Government of Bihar

GUIDELINES FOR FAECAL SLUDGE AND SEPTAGE MANAGEMENT IN BIHAR

JUNE 2018

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FOREWORD

Honourable Minister of Urban Development and Housing Department,
Government of Bihar

With due acknowledgement of CSE's support in developing of these guidelines

MESSAGE

Principal Secretary, Urban Development and Housing Department, Government of Bihar

With due acknowledgement of CSE's support in developing of these guidelines

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1. Introduction

According to Census 2011, Bihar reported 11.67 million urban population i.e. 11.25% of total population of state, dwelling in 199 urban centers (which accounts 3.14% of total urban population of country). The state has 143 statutory towns and 56 census towns. The state has 143 urban local bodies (ULBs) including 12 Municipal Corporation (*Nagar Nigam*), 46 *Nagar Palika Parishad* and 85 *Nagar Panchayat*. State ULBs with limited local resources and state support is responsible for provision of municipal services. A sanitation snapshot of urban Bihar in Table 1 clearly indicates that in the state, households with septic tank based sanitation systems (52.72%) far exceed those with sewer connections (7.21%). Such scenario poses a challenge to ULBs to safely manage the faecal sludge and septage throughout the sanitation service chain.

Table 1: Urban sanitation in Bihar – an overview

Sl. No	No. of Households Connected to	Population	Percentage of Population
1	**Piped sewer system**	**8,42,164**	**7.21**
2	Septic tank	61,54,413	52.72
3	Other Systems	4,08,008	3.50
4	Pit latrine with slab/VIP	3,88,577	3.33
5	Pit latrine without slab	1,44,008	1.23
6	Night soil disposed into open drain	59,978	0.51
7	Service latrine	52,471	0.45
8	Public latrine	2,51,789	2.16
9	Open defecation	33,71,464	28.89

Source: Census of India, 2011

1.1 Status of sanitation in Bihar

In 2016, Chief Minister of Bihar launched a *Saat Nischay Yojna* (CM's Seven Resolves), a campaign which delves towards holistic development of the state on 7 main issues. Two of the seven issues focused on sanitation service: 1. Coverage of access to toilets to improve sanitation facilities and be open defecation free. The scheme provides an outlay of INR 28,700 crore (USD 4.315 billion) to construct 1.72 lakh crore (1.72 billion) toilets in the state. 2. Provision of lined drains to the households and roads with an outlay of INR 78,000 crore (USD 11.73 billion). Under this scheme the state government has created its baseline data by means of collection of data of toilet interface facility, type of toilet, containment at site, availability or water and other subheads as per the 7 main issues.

Under Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Bihar State Annual Action Plan (SAAP) for FY: 2016 -17, reported that 23 out of 27 AMRUT cities have prepared CSPs and DPRs for water supply and/or sewerage and storm water drainage. According to State Annual Action Plan (SAAP) 2016-17, the sewerage and sanitation in Municipal Corporation and

Nagar Palika Parishads is not a priority of the state, despite huge gap in the demand and supply. Most of the funding is allocated to achieve 100% water supply, which will further increase this massive gap in terms of network coverage. There is only one project proposed on septage management in Katihar city. In addition, two *Nagar Nigams* namely Muzaffarpur and Katihar along with Buxar *Nagar Palika Parishad* and Bodhgaya *Nagar Panchayat* are being supported by Centre for Science and Environment (CSE) in preparing City Sanitation Plan mainstreaming effective Faecal Sludge & Septage Management Plan.

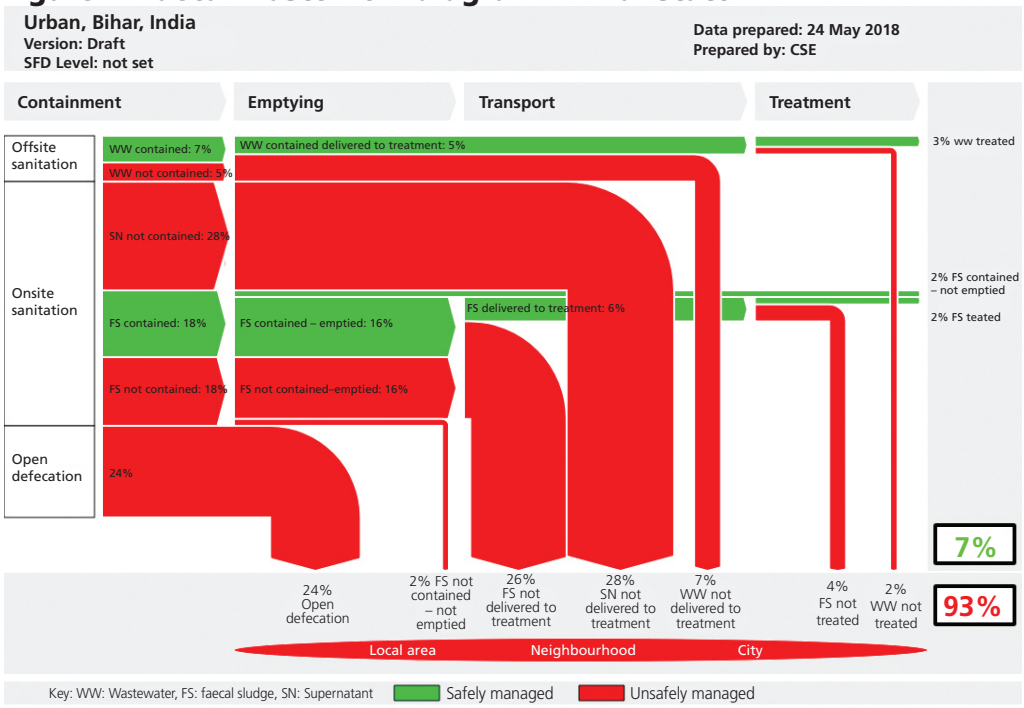
These town and cities are identified flagship cities by Ministry of Housing and Urban Affairs (MoHUA) so that they could act as model for other urban centers across state to initiate city wide sanitation. The analysis of coverage of latrines in Municipal Corporations reveals that most of the municipal corporations have fair coverage of latrines ranging from 63% to 92%. In *Nagar Palika Parishads*, the availability of latrines ranges from 27% in Benipur to 90% in Phulwari Sharif. According to Census, Patna *Nagar Nigam* has the highest coverage of sewerage network with only 21.6% coverage, followed by Bhagalpur. Though it is reported that some more cities have minimal sewerage network, but these cities do not have a working STP. As per CPCB report 2015, Bihar has only six numbers of sewage treatment plants (STPs) having cumulative treatment capacity of 124.55 MLD. Only two cities have STPs, namely Patna (5) and Bhagalpur (1). Out of this, two STPs with cumulative capacity 30 MLD are non-operational and are undergoing rehabilitation.

Under *Namami Gange*. 15 new STPs are proposed in ten towns and cities (Patna, Barh, Mokameh, Munger, Hajipur, Buxar, Begusarai, Bhagalpur, Sultanganj and Naugachhia), with a cumulative treatment capacity of 489 MLD. Out of these 15 projects, five are based on interception and diversion of drains. In more than 190 urban centers, there is no or negligible network coverage. **These cities only have Onsite Sanitation Systems (OSS) generating faecal sludge and septage.** All the households that are connected to septic tanks, and those connected to pit latrines (both sanitary and insanitary), generate faecal sludge. This faecal sludge finds its way to an open drain/ open ground/ vacant plot/ solid waste dump site: need to be covered under faecal sludge and septage management (FSSM). The Faecal Waste Flow Diagram (often referred as "SFD") of urban Bihar shows that 93% of excreta either mixes with the water bodies or is disposed off in the agricultural land or domestic environment which poses a huge risk to public health and the environment at large (Figure 1). This situation is evident in the absence of an effective post toilet infrastructure. The proportions of population using different sanitation option are shown according to where waste goes (e.g. sewer, on-site containment, etc.). At each stage of the chain, the proportion of faecal waste that is effectively managed continues as green arrow, while any proportion identified as ineffectively managed is represented in red arrow.

While on site sanitation is prevalent across town and cities in the state, there are major gaps across sanitation service chain. Further as urban households without toilets obtain facilities over the next few years under Swachh Bharat Mission (SBM) across town and cities, it is likely that many will require on-site arrangement like pit latrines and septic tanks in cities at locations where sewerage systems are not available. While construction standards have been codified by Bureau of Indian Standards (BIS), the actual construction is largely with households to manage – in practice, the installations are subject to local practices and considerable variations. In many instances for example, soak-ways or drain fields are not provided.

Limited capacities and resources with ULBs have also resulted in little regulation of maintenance and cleaning of septic tanks and pits. In many cases, households do not get the containment emptied years. Some ULBs have desludging equipment or there are private players providing emptying services but the supply of desludging service is far from adequate, resulting in many instances of faecal sludge and septage being dumped in drains and open areas posing considerable health and environmental risks. Sanitation workers also work in hazardous conditions to clean onsite sanitation system (OSS) pits and tanks, sometime without protective gear and equipment.

Figure 1: Faecal waste flow diagram – Bihar state



Source: sfd.susana.org

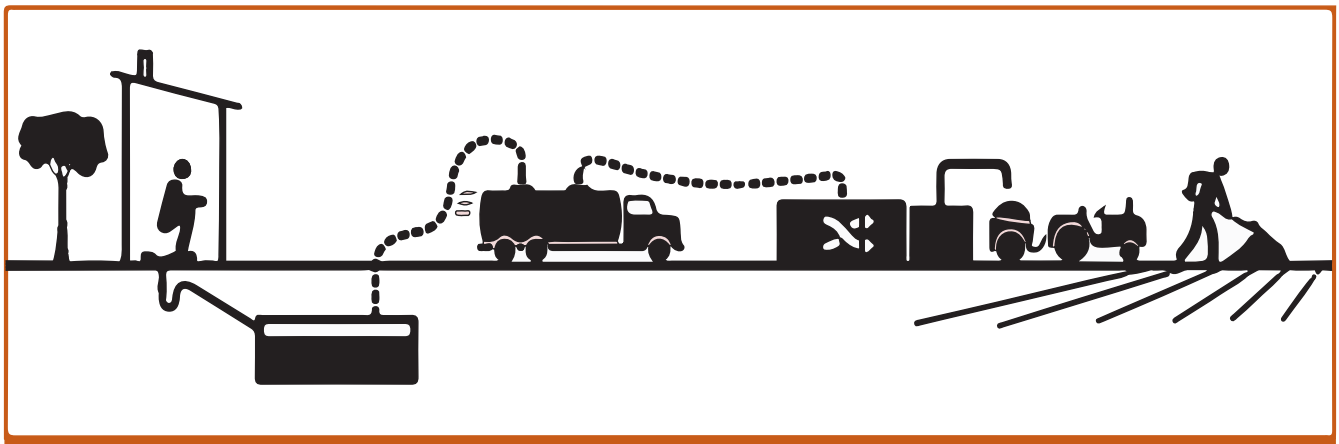
1.2 Faecal sludge and septage: How is it different from sewage?

Sewage is untreated wastewater which contains faeces and urine, this wastewater gets conveyed through the sewerage system. Generally, grey water from the kitchen and bathroom also becomes part of sewage. The biochemical oxygen demand (BOD) of sewage ranges from 150– 350 mg/l and all sewage treatment plants are designed for this load. Faecal sludge and septage is emptied out of pits or septic tanks and is much more concentrated than sewage; for example, BOD of septage ranges from 1,000 –20,000 mg/l. There appears to be a very thin line between septage and faecal sludge. Septage is limited to septic tanks, and has already undergone partial digestion, whereas faecal sludge includes contents from other onsite technologies, including septic tanks, and may or may not be digested.

What is faecal sludge and septage management?

Sanitation often focuses only on provisioning of physical infrastructure – toilets or latrines. In order to provide tangible and sustainable sanitation, there is a need to focus on the entire value chain also known as 'sanitation chain' (See Figure 2). It sets out interlinked steps vital to manage faecal sludge and septage and effluent from generation to disposal or end use, there by summarizing the city-level outcomes and current status of the same.

Figure 2: Sanitation chain



	Containment	Emptying and transport	Treatment	Disposal and end use
Definition	An onsite sanitation system into which a user interface discharges	Manual or motorized removal and transportation of faecal waste from the containment system	Process of converting faecal sludge into a product that is safe for end use	Disposal or utilization of output products derived from sanitation systems
Examples	Septic tanks, soakpits and cesspools	Vacuum trucks or carts	FSTPs, constructed wetlands and dewatering	Manure

Source: CSE, 2017

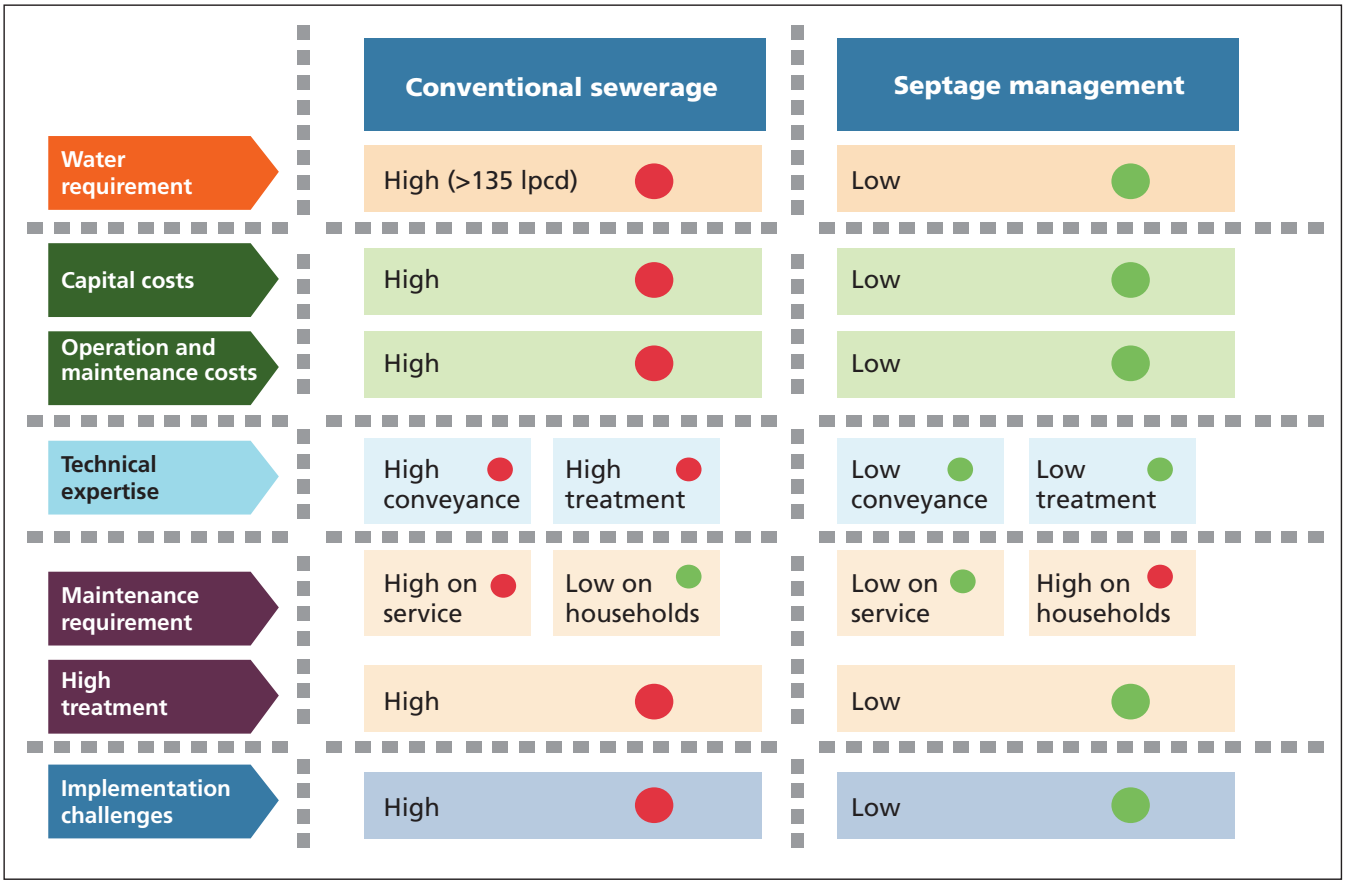
National FSSM Policy 2017 defines Faecal Sludge and Septage as follows:

"Faecal Sludge" is raw or partially digested, in slurry or semisolid form, the collection, storage or treatment of combinations of excreta and black water, with or without grey water. It is the solid or settled contents of pit latrines and septic tanks. The physical, chemical and biological qualities of faecal sludge are influenced by the duration of storage, temperature, soil condition, and intrusion of groundwater or surface water in septic tanks or pits, performance of septic tanks, and tank emptying technology and pattern. Faecal sludge is the solid or settled contents of pit latrines and septic tanks. Faecal sludge (FS) comes from onsite sanitation systems. Examples of onsite technologies include pit latrines, non-sewered public ablution blocks, septic tanks, aqua privies, and dry toilets.

"Septage" is the liquid and solid material that is pumped from a septic tank, cesspool, or such onsite treatment facility after it has accumulated over a period of time. Usually, septic tank retains 60% - 70% of the solids, oil, and grease that enter it. The scum accumulates on the top and the sludge settles to the bottom comprising 20% - 50% of the total septic tank volume when pumped. Offensive odour and appearance are the most prominent characteristics of Septage. It is a host of many disease-causing organisms along with the contamination of significant level of grease, grit, hair, and debris.

Septage is the combination of scum, sludge, and liquid that accumulates in septic tanks. The effluent from the septic tank can be collected in a network of drains and/or sewers and treated in a treatment plant designed appropriately. The accumulating sludge at the bottom of the septic tank however, has to be also removed and treated once it has reached the designed depth or at the end of the designed desludging frequency whichever occurs earlier. Such a removal is possible only by trucks. While sucking out the sludge, the liquid in the septic tank will also be sucked out. Such a mixture is referred to as septage.

Figure 3: Key features of conventional sewerage and septage management



Source: SM guideline, Maharashtra, 2016

Sanitation planning should be incremental, acknowledging the variation of urban conditions within and between areas and over time, and considering networked and non- networked solutions. Figure 3 explains salient features of both conventional sewerage and septage management.

The problem of faecal sludge and septage / sewerage must be addressed in a holistic manner, with a strategy that provides for minimum needs and is appropriate for all areas, considering the local situation. It must also address the enablers in the form of suitable regulation and institutional framework, capacity building and education and awareness among all stakeholders. Further need is to address efficiency of systems in place for onsite sanitation whereof the faecal sludge output needs to be managed environmentally safe manner including proper engineering design, construction and maintenance of septic tanks systems, pit latrines and such other systems generating faecal sludge.

1.3 Gaps and issues in effective FSSM in Bihar

While onsite sanitation is prevalent in cities across state, there are major gaps in its implementation across sanitation service chain. While the gaps and consequences of lack of access to toilets are well reported, those relating to containment systems, faecal sludge and septage collection, conveyance and treatment remain largely unknown and unaddressed by most, if not all state agencies dealing with sanitation and the urban local bodies. Even in general discourse this major health hazard is not well understood or talked. Key gaps and issues in faecal sludge and septage management are as follows:

Access: Issues in access to toilets arise due to households having financial issues and space crunch for constructing individual toilets. There are also significant cultural and social barriers (issues around perceptions of pollution and caste; and others)

Containment: In practice, the pits or septic tanks are not constructed according to the Indian Standard (IS) code; hence efficiency of the system is not up to the mark. This also affects the emptying frequency and quality of effluent and faecal sludge or septage recovered from these tanks. These systems are generally constructed by local masons according to space available and financial status of user. The masons make bigger pits then required. Often, the bottom of the tanks is not lined, to decrease the frequency of emptying. Thus, also contaminating the ground water that is also major source of drinking water supply.

Collection and conveyance: The frequency of cleaning has to be determined by the desired performance of the OSS for local conditions. In the absence of regular cleaning / desludging of septic tanks through systematic extraction and collection environmental pollution is common feature across all urban areas in Bihar. Following issues create barriers to regular cleaning and collection of faecal sludge and septage:

- Illegal manual scavenging
- No / limited access to tanks
- Inappropriate tank sizing and design
- Lack of infrastructure, and a regulated schedule for cleaning
- Lack of formal private players

Treatment and disposal: Typically, most small-medium town and cities lack adequate centralized / decentralized facilities and designated sites for sewage and for septage treatment and disposal. Cities with sewage treatment plant do not let disposal of faecal sludge or septage for co-treatment. As a result, all untreated faecal waste is dumped in rivers, lakes and any water body or open land in peri-urban areas at some distance away from the main city. Some key issues in treatment and disposal of faecal sludge and septage can be summarized as follows:

- Poor awareness
- Fragmented institutional roles and responsibilities
- Lack of integrated city-wide approach
- Limited technology choices
- Gender sensitive gap

1.4 Need for operational guidelines for FSSM

Ministry of Urban Development (now called Housing and Urban Affairs) aims to achieve considerable progress on containment of human waste under Swachh Bharat Mission (SBM), But ministry, recognizing that the end objectives and corresponding benefits of SBM cannot be achieved without proper management of faecal sludge and septage across value chain – notified a National Policy on Faecal Sludge and Septage Management (FS&S M) in February 2017.

The Objective and specific milestones stated in nation FSSM policy for urban India are:

National FSSM policy 2017: Objectives and scope

Key Objective

To set context, priorities, and direction for, and to facilitate, nationwide implementation of FSSM services in all ULBs such that safe and sustainable sanitation becomes a reality for all in each and every household, street, town and city.

Specific Milestones

- Leveraging FSSM to achieve 100% access to safe sanitation
- Achieving integrated citywide sanitation: mainstreaming sanitation
- Sanitary and safe disposal
- Awareness generation and behaviour change

Scope

Only OSS facilities and areas served by such facilities would under the purview of this policy. However, it will address synergies between FSSM and sewerage systems or municipal solid waste system e.g. co-treatment of FS and septage at sewage treatment plants (STPs) or with municipal solid waste. Scope of policy extends to:

- All projects, programs and schemes of Central Government and support sanitation services, urban development and improved delivery of services in urban and peri – urban areas of India town/cities.
- Applies to every urban local body, outgrowths in urban agglomerations, census towns, notified areas including industrial townships, special economic zones, defence establishments, places of pilgrimage, religious and historical importance as may be notified by State Government from time to time.
- The State Governments, ULBs and relevant public and private utilities should take necessary steps to ensure that this Policy covers all projects, programs and schemes related to provision of onsite sanitation services in their respective jurisdictions, irrespective of source(s) of funding for these projects, programs and schemes.

Role and Responsibilities of State (as defined in NFSSM Policy):

- Develop State Level FSSM Strategy & Implementation Plan
- Develop Operative Guidelines on FSSM
- Training and capacity building of ULB officials and other engaged in provision of FSSM services
- State level awareness and behavior change campaign
- Create enabling environment for participation of NGOs and CSOs in provision of FSSM services including to the poor and marginalized households and areas.
- Funding through specific schemes and plans
- Support Research and Capacity Building in the sector
- State level monitoring and evaluation

In addition, provide technical, financial and administrative support to ULBs; encourage coordination and cooperation among ULBs; regulate and help ULBs set up systems to ensure financial sustainability in provision of FSSM services and implement Municipal Bye – Laws.

Sanitation is a state subject and on-ground implementation and sustenance of public health and environmental outcomes require strong city level institution and stakeholders. Although there are some common elements across urban India, there are a number of factors, constraints and opportunities that are peculiar to specific situation of States and cities with respect to sanitation, climate, physiographic factors, economic, social and political parameters, and institutional variables. Therefore, each state and city needs to formulate its own FSSM strategy and integrate the same in their respective State and city sanitation plans in conformity to the National Policy. Several other stakeholders such as households, civil society organizations, the private sector (small, medium and large), the private sector (small, medium and large), research organizations, too have a critical role to play in achievement of safe and sustainable FSSM services for all.

1.5 Operative guidelines for faecal sludge and septage management in Bihar

These guidelines are framed by Urban Development and Housing Department Bihar drawing from provisions and specification, related to faecal sludge and septage, of the National Building Code 2005, Indian standard code of practice for installation of septic tanks (IS: 2470) - Bureau of Indian Standards (1986), National Urban Sanitation Policy 2008, CPHEEO Manual on Sewage and Sewerage Treatment 2013, Advisory note on Septage Management (issued by Ministry in 2013), National FSSM Policy 2017 and 'Septage Management – A Practitioner's guide : Urban India's journey beyond ODF' prepared in 2017 by CSE, New Delhi – a designated Centre of Excellence assisting Ministry in Sustainable Water Management area. The existing Faecal sludge and Septage Management Policies (Maharashtra, Odisha, Tamil Nadu, Jammu & Kashmir, Jharkhand, Rajasthan) and guidelines (Maharashtra, Gujarat, Tamil Nadu) including Septage Management regulations (Delhi and Warangal, Telangana) have been reviewed.

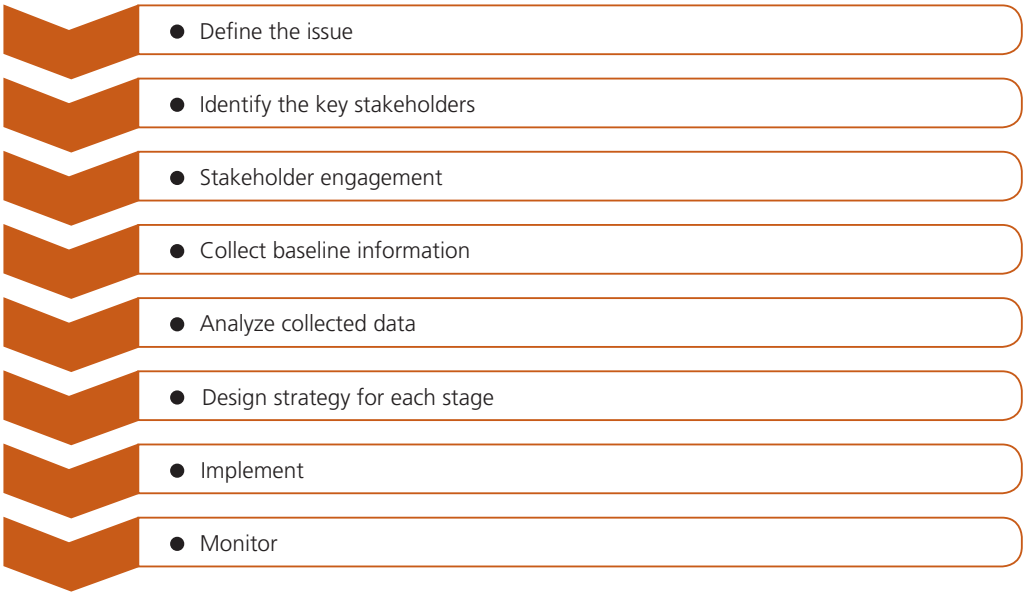
The guidelines cover the following key elements of faecal sludge and septage management:

- Faecal sludge and septage management plan for ULBs: how to start?
    1. Stakeholder identification and engagement
    2. Assessment of baseline information
    3. Suggested institutional framework
    4. Current economics and business model
    5. Monitoring and grievance redressal systems
    6. Awareness generation and capacity building
- Technological Options for FSSM
    1. Containment
    2. Emptying and transportation
    3. Treatment
    4. End use and resource recovery
- Bihar FSSM approach
- Financing considerations for FSSM

2. Faecal sludge and septage management: how to start?

Faecal sludge and septage management is a process and requires attention in every stage of the entire sanitation chain. It needs to be comprehensive and requires step wise approach beginning from systematic planning to ensuring infrastructure and human resource for transportation and treatment of faecal sludge and septage (refer Figure 4). It has to be sustainable and requires consideration of socio-economic aspects of region. The safe disposal/reuse of faecal sludge, septage and effluent in scientific manner for pollution abatement is the main goal of the FSSM.

Figure 4: Steps for planning FSSM



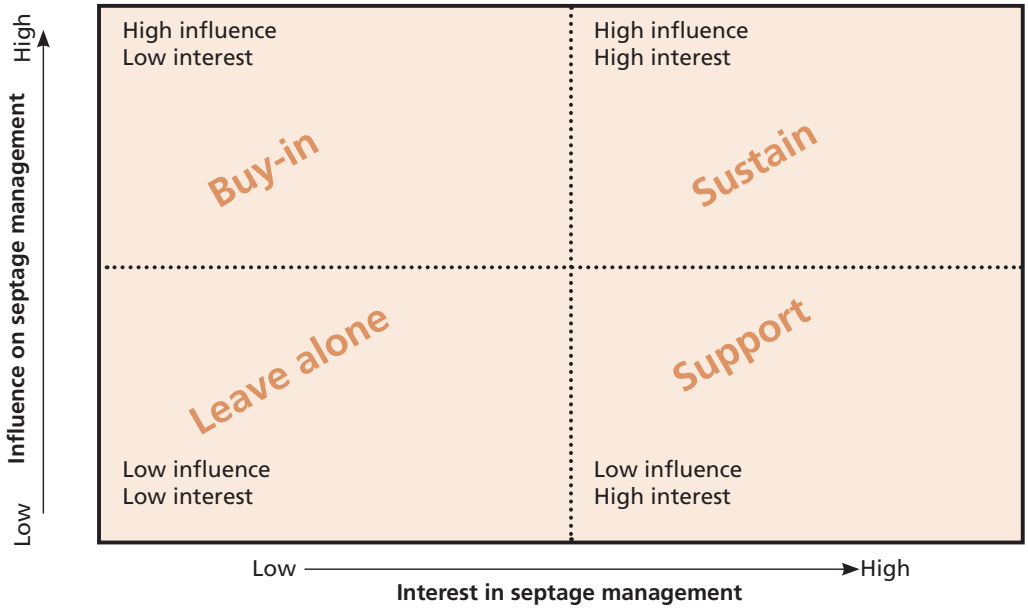
Source: CSE, 2016

2.1 Stakeholder identification and engagement

All interested parties, be they individuals, groups, organisations or entities, are stakeholders. Relevant stakeholders like representative from ULBs, PHEDS, Pollution Control Board, sanitary inspector, mason, vacuum truck operator, media, farmers etc. should be identified for the target area. Once identified, stakeholders are supposed to be analyzed based on the interest and influence chart, as shown in Figure 5. The analysis includes understanding their profile, their interests, their position (for or against), and their ability to influence FSSM practices. Stakeholders are then engaged through different strategies.

Stakeholder engagement is a key pre-requisite for successful implementation of FSSM. If the city already has a city sanitation task-force, as notified in NUSP, then the same team should deliberate about FSSM starting with collection and analysis of baseline data.

Figure 5: Stakeholder engagement strategy



Source: CSE, 2016

2.2 Assessment of baseline information

The next stage of FSSM is collection of baseline data from secondary sources like Census, state surveys, Detailed Project Reports (DPRs) of previous projects etc. and primary surveys wherever necessary for spatial information. It is important to understand how many households are using OSS. Spatial distribution of the houses in area should be qualitatively mapped. Preliminary surveys of households that are depended on the onsite sanitation system must be done to prepare comprehensive management plans. Table 2 provides basic but very crucial information to understand the situation for target area to plan FSSM.

Table 2: Essential baseline data to plan FSSM

Baseline data	Details and possible source of data
Base maps of the target area	Available with government agency. Can also be prepared using Google earth
Spatial distribution of households dependent on the OSS	Secondary data sources like Census, primary survey by NGOs, published reports. This might not be available for small/medium town cities and therefore primary surveys are essential
Containment: types of onsite sanitation system	Septic tank with or without soak pit/ pit latrine etc. with their average capacity, desludging frequency, fate of liquid waste (effluent) that is overflowing from the OSS is to be understood
Emptying and transportation: mode of emptying the OSS	Whether emptying service is provided by the government or by private operators. Number of service providers, infrastructure like no. of trucks, laborers etc. should be assessed
Treatment and disposal of FS	Whether there is any treatment of FS collected, where is it disposed

Source: Compiled by CSE, 2016

Once the baseline data is in place, next step is assessment of initial situation of target area i.e. community, ward, zone or city. There are several tools available to help the ULBs analyze the collected data. One such tool is called faecal waste flow diagram (also known as SFD). It is an easy to understand advocacy and decision-support tool that summarizes and presents what happens to the excreta of the whole city/town through the sanitation chain. To learn how to make an SFD visit www.sfd.susana.org. An SFD of Bihar state is shown in Figure 1 and SFD of a sample city is shown in Appendix 1. Another method to identify the gaps is to compare the existing services with the revised service level benchmarks proposed in NFSSM policy, refer Appendix 2.

2.3 Suggested institutional framework

In India, there are few institutions on the city and state level which take care of FSSM. This section enumerates the suggestions under the National Urban FSSM policy, which highlights that each state and city needs to formulate its own FSSM strategy and integrate the same in their respective state and city sanitation plans in overall conformity to the national policy. The roles and responsibility of each level of institution has been mentioned in Appendix 3.

2.4 Current economics and business model

In the present scenario, the FSSM is majorly in the hands of private operators. The operators charge for emptying service provided to different stakeholders. Emptying points can be from individual households, residential colonies, commercial establishments, institutions, toilet complexes, offices etc. Generally, the operators are called for emptying only when the containment is full. The fee for emptying varies widely. Due to absence of a dedicated disposal sites, private emptiers practice illegal dumping of FS/septage into water bodies, utterly disregarding the threat posed to health and environment. They run their business without paying any fees to government authorities which means that despite high charges collected from customers, no revenue is generated by government authorities from emptying business. Farmers in whose fields the collected septage or faecal sludge is disposed of also pay the private operators.

Business model

A business model not only depicts the financial spending of the institution towards a better FSSM, but reflects a return on the investment. A business model consists of four interlocking elements

- Customer Value Proposition (CVP): Products that create value for a target customer
- Cost structure: All costs incurred to operate the business model
- Profit formula: Revenue streams from each component of the sanitation
- Key resources: Most critical activities required for the business

For a business model of any institution working in the spectre of FSSM, the four elements should create and provide value to customers. The value propositions can be divided into multiple segments, but in this guideline, we have restricted to 5 types as listed below:

- Value Proposition 1 – Access to toilet and treatment for end-use: Providing an improved sanitation service to communities through access to toilet, and recovery of nutrient or energy through treatment of FS/septage.
- Value Proposition 2 – Emptying and transportation of FS: Providing a timely sanitation service for emptying pits and septic tanks at an appropriate frequency.

- Value Proposition 3 – Treatment of FS/septage for disposal: A healthier and safe environment through appropriate treatment of FS/septage.
- Value Proposition 4 – End-use through nutrient recovery: Producing high-quality compost as a soil conditioner.
- Value Proposition 5 – End-use through energy recovery: Improving access to energy.

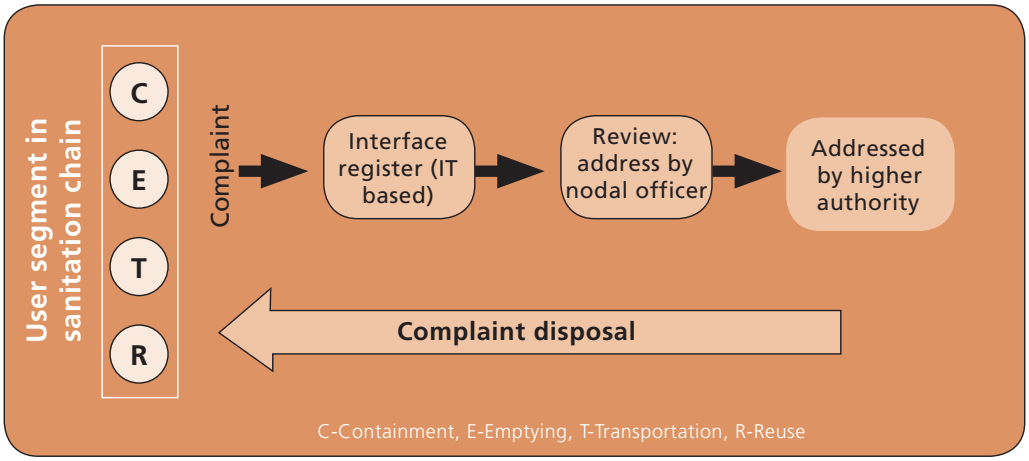
Depending on the value proposition offered by the business, its customer segment will vary. For a business providing emptying and transportation services, the customer segment is individual households, community toilet and institutions. A generic business model canvas is described in Appendix 4. Government could charge for following activities by private operators and septic tank owners to generate revenue for sustainably run FSSM programme.

a. Permits and their renewal for private operator through registration process
b. Charges to repair the faulty design through registered mason/plumbers
c. Fine to defaulters (private operator/containment owner) for not following instructions given by government agencies

2.5 Monitoring and grievance redressal systems

At each stage of sanitation chain i.e. from containment till end-use, monitoring is essential. Any lapse in monitoring means avoidable delays in achieving the goals of the programme (Refer Appendix 5). Format for issuing license and information collection by operator is shared in Appendix 6, 7 and 8. When any services are offered, there are always some issues and challenges associated with them. Customer satisfaction should be main objective of service provider. In FSSM many stakeholders/beneficiaries are involved. It may not be possible that each beneficiary is satisfied with services. Therefore, for appropriate disposal of the complaints with FSSM, a complaint redressal system must be put in place before services are offered. The mode of the redressal system should vary according to the size of the target area, from simple register to complex information technology-based system. Nodal officers must be appointed to dispose of the complaints for each stage of FSSM. Nodal officer should review the complaint and dispose it. However, in case the complaint is not addressed

Figure 6: Flowchart of complaint redressal system for FSSM



Source: Compiled by CSE, 2017

or user is not satisfied, there should be provision to take the complaint to higher authorities or institutions (e.g. pollution control board) for appropriate action. Figure 6 explains the complaint redressal system.

2.6 Awareness generation and capacity building

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 shared in Annexure 9. 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 FSSM 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 FS/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 service providers / private vendors:** Local bodies should ensure all safety norms are clearly explained to the FS/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.

3. Technological options for FSSM

3.1 Containment system

In practice the septic tanks are not constructed according to the IS code and hence the efficiency of the system is not up to the mark, it further affects the emptying frequency and the quality of effluent and FS/septage recovered from these tanks. These systems are constructed by local masons generally based on the space available and financial status of the user. The masons often create bigger systems than required. Often, the bottom of the tank is not lined, to decrease the frequency of emptying. See Table 3 for an overview of the ongoing containment practices in India. Refer Appendix 10 for a brief description of containment systems prevalent in Bihar and also the output expected out of such systems. The septic tank design prescribed by IS code is described in Appendix 11.

Table 3: OSS in urban India

Type of systems	Containment type	Prevalent OSS	OSS as per Census of India, 2011	Standards for OSS
Onsite sanitation systems	Lined containment	Septic tank with soak pit	Septic tank	Bureau of Indian standards
		Septic tank without soak pit		
		Collection tank		
		Bio-toilet	Other technology	DRDO and SBM
		Bio-digester		
	Unlined containment	Pit latrine/ VIP	Pit latrine	SBM containment guidelines
		Twin pit latrine		

Source: Compiled by CSE, 2017

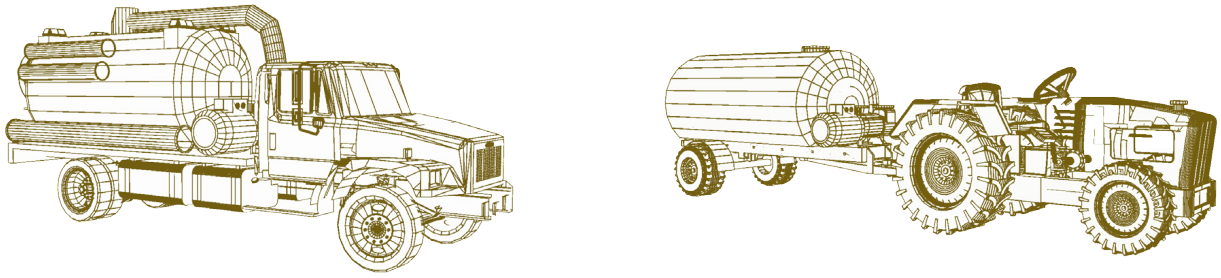
3.2 Emptying and transportation

Emptying of containment system is done both mechanically and manually. At the end of a fixed time period, ideally two-three years, containment system should be emptied of FS/septage. The scheduled emptying should be done in order to facilitate treatment of faecal matter in the onsite sanitation system. There are many benefits of regular desludging including increased efficiency of OSS and better discharge quality of effluent. The Prohibition of Employment of Manual Scavengers and their Rehabilitation Act, 2013 prohibits employment or engagement of manual scavengers, however many locations which are inaccessible to mechanical emptying continue to employ manual scavengers. Other than manual emptying, mechanised methods include use of vacuum tanker or tractor mounted vacuum tankers, these are used for emptying of containment systems. Mechanised systems are usually accompanied with a driver and a helper (which may be 2 in some cases). Vehicles that carry FS/septage act as a mobile sewer network for OSS. Ideally ultimate discharge point of collected FS/septage is STP or faecal sludge treatment facility if it exists. No Personal Protective Equipment (PPE) is used by the operators while emptying the tanks or pits posing risk to health.

Precautions to be taken during emptying

- Proper Personal Protective Equipment (PPE) should be used to avoid any transmission of pathogens to the operator providing de-sludging service
- Some amount of septage/sludge should be left in the septic tank to ensure retention of necessary microorganisms responsible for anaerobic digestion in the tank
- Due to anaerobic digestion processes, flammable gases are formed in septic tanks. While opening the chambers for de-sludging they escape into atmosphere. Hence, it is recommended not to light fire nearby it. (e. g. use of match stick for smoking) during that period
- Because of the sensitivity of septic systems due to presence of bacteria that speeds up anaerobic digestion process, care should be taken not to scrub the septic tank, clean using strong chemicals etc. so that bacteria do not die.

Figure 7: Two types of vehicles commonly used in Bihar



A truck-mounted vacuum tanker *Tractor-mounted vacuum tanker*

Graphic: Sunny Gautam / CSE

The two main types of vehicles used in India are:
1. Truck mounted vacuum tanker (Vacuum tanker)
2. Tractor mounted tanker

1. Truck mounted vacuum tankers (Vacuum trucks)

These trucks have vacuum pumps, whose sizes are based on lift elevation, pumping distance, volume of sludge to be removed, and volume of the tank. Their capacity varies from 3000 liters- 10,000 liters.

2. Tractor mounted vacuum tankers

These vehicles are locally made across India, but capacity is similar to the vacuum trucks. The motor, the tank and the tractor are joined together according to the complimenting capacity of each module.

3.3 Faecal sludge and septage treatment

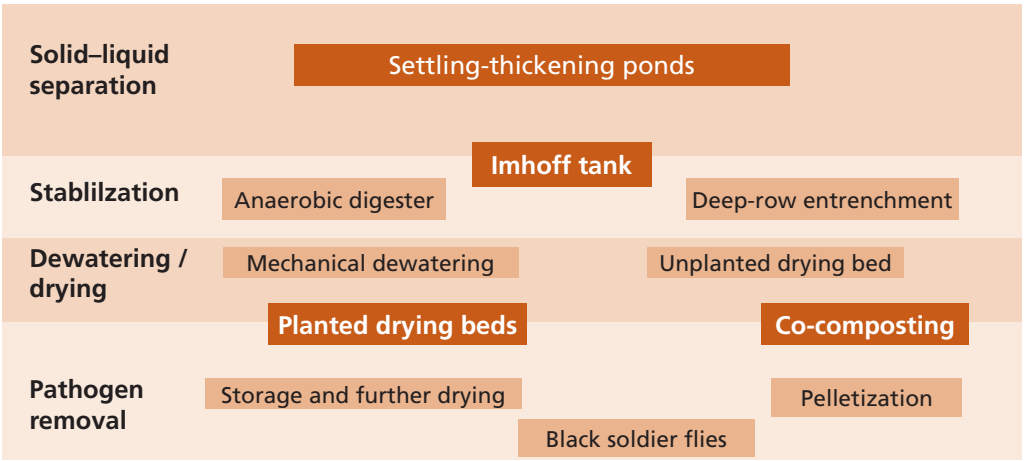
The characteristics of FS/septage show that it is that FS/septage collected from various points in the city needs to be disposed at an appropriate treatment harmful for environment and health of living beings if it is disposed without treatment. Therefore, it is necessary facility. Both FS/septage and effluent needs to be treated. Small bore systems can be used to convey effluent to small distances and then treat it at decentralized scale, refer Appendix 12 for more details. To choose the best combination of technologies the existing scenario of the city has to be discussed among the stakeholders. Things like population density, water usage, type of onsite system prevalent in city, soil strata, ground water table, land available, topography of the city, and characteristics of the FS/

septage, demand of the end product, capital cost and operation cost should be considered before deciding on the technology combination. The treatment can be achieved in three ways

1. Co-treatment with wastewater at sewage treatment plant
2. Co-composting with municipal solid waste
3. FS/Septage treatment plant

The four main functions of FS/septage treatment are: the solid-liquid separation, stabilization, dewatering or drying, and pathogen reduction. Figure 8 shows the different technologies based on their functions. Comparison of various technologies with respect to various parameters is shown in Appendix 13. Refer Figure 9 for understanding the selection of best suitable effluent disposal method.

Figure 8: Different treatment technologies based on their function

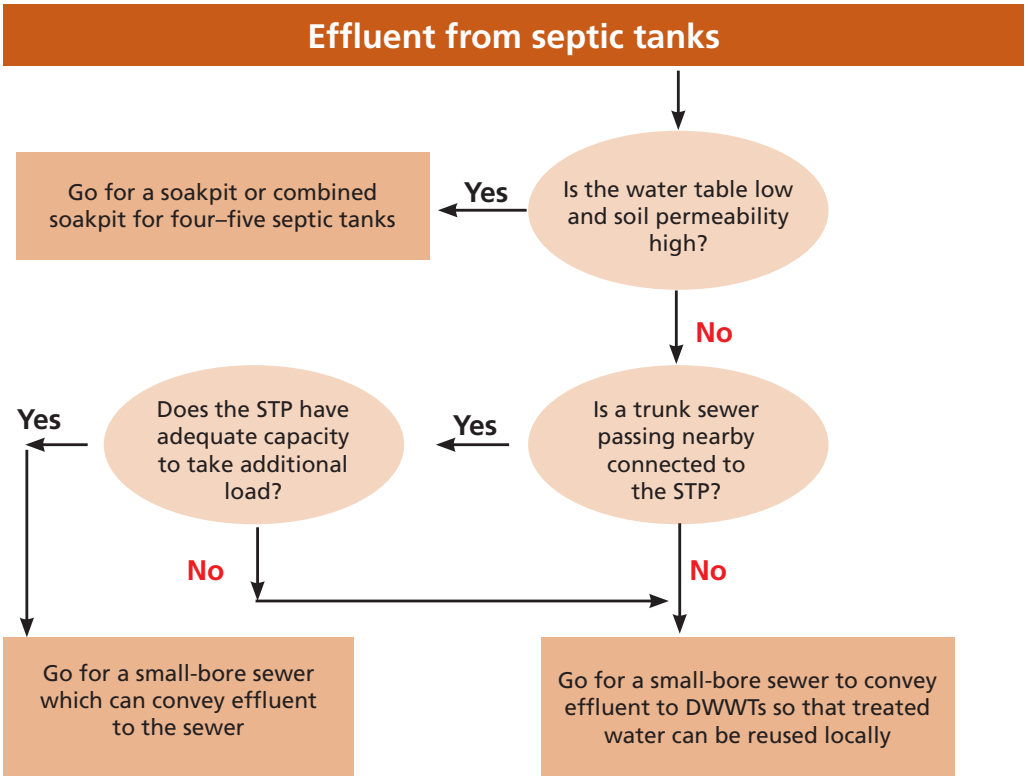


Source: Tilley et al, 2014

3.4 End-use and resource recovery

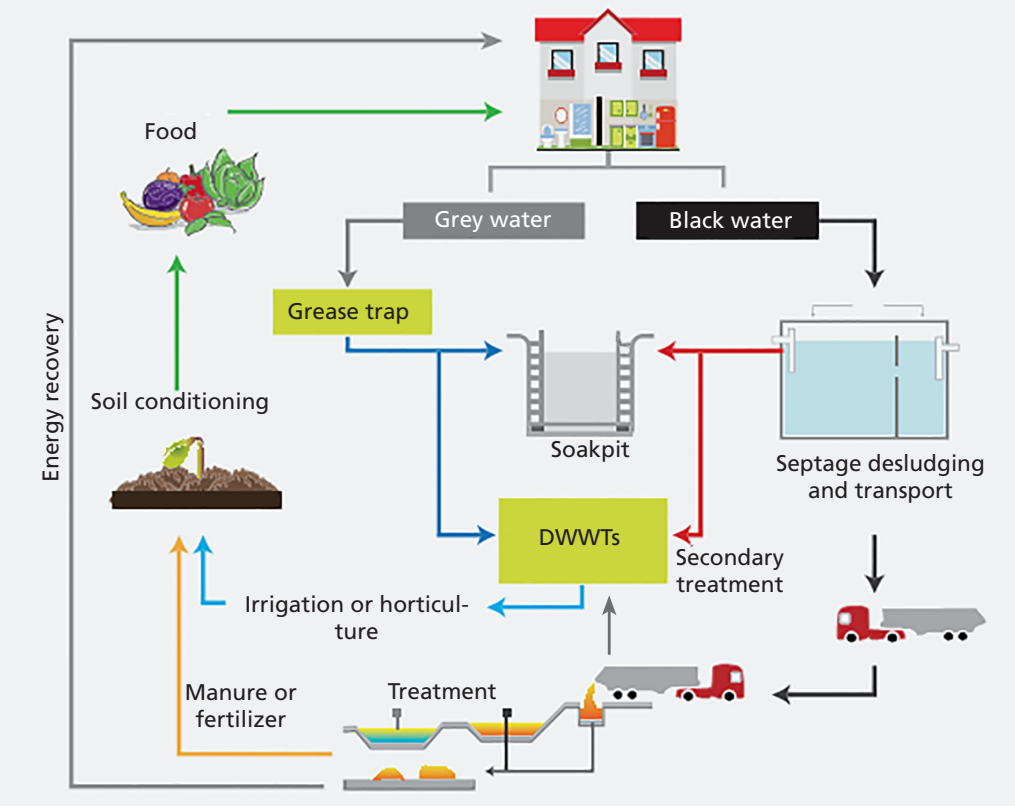
End-use of FS/septage refers to the safe, beneficial use of human excreta, i.e. faeces and the wastewater from onsite sanitation technologies. The type of end-use should decide the level of treatment. Considering the nutrients, organic matter and energy contained in FS/septage, it can be used as soil conditioner or fertilizer in agriculture, gardening, aquaculture or horticultural activities (See Figure 10). Other uses include use as a fuel source, building material or for protein food production. Closing the loop would not only help in reducing fresh water demand and chemical fertilizer demand but also prove to be a source of revenue, in other words can help improve the business model. Appendix 14 and 15 details out the permissible standards for the compost to be used in food crops and the discharge standards for effluent respectively.

Figure 9: Flowchart to select suitable effluent disposal method



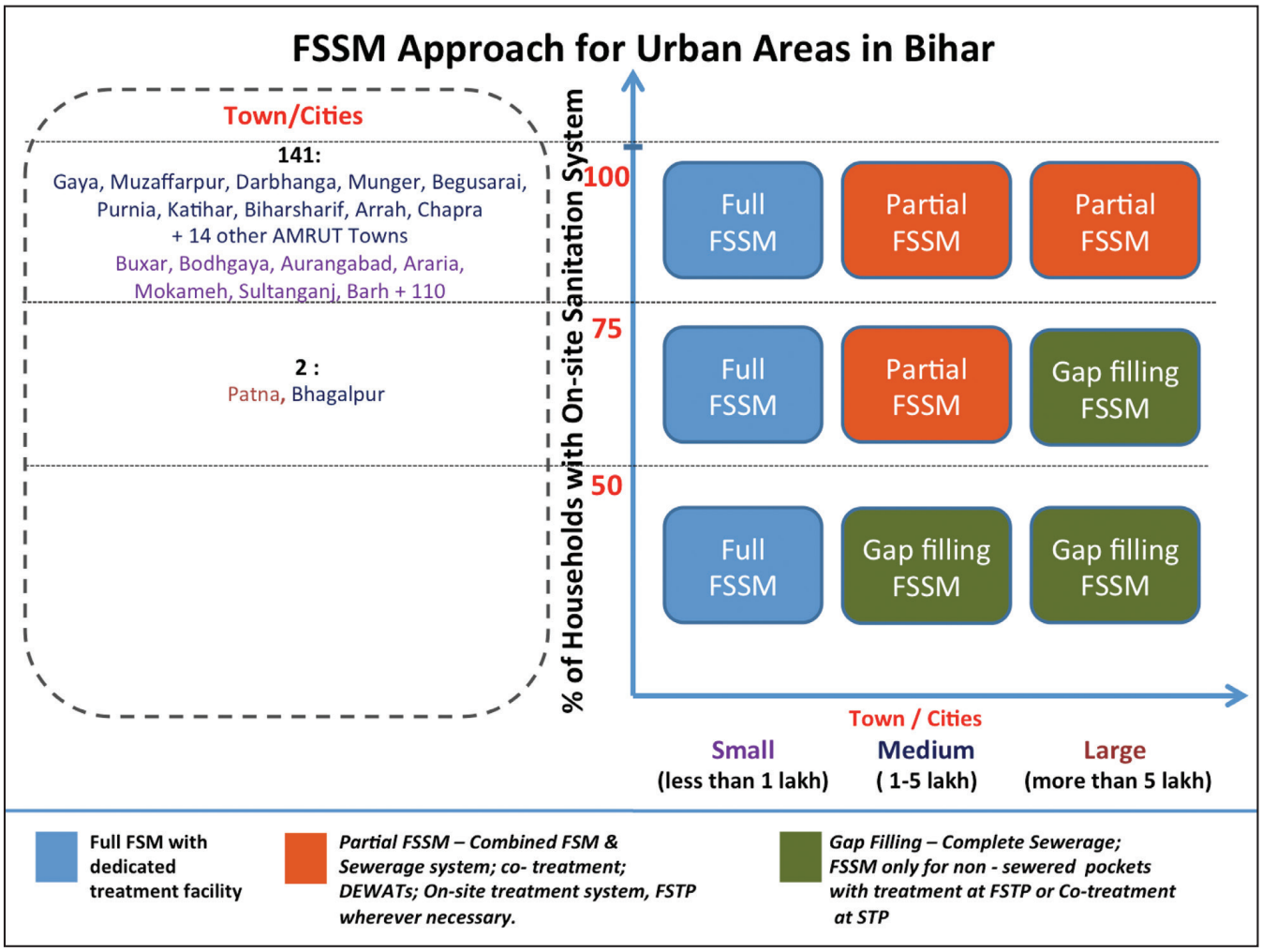
Source: CSE, 2017

Figure 10: Closing the loop



Source: GIZ-CSE, 2016

4. FSSM approach



Note: To optimize the cost of implementing FSSM, cluster approach (desludging and treatment services can be shared among two smaller cities or small cities can make use of infrastructure at larger cities) should be adopted

5. Milestones and timelines

Milestones and timeline

Category	Actions	Year 1				Year 2				Year 3				Year 4				Year 5			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
AMRUT Cities	A1																				
	A2																				
	A3																				
	A4																				
	A6 + A7																				
	A5																				
	A8 + A9																				
	A10																				
	A11																				
Class II Towns	A12																				
	A1																				
	A2																				
	A4																				
	A3+A5+A6																				
	A7																				
	A8 + A9																				
	A10																				
	A11																				
Class III & IV	A12																				
	A1																				
	A2																				
	A4																				
	A3 + A5																				
	A7																				
	A8 + A9																				
	A10																				
	A11																				
	A12																				

A1	Baseline data collection and CSTF formation
A2	Preparation of city FSSM strategy
A3	Licensing of existing desludgers
A4	Preparation of Citywide Sanitation Plan
A5	Identification of trenching sites for proper disposal of faecal sludge, till the time proper treatment plant is in place
A6	Operationalising co-treatment at existing STP and/or co-composting with municipal solid waste wherever feasible for safe treatment of collected FS
A7	Implement and operationalise faecal sludge treatment plants with reuse wherever necessary for safe treatment of all the generated FS
A8	Capacity building programme for ULB, service providers, masons, operators etc
A9	Adequate manpower and equipment for collection and transport of faecal sludge
A10	Implement scheduled desludging
A11	Operationalise decentralised wastewater treatment and reuse for the effluent generated from onsite sanitation systems
A12	All households with individual toilet in non sewered areas to have safe onsite sanitation system

6. Financing considerations for FSSM

6.1 Options for financing

FSSM when compared with either centralized or decentralized sanitation infrastructure is more cost effective. Most of the initial source of funding across the sanitation value chain will have to be provided by the joint effort of the central and state government primarily through the allied programme funding like Swachh Bharat Mission, Smart City or AMRUT.
Following are the options for sources of revenue for the private service provider:

1. Desludging fee paid by user to the desludging service provider
2. Fine for faulty containment system construction and illegal disposal of faecal sludge.
3. Sale of end products (For e.g. dried faecal sludge, water)
4. Property tax designated for FSSM

6.2 State level funding options

Sources of revenues for FSSM

a. As per the Bihar Municipal Bill, 2007, Chapter XV: Municipal Revenue, Section 128(i), The Municipality has the power to levy user charges for provision of water supply, drainage and sewerage services.
b. If ULB explore the possibility of private sector involvement in FSSM, 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 FS/septage** for agriculture/horticulture or other purposes including local reuse of treated water to meet various non-potable requirements
e. Funding could be explored through various other central/state schemes- Smart Cities Mission (SCM), HRIDAY, PMAY, NULM, Namami Gange and other state programmes like *Saat Nishchay* etc.
f. CSR funding opportunities under Namami Gange, SCM and SBM also are available.

Out of the 199 towns and cities in Bihar, only 27 have been selected under the AMRUT scheme. The overall planning and implementation process remains the same. The critical part is the CAPEX and OPEX requirement.

An investment plan suited to the local capacities will be needed by the municipality for asset creation. In order to lower the financial burden on public investments, innovative private sector funding ideas will have to be evolved and a revenue model to determine the user charges will have to be worked out for collection and conveyance.

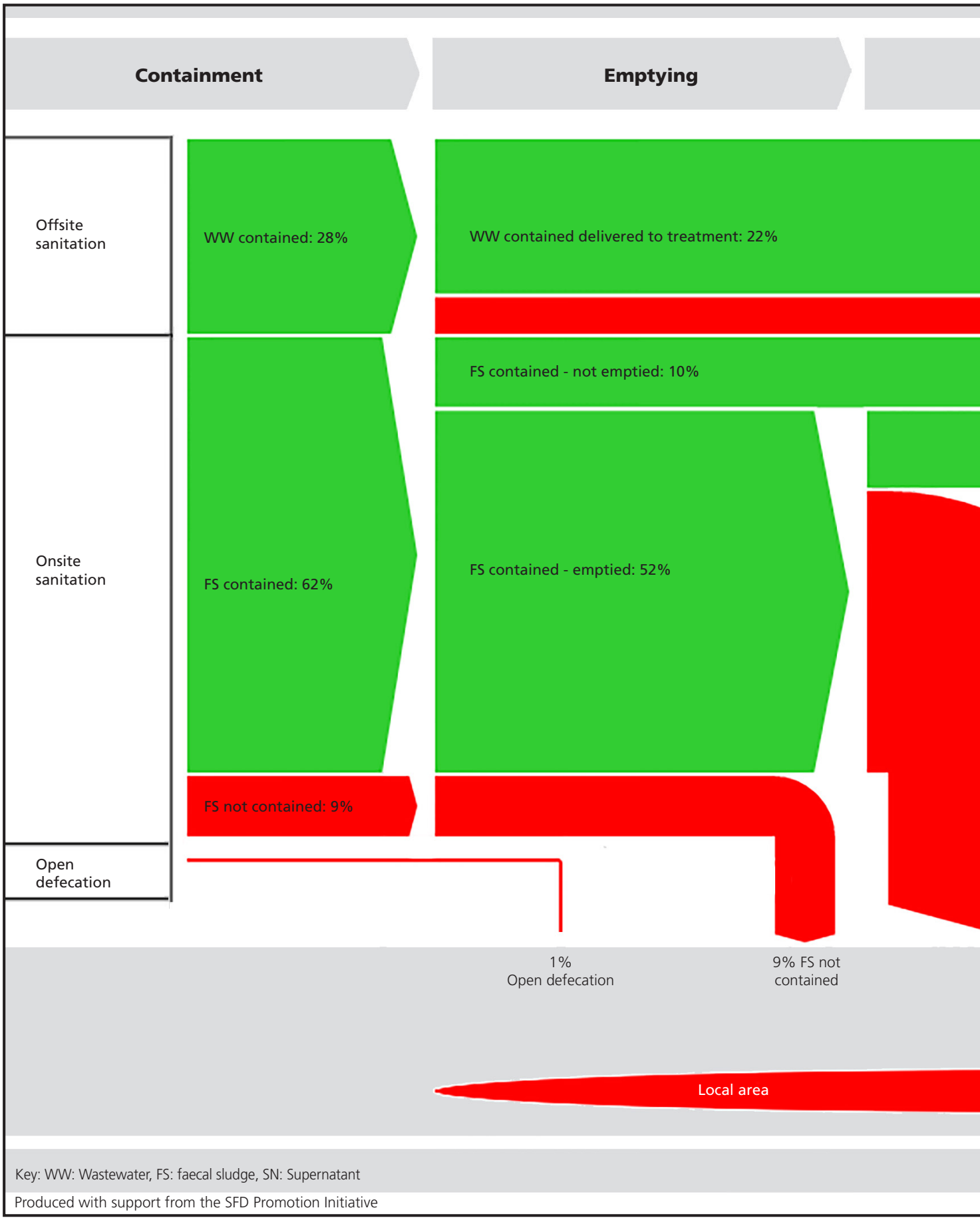
6.3 Other funding models

In the absence of any special scheme based funding the towns and cities can resort to either of the financial models.

Table 5: Alternate funding models

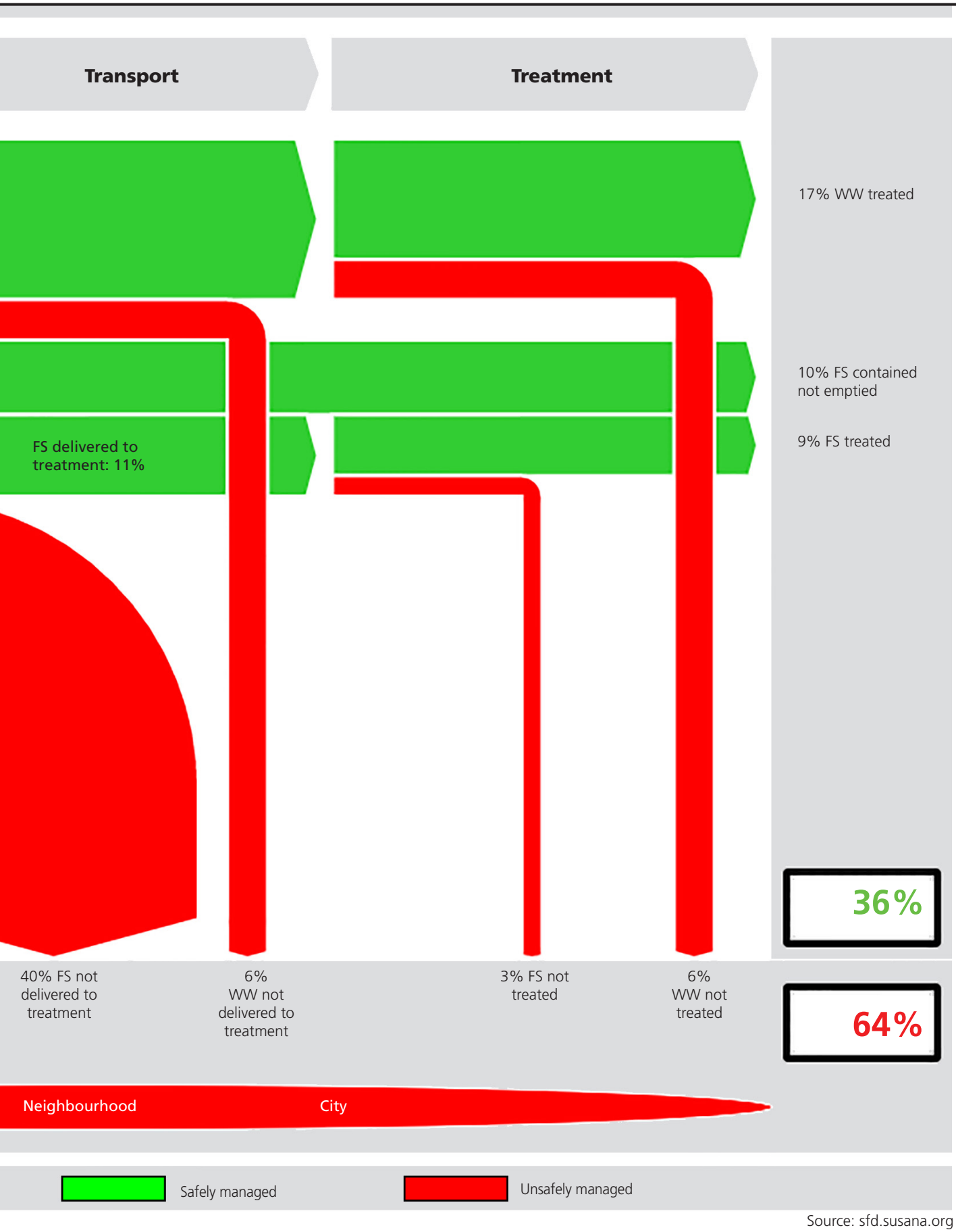
	Public sector	Outsourcing	Hybrid annuity Model	Private sector
CAPEX	State Government / ULB / grant from funding agency (100%)		Government 20-50% Private sector 50-80% Use of land for FSTP on leasehold	Private sector
O&M	ULB operates and maintains the facility	Operation carried out by private sector with service level agreements		Complete private sector with monitoring mechanism
Capital Recovery	Tax from polluters/ cross subsidization/ Expenditure Budget		Tax from polluters, Revenue from services	Revenue from services
Role of ULB	Ownership of assets and operations	Contract management and monitoring	Monitoring for service level agreements	Regulatory

Appendix 1: Faecal waste flow diagram of a sample city



Key: WW: Wastewater, FS: faecal sludge, SN: Supernatant

Produced with support from the SFD Promotion Initiative



Source: sfd.susana.org

Appendix 2: Revised service level benchmarks for sanitation

Current SLB indicators (Sewerage System)	Proposed Sanitation Benchmark (Sewerage + Onsite systems)
1. Coverage of sewerage network services	**1. Coverage of adequate sanitation system**
Total number of properties with individual connections to sewerage network as a percentage of total number of properties in the city.	Percentage of households with individual or group toilets connected with adequate sanitation systems (sewer network/ septic tank / double pit system) to total households in the city
2. Collection efficiency of sewerage network	**2. Collection efficiency of sanitation system**
Quantum of sewage collected at the intake of the treatment plant to the quantity of sewage generated (as per CPHEEO, 80% of water consumed is generated as sewage)	Weighted average of collection efficiency of each sanitation system, weighted by share of households dependent on each sanitation system
3. Adequacy of sewage treatment capacity	**3. Adequacy of treatment capacity of Sanitation System**
Adequacy is expressed as secondary treatment capacity available as a percentage of normative wastewater generation.	Weighted average of adequacy of treatment plant capacity available for each sanitation system, weighted by share of households dependent on each sanitation system.
4. Quality of sewage treatment	**4. Quality of treatment of sanitation system**
Quality of treatment is measured as a percentage of WW samples that pass the specified secondary treatment standards, that is, treated water samples from the outlet of STPs are equal to or better than the standards lay down by the GoI agencies for secondary treatment of sewage.	Weighted average of quality of treatment of each sanitation system, weighted by share of households dependent on each sanitation system.
5. Extent of reuse and recycling of sewage	**5. Extent of reuse and recycling in sanitation system**
Quantity of sewage that is recycled or reused after secondary treatment as a percentage of quantity of sewage received at the treatment plant.	Weighted average of extent of reuse of treated wastewater and sludge after adequate treatment as a percentage of sewage and sludge received at the treatment plant, weighted by share of household dependent on each sanitation system.

Source: National Policy on FSSM, MoHUA, 2017

Appendix 3: Roles and responsibilities of institutions

Agency	Role	Responsibility
Ministry of Urban Development	• Technical and planning support to states and ULBs • Training and capacity-building of state level officials and those from select ULBs • Funding through specific schemes and plans • National level awareness and behaviour change campaign • Support research and capacity building in the sector • Create enabling environment for participation of the private sector, NGOs and CBOs in provision of FSSM services including to the poor and marginalized households and areas • National-level monitoring and evaluation	Formulation of state- and city-level FSSM strategies and implementation plans
Ministry of Environment, Forest and Climate Change	Enforce compliance of the relevant environmental laws and rules during the collection, transport, treatment and disposal of faecal sludge and septage	Support and build capacity of state pollution control towards enforcement of relevant laws and rules
Ministry of Social Justice and Empowerment	• Elimination of manual scavenging and rehabilitation of manual scavengers • Monitor and evaluate progress at the national level • National-level awareness campaign	Help states and ULBs eliminate manual scavenging and rehabilitate manual scavengers
Ministry of Women and Child Development		Gender mainstreaming in IEC material for FSSM across the country
State Governments	• Develop state-level FSSM strategies and implementation plans • Develop operative guidelines on FSSM • Training and capacity-building of ULB officials and others engaged in provision of FSSM services • State-level awareness and behaviour change campaign • Create enabling environment for participation of the private sector, NGOs and CSOs in provision of FSSM services including to the poor and marginalized households and areas • Funding through specific schemes and plans • Support research and capacity-building in the sector • State level monitoring and evaluation	• Technical, financial and administrative support to ULBs • Encourage coordination and cooperation among ULBs • Regulate and help ULBs set up systems to ensure financial sustainability in provision of FSSM services • Implement municipal by-laws.
Urban local bodies	• Design, develop, plan and implement ULB-level FSSM strategies • Set up and ensure operation of systems for 100 per cent safe and sustainable collection, transport, treatment and disposal of faecal sludge and septage • Develop expertize, in-house and outsourced, to provide safe and effective FSSM services • Awareness and behaviour change campaigns to engage diverse stakeholders • Develop training programmes for masons to build requisite skills in the construction of quality septic tanks as per IS codes • Set up systems to ensure financial sustainability in provision of FSSM services • Achieve objectives of FSSM policy in a time-bound manner • Design and implement plans to eliminate manual scavenging and rehabilitate manual scavengers • Funding through specific schemes and plans • Monitor and evaluate FSSM strategies and implementation plans • Implement municipal by-laws	Create enabling environment for NGOs and private initiatives to achieve safe and sustainable FSSM
Households	• Timely and regular emptying of septic tanks through approved entities • Regular maintenance and monitoring of septic tanks • Timely payment of user fee and charges, if any, towards FSSM services • Practice building by-laws for construction of OSS	Engage with decision-makers at the state- and ULB-level to ensure they receive good quality FSSM services

Source: National Policy on FSSM, MoHUA, 2017

Appendix 4: Generic business model for FSSM

<table>
<tr><th>Key partners</th><th>Key activities</th><th>Value propositions</th><th>Customer relationships</th><th>Customer segments</th></tr>
<tr><td rowspan="8">• Municipal corporation and local authorities
• Technology suppliers
• Financial institutions
• Community-based organizations
• Research and development institutions (e.g., local university)</td><td>• Toilet provision
• Waste collection</td><td>• VP1: Access to toilet and increased revenue from end use</td><td>• Direct sale of toilet</td><td>• Community
• Businesses</td></tr>
<tr><td>• FS collection</td><td>• VP2: Timely emptying and transportation of FS</td><td>• One-on-one service provision
• Contracts with municipality
• Direct or through contracts</td><td>• Households
• Businesses</td></tr>
<tr><td>• FS treatment</td><td>• VP3: FS treatment for healthy and safe environment</td><td>• Direct compost sales</td><td>• Municipality</td></tr>
<tr><td>• Organic waste and FS collection
• Compost production
• Compost – Sales & marketing</td><td>• VP4: High-quality compost (soil ameliorant)</td><td>• Distributors
• Direct energy sale</td><td>• Farmers
• Municipal park department
• Agriculture department
• Agroforestry
• Fertilizer industry</td></tr>
<tr><td>• Biogas production
• Biogas sale</td><td>• VP5: Reliable and renewable energy service</td><td>• Power purchase agreement</td><td>• Households
• Community
• Small businesses</td></tr>
<tr><td>• Customer relationship management</td><td rowspan="4"></td><td></td><td>• Public sector (e.g., municipality, ministry, etc.)
• Institutions</td></tr>
<tr><td>Key resources</td><td>Channels</td><td rowspan="3"></td></tr>
<tr><td>• Appropriate technology and equipment
• Labor
• Finance
• License and contracts for collecting waste</td><td>• Direct
• Municipality
• Word-of-mouth
• Brochures and other media communications</td></tr>
<tr><td></td><td>• Distributors and extension agents</td></tr>
<tr><td colspan="2">Cost structure</td><td colspan="3">Revenue streams</td></tr>
<tr><td rowspan="2">• Fixed investment cost (construction, trucks, equipment, etc.)
• Operation and maintenance cost (labour, raw material input, utilities, sales and marketing, license, etc.)
• Interest payments</td><td></td><td rowspan="2"></td><td>• Sale of toilet and end use products</td><td>• FS disposal fees, sanitation tax and O&M budget support</td></tr>
<tr><td>• Emptying fees and, in some instances, FS delivery fees</td><td>• Sale of compost</td><td></td></tr>
<tr><td></td><td></td><td colspan="2">• Sale of Energy</td><td></td></tr>
<tr><td colspan="2">Social and environmental costs</td><td colspan="3">Social and environmental benefits</td></tr>
<tr><td colspan="3">• Potential health risk for those in direct contact with FS (can be mitigated with the use of protective equipment)
• Improper FS treatment and disposal causing environmental and health risks for citizens
• Improved energy security</td><td>• Reduced pollution of water bodies and soils
• Reduced human exposure to untreated faecal sludge
• Job creation</td><td>• Improved soil and agricultural productivity</td></tr>
</table>

Note: Colours indicate relevance to corresponding value proposition (VP). Beige is applicable to all VPs
Source: Source: Krishna C. Rao, 2016, Business models for fecal sludge management, IWMI

Appendix 5: Monitoring FSSM programme

Stage	Monitoring
Containment	• Construction as per prescribed standards by BIS or CPHEEO • Construction of the containment by licensed masons and plumbers • Overflow from containment is not diverted in open areas/drains • Census of the OSS and retrofitting of the faulty containment is done. If not done within timeline, defaulters should be charged
Emptying	• Safety standards are followed • Legislative provisions like Manual Scavenging Act 2013 • Fixed charges are collected by private or government operators
Transportation	• Vehicles are registered with ULB with transparency • Vehicles are well maintained • All vehicles are GIS enabled, so that disposal can be monitored • FS/septage is disposed in designated disposal/treatment sites
Treatment	• FS/septage characteristics are determined to design the treatment system • In case of co-treatment at STP, design parameters to take additional FS/septage load is checked • Effluent resulting from dewatering is treated to discharge standards • Independent FS/septage treatment plant has adequate provisions for vehicles parking places without disturbance to surrounding • Sludge drying beds are emptied regularly
Disposal/ End-use	• Legislative provisions like water pollution and environment protection acts are followed • Defaulters are charged/fined as per the provisions • Quality checks of end product is done before reuse • Rates of end product are affordable • Treated waste water overflowing from containment meets prescribed standards of reuse for designated purpose

Source: Compiled by CSE, 2017

Appendix 6: Form of application for the license of collection, transportation and disposal of FS/septage

Paste Self-Attested Recent Passport Size Photograph

1. Name of the applicant: Mr/Ms_____
2. Nationality: Indian_____Other_____
3. Address: Regd. Office:_____

   Headoffice:_____
4. Telephone No.: (O)_____Mobile No._____

   Email ID_____
5. Registration No. of Vehicle :_____
6. Pollution certificate of the vehicle valid up to:_____
7. Insurance of the vehicle valid up to:_____
8. Fitness of the vehicle valid up to:_____
9. Vehicle, whether fitted with GPS:_____
10. Details of the vehicles indicating model, type, capacity, leak proof, odour and spill proof having proper vacuum/ suction and discharging arrangement (Document proof of any may be enclosed).
11. Processing fee for license Rs. 1000/- (Non-refundable)

    D.D. No._____Date_____

    Bank_____

I/We certify that information given by me/us in column 1 to 11 are true to the best of my knowledge and belief. I also certify that I have read and understood the attached terms and conditions 1 to 13 and agree to abide by them. I agree that if any information given by me is found wrong the application for license will be liable for cancellation at any time.

Signature(s) of applicant(s) Date: _____

No. of document attached: _____

Annexure 7: License for collection and transportation of FS/Septage

In accordance with all the terms and conditions of the By-laws/ Regulations, Municipal Corporation Act rules, the special license conditions accompanying this license and applicable rules and laws of Government of Bihar, the permission is hereby granted to:

NAME OF LICENSEE……...

ADDRESS……..…

Licence No……..……..…

For the disposal of FS/septage from septic tanks in city

This license is based on information provided in the FS/Septage Collection and Transportation License Application. This license is effective for a period of five years from date of issue, set forth below.

EFFECTIVE DATE

EXPIRATION DATE

The license may be suspended or revoked for condition of Non-Compliance and is not transferable. The original license shall be kept on file in the Licensee's office. A copy of this license shall be carried in every registered vehicle used by the Licensee.

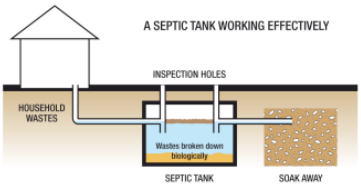
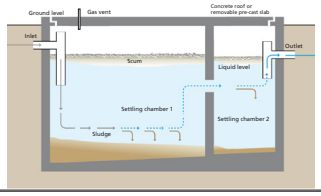
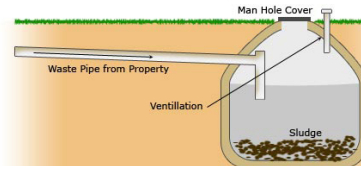
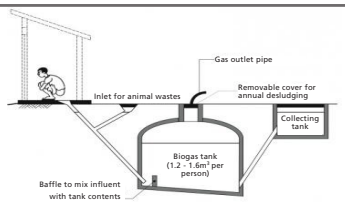
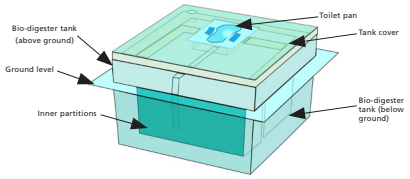
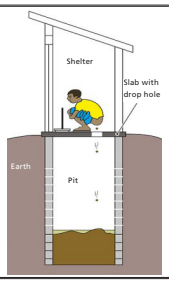
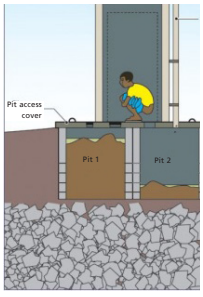
Annexure 8: Format for record keeping by operator

S. No	Name of the customer	Area and location	Date of request for desludging	Date of completed desludging	Type of septic tank	Age of septic tank	Quantity of FS/septage desludged	User charge	Any accident /slippage	Next date of desludging

Annexure 9: Sample IEC material

Source: Guidelines for Septage Management in Maharashtra, Government of Maharashtra

Appendix 10: Type of containment systems

Containment system	Description	Output
	A septic tank with soak pit, is a decentralized wastewater treatment system. It is basically a sedimentation tank with chambers, which has settling and anaerobic processes to reduce solids to organics, which lets out the effluent content to flow into a soak pit, from where it infiltrates into water. (EAWAG, 2014)	Septage found within the septic tank
	A septic tank without soak pit has a same function as a septic tank with a soak pit. The only difference between the two is that effluent is let out on ground/water body or open drains. (EAWAG, 2014)	Septage found within the septic tank and effluent let out in the open drains
	A reservoir or a closed tank for collection of wastewater, with no intent to treat or discharge any of its components. (WTE, 2014)	Slurry from mixture of faeces and water
	Bio-digester is a decomposition mechanical toilet which decomposes waste water in the digester tank using specific high graded bacteria further converting it into methane and water, discharged further to the desired surface. (CSE, 2013)	Pathogen-free water which can be used for agriculture purposes
	This technology is evolved around aerobic digestion - which involves a different multi-strain of bacteria which breaks down the waste matter through oxidization.	Digested septage
	Defecation into pits dug into ground for the reception of night soil directly without flushing are reckoned as pit latrines. (Census of India, 2011)	Faecal sludge
	This type of system may be lined or unlined. It consists of two identical pits, which are used alternatively, where pit is closed upon the filling up, where anaerobic digestion of the faecal waste takes place. (Ministry of Urban Development, 1992)	Faecal sludge

Source: Compiled by CSE, 2017

Appendix 11: Design of septic tank

BIS provides code of practice for installation of septic tanks (IS 2470 [part 1] 1985). It illustrates design criteria to construct the septic tank based on certain assumptions. It provides details to design installations for small and large areas considering the population. Comprehensive design standards on OSS are provided in the part A of manual on sewerage and sewage treatment published by Central Public Health and Environmental Engineering Organization, the research wing of MoHUA. The standard designs for prevalent and safe onsite sanitation technologies have been stated in this section. Also, to highlight septic tanks in India are generally meant for black water only.

Specifications of a septic tank

- Rectangular: length to breadth ratio: 3 to 1
- Depth: between 1.0 to 2.5m
- Two chambered: first chamber 2/3 of total length
- Three chambered: first chamber half of total length
- Manholes above each chamber
- Watertight, durable and stable tank

Recommended sizes of septic tank

No. of users	Length (m)	Breadth (m)	Liquid depth (cleaning interval of) (m)	
			One year	Two year
5	1·5	0·75	1·0	1·05
10	2·0	0·90	1·0	1·40
15	2·0	0·90	1·3	2·00
20	2·3	1·10	1·3	1·80

Note 1: The size of septic tanks is based on certain assumptions (liquid discharge), while choosing the size of septic tanks, exact calculations shall be made. For information on the same, please refer to BIS: 2470 (Part 1), 1985.

Note 2: A provision of 300 mm should be made for a free board.

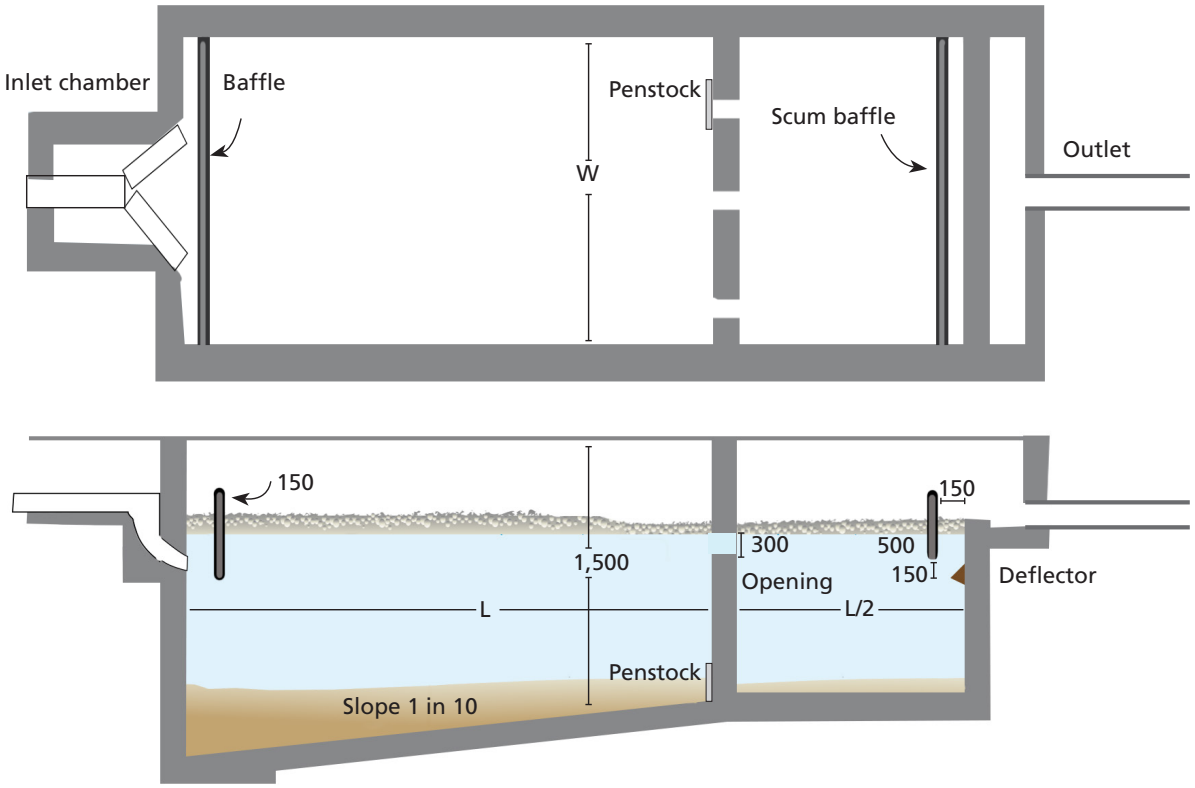
Source: Manual on Sewerage and Sewage Treatment—Part A: Engineering. CPHEEO, 2012.

Capacity of a septic tank

The capacity of the tank is useful to understand the durations for desludging, following are key points useful to measure the capacity of a septic tank:

- **Sedimentation:** An area of 0.92 m^2 is required for every 10 l/min. peak flow rate to support adequate sedimentation of suspended solids. Generally, depth of sedimentation zone is 0.3 m.
- **Sludge digestion**: Capacity of digestion zone works out to be 0.032 m^3/capita.
- **Sludge and scum storage**: For interval of 1 year of sludge cleaning, a sludge storage capacity of **0.0002*365 = 0.073 m^3/capita** is required
- **Free board:** At least 0.3m

Standard septic tank design



All measurements in millimetres (mm)
Source: Manual on Sewerage and Sewage Treatment—Part A: Engineering. CPHEEO, 2012

Appendix 12: Small-bore sewer

Conventional vs small-bore sewers

S. No.	Parameter	Conventional sewers	Solids-free sewers	Effect
1	Excavation	Deep	Shallow	+ ve for solids-free
2	Water supply	More (125–135 per capita LPD) required for self-cleansing	Less (40 per capital LPD) is sufficient	+ ve for solids-free
3	Capital cost	High	Low	+ ve for solids-free
4	Individual septic tanks	Not required	Required	+ ve for conventional
5	Operation and maintenance cost	Very high	Very low	+ ve for solids-free
6	People's perception	Preferred	Less preferred	+ ve for conventional

Source: Innovation for scaling up to citywide sanitation, CEPT, 2012

Cost of installing small-bore sewer

S. No	Sewerage scheme	Cost (in lakh Rs)				Population		Cost per capita	
		Pipe sewer	STP	Maintenance cost	Total	Present (2012)	Prospective (2027)	Total (2012)	Sewer (2012)
1	Abiana Kalan and Abiana Khurd, Ropar	123.5	73.16	19.75	216.41	2,131	2,557	9,232	5,798
2	Boje Majra, Ropar	91.8	59.28	17.30	168.38	1,166	1,399	12,959	7,872
3	Chitamali, Ropar	127.5	82.56	19.57	229.63	1,415	1,699	14,838	9,008
4	Bhajouli, Mohali	61.5	61.49	15.20	138.19	1,161	1,393	10,808	5,295
5	Singhpura, Mohali	88.0	55.85	15.14	158.99	822	986	17,497	10,703
6	Jaula Kalan, Mohali	127.0	59.80	17.59	204.39	1,852	2,223	10,083	6,854

Source: Innovation for scaling up to citywide sanitation, CEPT, 2012

Appendix 13: Comparisons of systems with respect to various parameters

System number	System name	Type of system	System Life time	Applicability of system	Land availability	Performance of the system	Energy requirement	CAPEX	OPEX
System 1	Twin-pit system	Onsite system	Twin-pit, 10 years	Household level	5 m^2 per household for pit + toilet	-	Not required	Rs 4,500 per household for pit	Rs 400 per household per year
System 2A	UDB + WSP + co-composting + chlorination	Decentralized system	Septic tank, 50 years; soakpit, three-five years, UDB or WSP, 50 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet; WSP, 6,000 m^2/MLD	BOD, 75–85 per cent; COD, 74–78 per cent; TSS, 75–80 per cent; TN, 70–90 per cent; TP, 30–45 per cent; coliform, 60– 99.9 per cent	WSP, 5.7 kWh/d/MLD	IST, Rs 75,000 per household; WSP: Rs 23,00,000/MLD; UDB: 3,00,00,000/MLD	IST, Rs 1,500 per household year; UDB, Rs 50,00,000/MLD/ year; WSP, Rs 2,00,000/MLD/ year
System 2B	AD + co-composting + chlorination	Decentralized system	Septic tank, 50 years; soakpit, three–five years, AD, 50 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet; AD, 600 m^2/MLD	BOD, 60–90 per cent; COD, 60–80 per cent; TSS, 60–85 per cent	AD, 60 kWh/d/ MLD	IST, INR 75,000/HH; AD, INR 5,00,00,000/ MLD	IST, INR 1,500/ HH/year; AD, INR 30,00,000/ MLD/year
System 2C	Centrifugation + ASP + vermicompostin g + ozonation	Decentralized system	Septic tank, 50 years; soakpit, three-five years, UDB or WSP, 50 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet; ASP, 900 m^2/MLD	BOD, 85–92 per cent; COD, 93–94 per cent; TSS, 75–80 per cent; TN, > 90 per cent; TP, > 90 per cent; coliform, 60– 90 per cent	ASP, 185.7 kWh/d/MLD; Centrifugation: 20–300 kWh per metric tonne of solid	IST, INR 75,000/HH; ASP, 68,00,000/MLD	IST, INR 1,500/ HH/year; ASP, INR 7,00,000/ MLD/year
System 2D	Centrifugation + SBR + co-composting + chlorination	Decentralized system	Septic tank, 50 years; soakpit, three-five years, SBR, 50 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet; SBR, 450 m^2/MLD	BOD, 95 per cent; COD, 90 per cent; TSS, 95 per cent; TN, 70–80 per cent	SBR, 153.7 kWh/d/ MLD; Centrifugation: 20–300 kWh per metric tonne of solid	IST, INR 75,000/HH; SBR, INR 75,00,000/ MLD	IST, INR 1,500/ HH/year; SBR, INR 6,00,000/ MLD/year
System 2E	Centrifugation + MBR + co-composting + ozonation	Decentralized system	Septic tank, 50 years; soakpit, three-five years, MBR, 50 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet; MBR, 450 m^2/MLD	BOD, 95 per cent; COD, >90per cent; TSS, >90 per cent; TN, >90 per cent; TP, >90per cent	MBR, 302.5 kWh/d/ MLD; Centrifugation: 20–300 kWh per metric tonne of solid	IST, INR 75,000/HH; MBR, INR 30,000,000 /MLD	IST, INR 1,500/ HH/year; MBR, INR 9,00,000 / MLD/year

System number	System name	Type of system	System lifetime	Applicability of system	Land availability	Performance of the system	Energy Requirement	CAPEX	OPEX
System 3A	MD + AF + CW + co-composting + chlorination	Decentralized system	Treatment plant life, 50 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet	BOD, 50–90 per cent; TSS, 50–80 per cent	AF, 34 kWh/d/MLD	BD, INR 60,000/HH	BD, INR 1,400/HH/year
System 3B	MD + WSP + co-composting + chlorination	Decentralized system	Treatment plant life, 50 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet	BOD, 75–85 per cent; COD, 74–78 per cent; TSS, 75–80 per cent; TN, 70–90 per cent; TP, 30–45 per cent; coliform, 60– 99.9 per cent	WSP, 5.7 kWh/d/MLD	IST, INR 75,000/HH; WSP, INR 23,00,000/MLD	IST, INR 1,500/HH/year; WSP, INR 2,00,000/MLD/year
System 4	ASP + reed bed + sludge drying bed + co-composting	Networked system	Sewer and treatment plant life, 50 year	Ward-, city-, or cluster-level	ASP, 900 m^2/MLD	BOD, 90–95 per cent ; COD, 85–90 per cent; TSS, >90 per cent; TN, >60 per cent; coliform, 90– 99.9 per cent	ASP: 185.7 kWh/d/MLD	ASP, INR 68,00,000/MLD	ASP, INR 7,00,000/MLD/year
System 5	IT + CW + sludge drying bed + co-composting + chlorination	Decentralized system	Septic tanks, 50 years; Individual toilet, 50 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet; IT, 900 m^2/MLD	BOD, 30–50 per cent; TSS, 50–70 per cent.	IT, 45 kWh/d/MLD	IST, INR 75,000/HH; IT, INR 5,00,00,000/MLD	IST, INR 1,500/HH/year; IT, INR 30,00,000/MLD/year
System 6A	ABR+ sludge drying bed + co-composting	Networked system	Treatment plant life, 50 years	Ward-, city-, or cluster-level	ABR, 1,000 m^2/MLD	BOD, 70–95 per cent; TSS, 80–90 per cent; coliform, 20– 30 per cent	ABR, 34 kWh/d/MLD	ABR, INR 5,00,00,000 INR/MLD	ABR, INR 30,00,000/MLD/year
System 6B	AF+ sludge drying bed + co-composting	Networked system	Treatment plant life, 50 years	Ward-, city-, or cluster-level	-	BOD, 50–90 per cent; TSS, 50–80 per cent	AF, 34 kWh/d/MLD	AF, US$350 to US$500 per cu.m for a treatment capacity of 10 cu.m, if the AF is used in combination with other treatment modules (e.g., in DEWATS) [39	-

System number	System name	Type of System	System Lifetime	Applicability of system	Land availability	Performance of the System	Energy Requirement	CAPEX	OPEX
System 7	Belt filter press + CW + lime stabilization + chlorination	Decentralized system	Septic tank, 50 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet	-	22 kWh/d/MLD	-	-
System 8	UASB + sludge drying bed + co-composting	Networked system	> 50 years	Ward-, city-, or cluster-level	UASB, 1,000 m^2/ MLD	BOD, 75–85 per cent; COD, 60–80 per cent; TSS, 75–80 per cent; TN, 10–20 per cent.	UASB, 34 kWh/d/MLD	UASB, INR 68,00,000 /MLD;	UASB, INR 6,00,000/MLD/ year
System 9	MD + WSP + solar drying + chlorination	Decentralized system	Septic tank, 50 years; WSP, 50 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet; WSP, 6,000 m^2/ MLD	BOD, 75–85 per cent; COD, 74–78 per cent; TSS, 75–80 per cent; TN, 70–90 per cent; TP, 30–45 per cent; coliform, 60– 99.9 per cent	WSP, 5.7 kWh/d/MLD	IST, INR 75,000/ HH; WSP, INR 23,00,000MLD	IST, INR 1,500/ HH/year; WSP, INR 2,00,000/ MLD/year
System 10	PDB + CW + shallow trenches + chlorination	Decentralized system	Septic tank, 50 years; trenching site, five–10 years	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet	-	-	IST, INR 75,000/HH	IST, INR 1,500/ HH/year
System 11	Geo-bags + WSP+ chlorination	Decentralized system	Septic tank, 50 years; geo-bag, six–12 months	Ward-, city-, or cluster-level	7 m^2 per household for storage + toilet; WSP: 6,000 m^2/ MLD	BOD, 75–85 per cent; COD, 74–78 per cent; TSS, 75–80 per cent; TN, 70–90 per cent; TP, 30–45 per cent; coliform, 60– 99.9 per cent	WSP, 5.7 kWh/d/MLD	IST, INR 75,000/HH; WSP, INR 23,00,000/ MLD	IST, INR 1,500/ HH/year; WSP, INR 2,00,000/ MLD/year
System 12	ABR + CW + sludge drying bed + co-composting + chlorination	Decentralized system	> 50 years	Ward-, city-, or cluster-level	ABR, 1,000 m^2/ MLD	BOD, 70–95 per cent; TSS, 80–90 per cent ; coliform, 20– 30%	ABR, 34 kWh/d/MLD	IST, INR 75,000/HH; ABR, INR 5,00,00,000 /MLD;	IST, INR 1,500/ HH/year; ABR, INR 30,00,000/ MLD/year

ABR = Anaerobic baffled reactor, AD = Anaerobic digester, AF = Anaerobic filter, ASP = Activated sludge process, BD = Biogas digester, BOD = Biological oxygen demand, COD = Chemical oxygen demand, CW = Constructed wetland, HH = Household, INR = Indian rupee, IST = Improved septic tank, IT = Imhoff tank, kWh = Kilowatt hour, MBR = Membrane bio-reactor, MD = Mechanical dewatering, MLD = Million litres per day, PDB = Planted drying bed, SBR = Sequence batch reactor, ST = Septic tank, TN = Total nitrogen, TP = Total Phosphorous, TSS = Total suspended solid, UASB = Upflow Anaerobic sludge blanket, UDB = Unplanted drying bed, WSP = Waste stabilization pond

Source: Technology options for the sanitation value chain, CStep, 2016

Appendix 14: Standards for composting

Parameters (1)	Organic Compost (FCO 2009) (2)	Phosphate Rich Organic Manure (FCO 2013) (3)
Arsenic (mg/kg)	10	10
Cadmium (mg/Kg)	5	5
Chromium (mg/Kg)	50	50
Copper (mg/Kg)	300	300
Lead (mg/Kg)	100	100
Mercury (mg/Kg)	0.15	0.15
Nickel (mg/Kg)	50	50
Zinc (mg/Kg)	1000	1000
C/N ratio	<20	Less than 20:1
pH	6.5-7.5	(1:5 solution) maximum 6.7
Moisture, percent by weight, maxiumum	15-25	25
Bulk density (g/cu. M)	<1	Less than 1.6
Total Organic Carbon, per cent by weight,minimum	12	7.9
Total Nitrogen (as N),per cent by weight, minimum	0.8	0.4
Total Phosphate (as P2O5), percent by weight, minimum	0.4	10.4
Total Potassium (as K2O), percent by weight, maximum	0.4	-
Colour	Dark brown to black	-
Odour	Absence of foul odor	-
Particle size	minimum 90% material should pass through 4.0 mm IS sieve	minimum 90% material should pass through 4.0 mm IS sieve
Conductivity (as dsm-1), not more than	4	8.2

Note: Compost (final product) exceeding the above stated concentration limits shall not be used for food crops. However, it may be utilized for purposes other than growing food crops.
Source: Solid Waste Management Rules, 2016

Appendix 15: General standards for discharge of environmental pollutants

Parameter	Standards
Odour and colour	All efforts should be made to remove colour and unpleasant odour as far as practicable
Suspended solids mg/l, Max.	200
pH value	5.5 to 9.0
Oil and grease (mg/l, max.)	10
Biochemical oxygen demand [3 days at 27 °C] mg/l max.	100
Arsenic (as As), mg/l, max.	0.2
Cyanide (as CN) mg/l Max.	0.2
(a) Alpha emitter micro curie/ml.	10^{-8}
(b) Beta emitter micro curie/ml.	10^{-7}
Bio-assay test	90% survival of fish after 96 hours in 100% effluent

Source: General standards for discharge of environmental pollutants Part A: Effluents, 1993