fertilizer after drying and composting. Additionally, lime stabilization also helps to reduce/ minimize odour. The common practice is to add lime to raise the pH to 12 and hold it for a period of 30 minutes. The filtrate from the dewatering units needs to be further treated through treatment process such as waste stabilization ponds, anaerobic baffled reactor, constructed wetland or aerobic treatment systems before discharging into the environment.

However, the choice of an appropriate septage management system is dependent on land availability, local site conditions, level of treatment required, hauling distance, technical requirements, costing , requirement of expertise for construction and operation, availability of skilled labour, legal and regulatory requirements. The management option selected should be in conformity with local, state, and central regulations. From review of various options for the Septage treatment, it was observed that treatment options could broadly be divided into two types. One form of technology is to convert faecal sludge/septage to compost and another is to convert septage to energy. These technologies can be grouped as shown in the figure. Details of these technologies is detailed out in section below

1. **Sedimentation ponds /Settling Tank/ Thickening ponds**

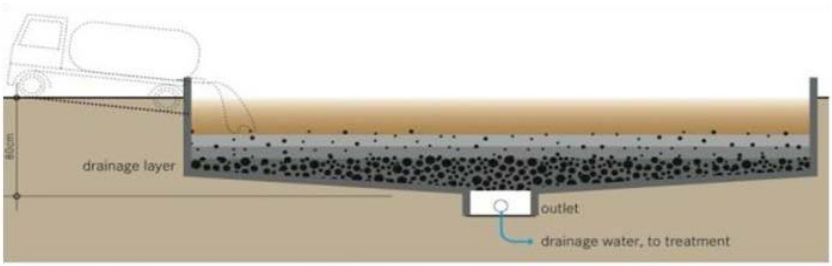
   Sedimentation or Thickening Ponds are simple settling ponds that allow the sludge to thicken and dewater. The effluent is removed and treated, while the thickened sludge can be treated in a subsequent technology. Settling tanks provide a liquid retention time of a few hours (enough to ensure quiescent settling of settle able solids).

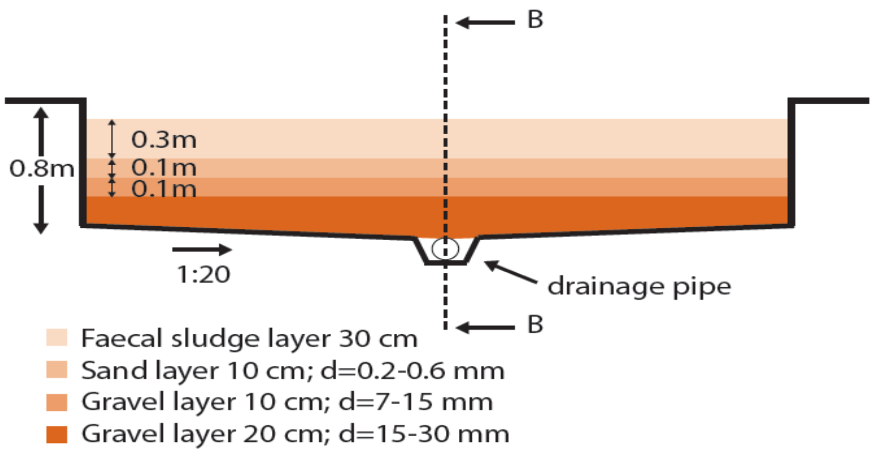


Here input is faecal sludge and output is dried Septage and effluent, which can be used in agriculture, arboriculture and pastures. This treatment option can be coupled with sludge drying bed or co-composting for treatment of thickened sludge. This technology is affected by seasonal changes and can be efficiently used in hot and temperate climate. The discharging area must be maintained and kept clean. The thickened sludge must be removed mechanically when the sludge has thickened sufficiently. Septage and effluent may require further treatment.

2. Sludge drying bed / Unplanted sludge drying bed

An unplanted sludge 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. The bottom of the drying bed is lined with perforated pipes that drain away the leachate. On top of the pipes are layers of sand and



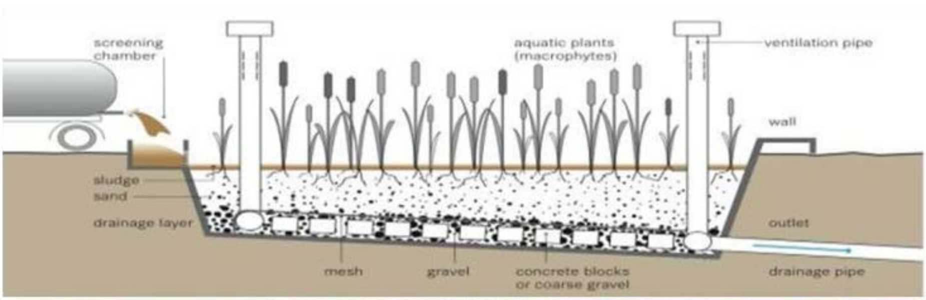


gravel that support the sludge and allow the liquid to infiltrate and collect in the pipe.

In this technique input is faecal sludge and output is treated sludge and effluent, which can be use in agriculture, arboriculture and pastures. Sludge drying bed can be coupled with co-composting for further treatment. This technology is affected by seasonal changes and can be used in hot and temperate climate. Excessive rain may prevent the sludge from proper settling and thickening or this can be avoided by providing transparent sheds over the sludge drying bed.

Over most of the year, the septage drying time is expected to be about seven days; however, an average of 10 days is considered to accommodate longer drying periods during the rainy season. Dried sludge must be removed every 10 to 15 days. Sand must be replaced when the layer gets thin. Treated Septage and leachate may require further treatment based on output quality.

3. **Planted sludge drying bed**
Planted sludge drying bed is similar to an unplanted drying bed with the benefit of increased transpiration. The key feature is that the filters do not need to be desludged after each feeding /drying cycle. Fresh sludge can be applied directly onto the previous layer; it is the plants and their root



systems that maintain the porosity of the filter. The roots of the plants create pathways through the thickening sludge to allow water to escape more easily.

In this technique input is faecal sludge and output is treated sludge and effluent, which can be use in agriculture, arboriculture, pastures and as cattle fodder. Planted sludge drying bed can be coupled with co-composting for further treatment. It is affected by seasonal changes.

The drains must be maintained and the effluent must be properly collected and disposed off. The plants should be periodically thinned and/or harvested. Treated Septage and Leachate may require further treatment based on output quality

4. Co-composting

Co-Composting is the controlled aerobic degradation of organics using more than one feedstock. Faecal sludge has a high moisture and nitrogen content while biodegradable solid waste is high in organic carbon and has good bulking properties. There are two types of Co-Composting designs: open and in-vessel. A Co-Composting facility is only appropriate when there is an available source of well-sorted biodegradable solid waste. Mixed solid waste with plastics and garbage must first be sorted.

In this technique input is faecal sludge and biodegradable organic solid waste and output is compost which can be use in agriculture, arboriculture and pastures. It is affected by seasonal changes and depending on the climate (rainfall, temperature and wind) the Co-Composting facility can be built to accommodate the conditions. At places where there is heavy rainfall covered facilities are especially recommended.

Careful monitor of the quality of the input materials & track of the inflows, outflows, turning schedules, and maturing times is required to ensure a high quality product. Turning must be done periodically.

5. Deep row Entrenchment (Trenching)

It consists of digging deep trenches, filling them with sludge and covering them with soil. Trees are then planted on top, which benefit from the organic matter and nutrients that are slowly released from the FS. Availability of land is a major constraint & distance to groundwater bodies. This technology is feasible in areas, where the water supply is not directly obtained from the groundwater and groundwater table is low.

6. Mechanical Dewatering

Mechanical dewatering is normally associated with large wastewater treatment plants and is used to separate sludge (residual sludge from wastewater treatment plants or faecal sludge from on-site sanitation) into a liquid and a solid parts. These techniques are usually sophisticated and costly for smaller systems to be implemented on community level. The process does not treat the sludge, it only separates solid from liquid parts.

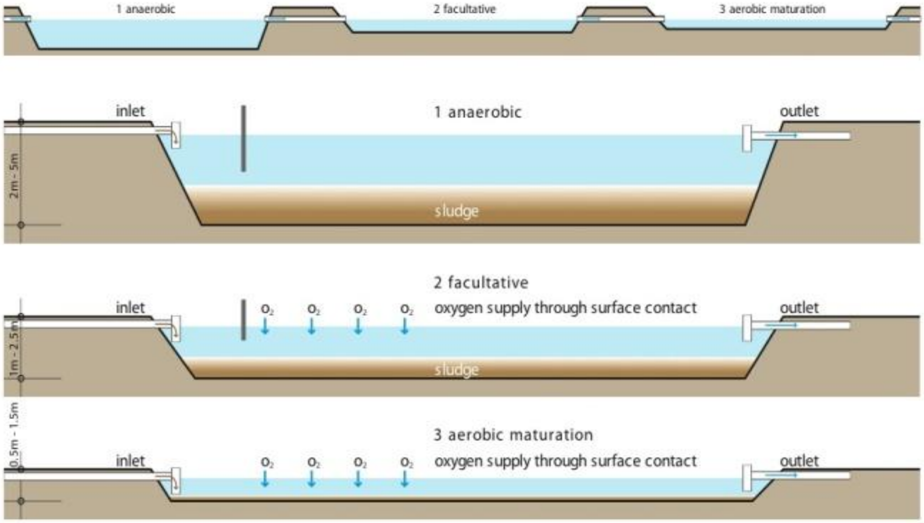
Both solid and liquid parts still contain pathogens and pollutants and further treatment is necessary. Mechanical parts need periodical inspection and replacement.

In this technique input is faecal sludge and output is black water, organic solid waste, compost/biosolids which can be use in agriculture, arboriculture and pastures. It requires to be coupled with co-composting or incineration treatment technique. This technology is not affected by seasonal changes as it is entirely depends on mechanical process. This technology requires less space.

7. **Waste Stabilization Pond (Non - aerated)**

WSP comprises pre-treatment units (tanks or ponds) for solid-liquid separation followed by a series of one or more anaerobic ponds and one facultative pond.

A number of problems may arise where waste stabilisation ponds are used to treat municipal wastewater and co-treat FS. In many instances, the problems are linked to the fact that the wastewater ponds were not originally designed and equipped to treat any additional FS load. In this technique input is faecal sludge and output is sludge & effluent, which can be use in agriculture, arboriculture, pastures, ground water recharge in deep aquifer and in desert areas. It requires to be coupled with co-composting or sludge drying bed. It can be implemented at neighbourhood level or city level. This technique is affected by seasonal changes.



As per sanitation experts and review of various technical documents, it was analysed that waste stabilization pond is good option for treatment of wastewater but not a good option for treatment of Septage.

8. Advanced nutrient recovery

Wastewater, municipal sludge or the ash after dried sludge, which is incinerated or disposed of, can be a very rich source for nutrients, in particular phosphorus and nitrogen. There is a wide range of promising technologies emerging which can convert septage to phosphorus and nitrogen. Some of these techniques are still not fully developed. These technologies are expensive and require engineering knowledge to guarantee a sustainable and long-term operation of the facility.

In this technique black water, faecal sludge and grey water is converted to fertilizer and treated waste which can be use in agriculture, arboriculture, pastures, ground water recharge in deep aquifer and desert areas. This technology is highly expensive.

The following table details out advantage, disadvantages and prevalence of this composting technologies.

Table 2: Advantages, Disadvantages & Prevalence of Septage to Compost technologies

Sr. No.	Description	Advantages	Disadvantages	Prevalence in India/Abroad
1	**Sedimentation ponds /Settling Tank/ thickening ponds**	• Can be built with local available materials • Low capital and operating cost • No energy requirement • After sedimentation, sludge is used for agriculture / tree plantation.	• A major minus is the smell, especially if fresh undigested Septage is coming from public toilets. • Large land requirement • Post treatment required for both solid and liquid effluent through SDB or Co-composting	Accra/Ghana & Bangkok, Alcorta (Argentina)
2	**Sludge drying bed / Unplanted sludge drying bed**	• No energy requirement • Can be built with local available materials • Moderate capital cost and low operating cost	• Requires large area • Only applicable during dry seasons or needs a roof during rainy season	Punjab (100 villages) World Bank Project; Accra, Ghana, USA , Dakar, Senegal, Malaysia
3	**Planted sludge drying bed**	• Can handle high loading • Moderate capital cost; Moderate operating cost • No energy requirement	• Requires large land area • Long storage time • Requires expert design and operation • Leachate requires	Europe, USA, Thailand, Dakar senegal, Africa

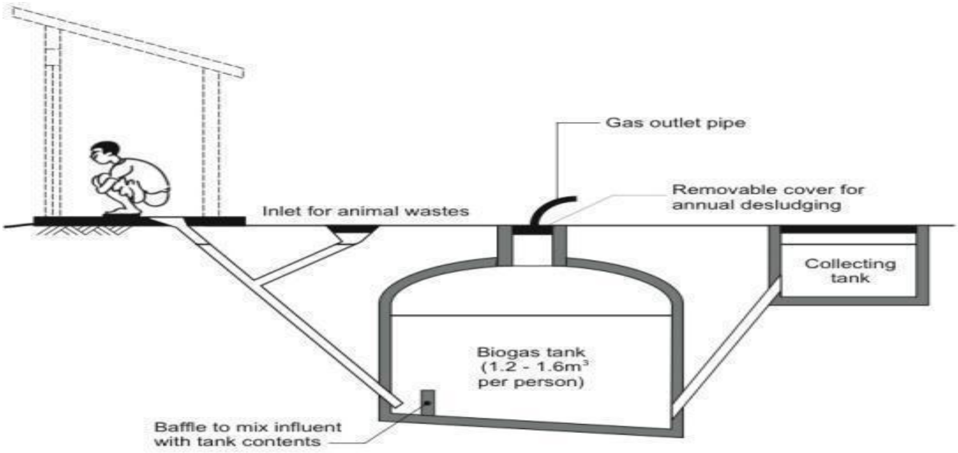
Sr. No.	Description	Advantages	Disadvantages	Prevalence in India/Abroad
		• Widely used by DEWATS for sewage treatment; could as well be used to treat Septage after diluting by mixing with sewage.	secondary treatment • Large de-sludging cycle hence larger area required • More capital and O&M cost as compared to unplanted SDB	
4	**Co - Composting**	• Best combination of cheap bio-technology and agriculture • Good choice for most Indian hot weather cities. • Low capital & operating cost • Easy to set up and maintain and can be built with local materials • No energy requirement	• Requires large land area • Requires segregated organic waste • Long storage times • Operational issues in terms of constant mixing required	Massachusetts, U.S.A; Kalpabriksha Compost Plant in Kathmandu, Bangladesh. Till recently in Dhrangadhra (Gujarat) and Barshi (Maharashtra)
5	**Deep row entrenchment (Trenching)**	• No expensive infrastructure or energy required • Odours are eliminated. • Risk of exposure to pathogens is reduced	• Large land requirement • Not feasible where GW is high	China, south-East Asia, Africa
6	**Mechanical Dewatering**	• Reduces volume of sludge • Process can be fully automated • Requires less space	• Constant power supply required • Need expert design • Both dewatered sludge and effluent requires post treatment	Vizag: built and operated by Pune based Thermax company, Malaysia
7	**Waste**	• No energy	• Not a good option	

Sr. No.	Description	Advantages	Disadvantages	Prevalence in India/Abroad
	stabilization pond (Non - aerated)	requirement • Low O&M cost	for treatment of Septage alone • Requires wastewater for process to work • Requires large area • Requires expertise for design and operation	
8	**Advanced nutrient recovery**	• Recovery of nutrients • Effluent requires no further treatment • Production of fertiliser	• Highly expensive technology • Requires expert knowledge • Some processes are still in development stage • Not proven technology • Sludge requires further treatment	

Septage to energy

1. Bio-Methanation/Anaerobic biogas reactor

In this treatment technology there is microbes driven anaerobic decomposition of organic components in faecal sludge to biogas. Faecal sludge & organic solid waste is converted to treated sludge, effluent and Biogas. Pretreatment of sludge is required but not compulsory. To start the reactor, active sludge (e.g. from a septic tank) should be used as a seed. The tank is essentially self-mixing, but it should be manually stirred once a week to prevent uneven reactions. However once stable state reached, stirring not essential. Gas equipment should be cleaned carefully and regularly so that corrosion and leaks are prevented. Grit and sand that has settled to the bottom should be removed once every year. Bio-Methanation/ Anaerobic biogas reactor option is popularised by Sulabh organization in India.



Advantages:

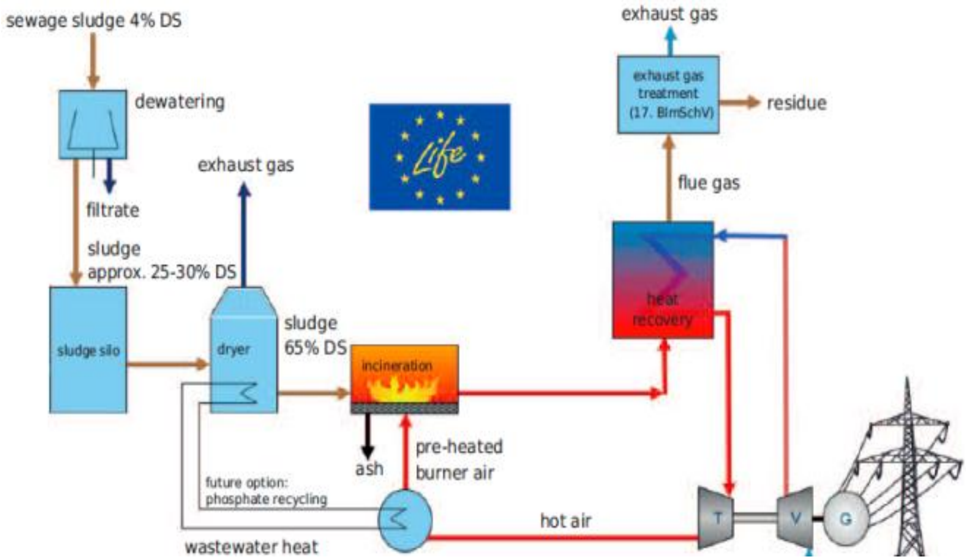
- Established and mature technology.
- Best suitable for wastes with high moisture content.
- Technology could be optimized for any scale.
- Considerable reduction in the emission of greenhouse gases like methane is possible.

Disadvantages:

- There are concerns with odour and pathogen dissemination from the digestate.
- Issues are there in controlling microbial activity if the digester is beyond a certain size.
- Affected by temperature less efficient in colder climates

2. Incineration

In Incineration treatment option there is oxidation of organics in the sludge under the conditions of complete aeration or oxygenation and requires high temperature. Incinerators are a useful technology to combust household waste, medical waste, slaughter waste, etc. instead of discharging it in a landfill. Furthermore, heat and energy may be recovered and it helps to avoid open burning of municipal waste which creates much more harmful emissions and endanger human health and environment. In this treatment sludge is converted to heat. Drying of sludge is required prior for treatment in incinerators. This technology requires trained operators. There is risk of malfunction if not properly maintained and operated.



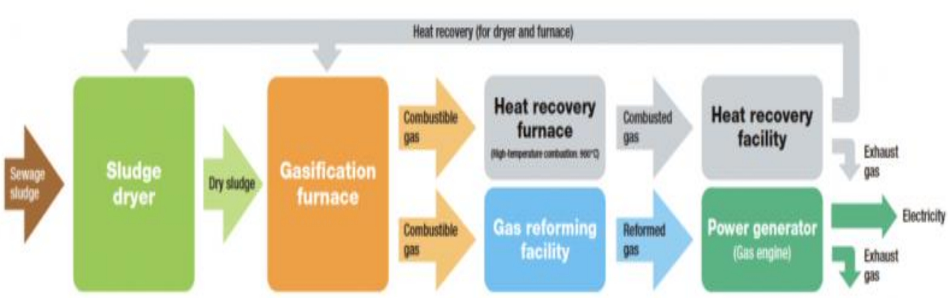
Advantages: Incineration is relatively a simple technology for treating all kinds of wastes.

Disadvantages:

- Liberates considerable amounts of emission
- Sludge incineration costs are not attractive to be used in India
- Sludge incineration is not proven in India

3. Gasification

In Gasification treatment technology there is thermal transformation of organic mass under limited supply of air/oxygen to Syngas. In this technology sludge is converted to syngas & biochar. Drying of sludge is required prior for treatment in incinerators. This technology also requires trained operators and there is risk of malfunction if not properly maintained and operated.



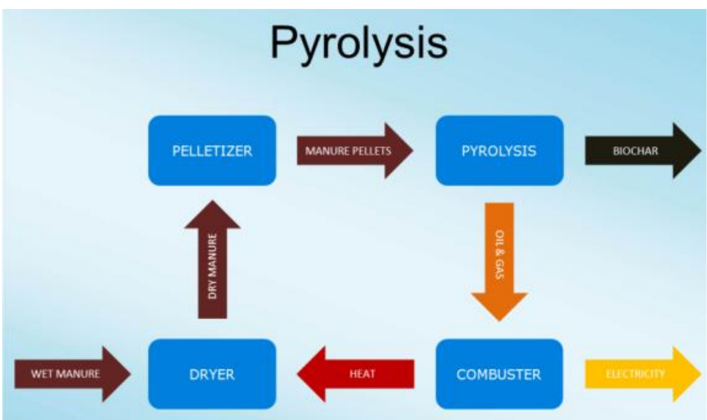
Advantages: Technology best suitable for dry feed stocks. The produced gas can be converted into any type of fuel by FT synthesis.

Disadvantages:

- Gasification of faecal sludge is a relatively new concept in India.
- Process is very energy intensive, as wet feedstock cannot be used directly in a gasifier.
- The process is economically less viable.

4. Pyrolysis

In pyrolysis treatment technology there is thermal conversion of carbonaceous materials in sludge to



produce complex oil in the absence of air/oxygen. In this technology sludge is converted to Bio-oil, Pyrolytic Gas and Bio-char. Here also drying of sludge is required prior for treatment in incinerators. This technology requires trained operators and there is risk of malfunction if not properly maintained and operated.

Advantages: Energy recovery efficiency is high.

Disadvantages:

- Pyrolysis has been attempted only for the treatment of plastic and related feed stocks so far.
- This process is also energy intensive like gasification, as more energy is needed to dry of feedstock.
- High capital and operational costs make the process economically less viable.

Annexure 6. Safe reuse/disposal of treated septage[10]

For dewatered septage/sludge can be used as fertilizer in agriculture application, it should satisfy the following criteria of Class A Bio-solids of US EPA: A faecal coliform density of less than 1000 MPN/g total dry solids, Salmonella sp. 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

MSW Rules (2000) recommended the quality for compost as referred to Table below.

In the absence of any standards, it is recommended that these be adopted until such time standards are notified by the Central Pollution Control Board.

Table 3: Compost Quality as per MSW Rules, 2000

Parameter	Concentration not to exceed (mg/kg dry basis, except for pH and carbon to nitrogen ratio)
Arsenic	10
Cadmium	5
Chromium	50
Copper	300
Lead	100
Mercury	0.15
Nickel	50
Zinc	1000
C/N ratio	20 – 40
pH	5.5 – 8.5

Properly treated sludge can be reused to reclaim parched land by application as soil conditioner, and/or as a fertilizer. 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 contains nutrients in considerable amounts, which supports the growth of a number of plants.

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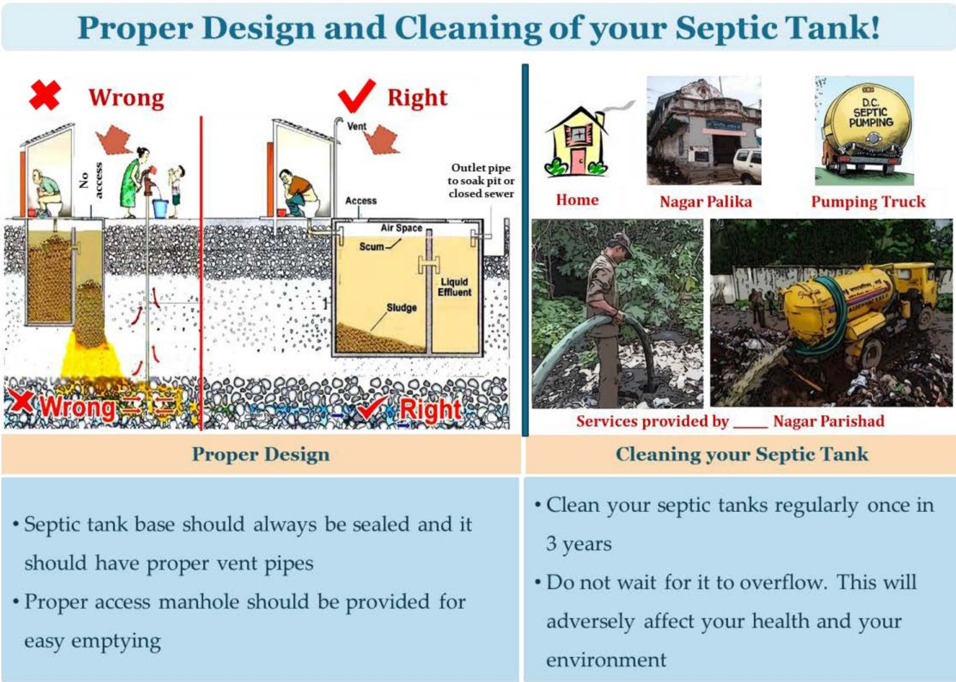
[10] Source: Advisory note: Septage Management in Urban India, Ministry of Urban Development, Government of India. (2013) and Guidelines for 'Open defecation Free Towns' under Mahatma Gandhi Swachhata Mission, Government of Gujarat.(2015)

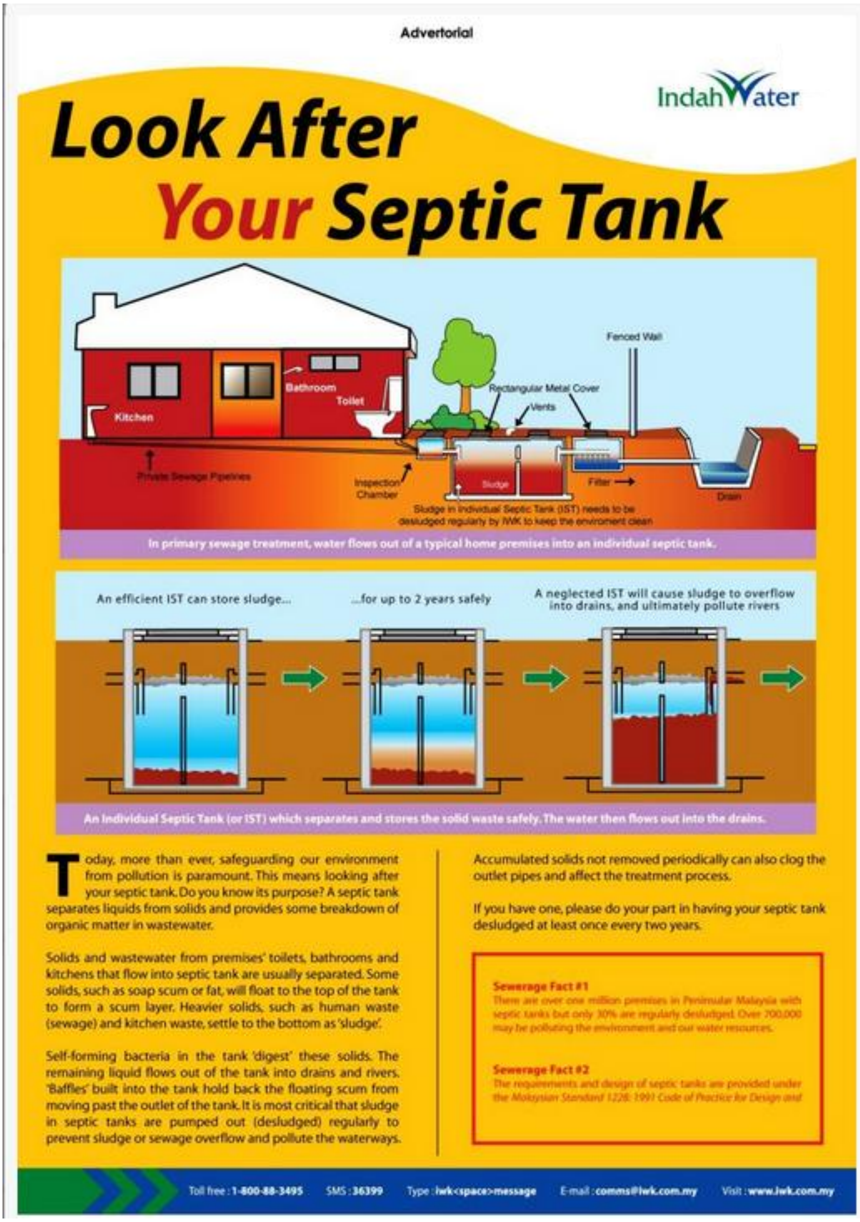
Drip irrigation is the preferred irrigation method for settled septage effluent when irrigation is feasible. Crops which could be safely grown are corn, fodder, cotton, trees including fruit trees, eucalyptus and poplar.

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.

Annexure 7. Sample IEC materials

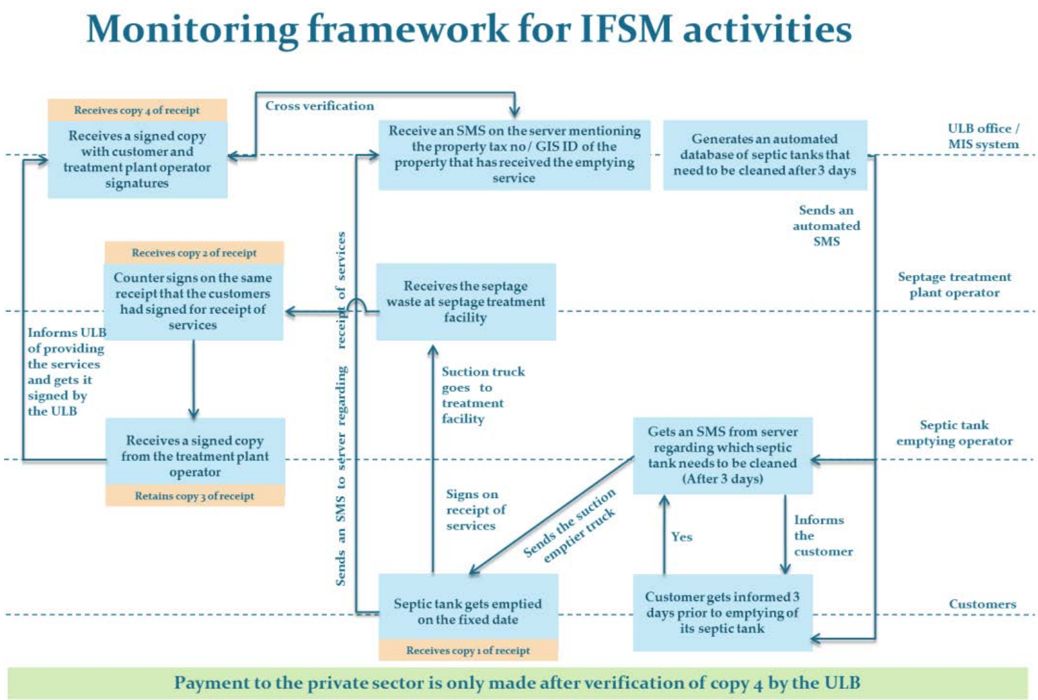


Source: IEC material used for awareness generation activities in Wai and Sinnar by CEPT University / AIILSG



Source: Indah Water, Malaysia, as shown in advisory note: Septage Management in Urban India, Ministry of Urban Development, Government of India. (2013)

Annexure 8. Monitoring framework for IFSM activities[11]



[11] Source: Monitoring framework to be used for monitoring septage management activities in Wai and Sinnar by CEPT University / AIILSG / Urban Local Body

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